RSF Elektronik

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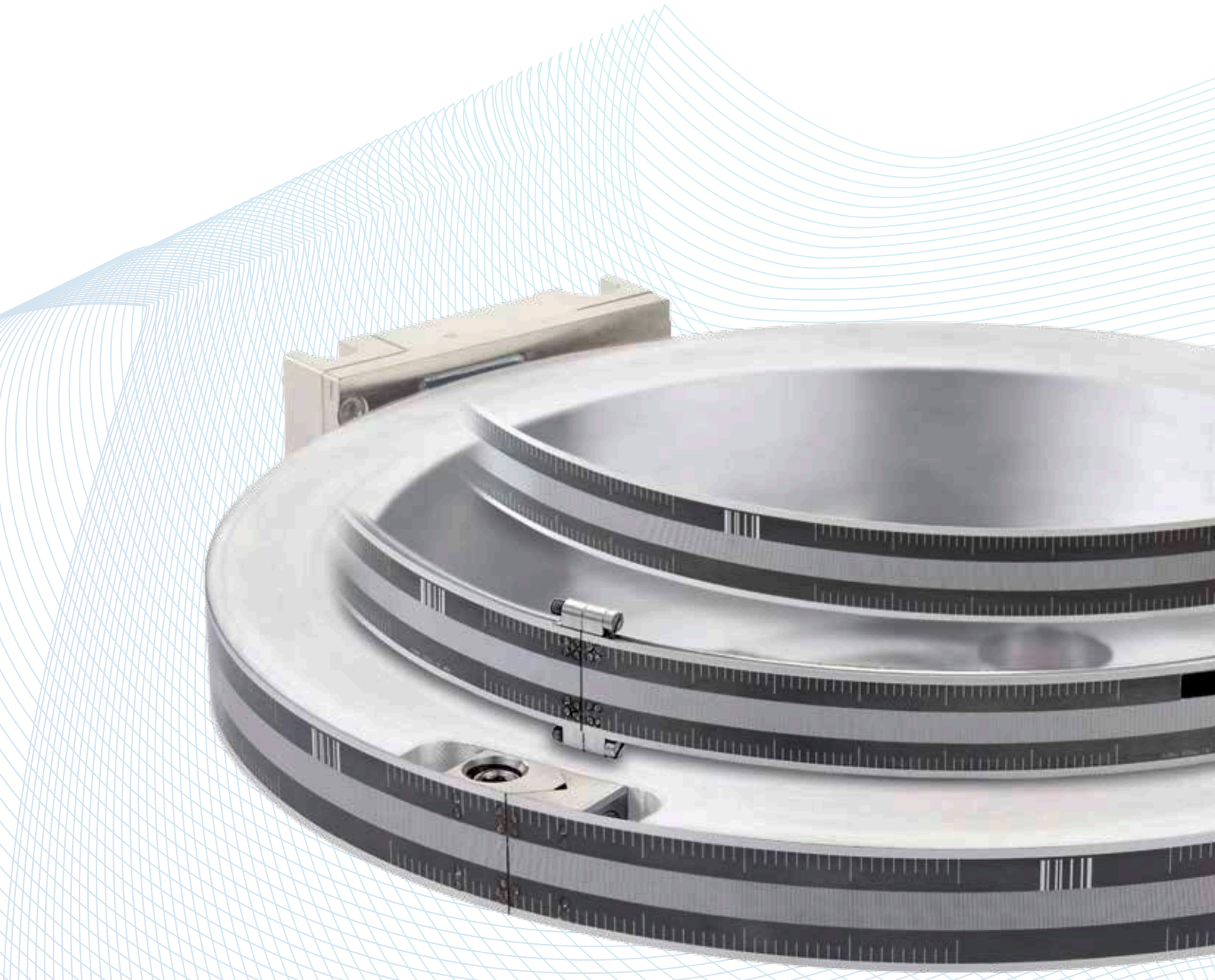
MSR 45

MODULAR ANGLE MEASUREMENT DEVICE WITH SINGLEFIELD SCANNING



CONTENT

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 (sometimes 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.

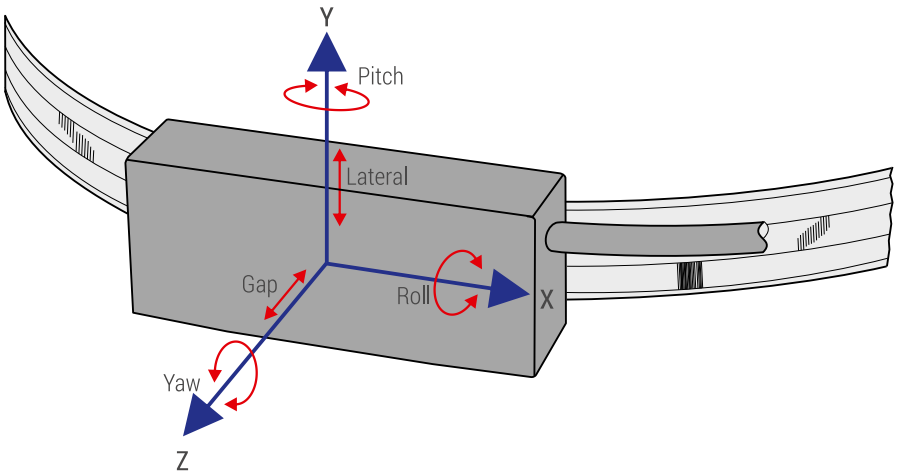
Reference pulse (reference mark)
There is an additional track of marks printed next to the grating to allow an user to find an absolute position along the length of the scale. An one increment wide signal is generated when the encoder head passes the reference mark on the scale. This is called a "true" 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 ($\overline{US}$)
This signal appears when a malfunctioning encoder generates faulty scanning signals.

Line rates
Number of the grating pitches per rotation.

Online signal stabilization
During moving the amplitude, offset-error, amplitude differences and phase shift error are measured and stabilized cyclic.

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



REQUIREMENTS ON A MODULAR ANGLE MEASUREMENT DEVICE

- CONTAMINATION RESISTANCE
- IMMUNITY AGAINST AGING AND TEMPERATURE CHANGES
- HIGH TRAVERSING SPEED
- EASY MOUNTING - LARGE MOUNTING TOLERANCES
- SMALL DIMENSIONS
- NO MECHANICAL BACKLASH
- ZERO FRICTIONAL FORCE
- REFERENCE MARKS, REPEATABLE FROM BOTH TRAVERSING DIRECTIONS
- RESOLUTION: 10 µm – 0,5 µm

MODULAR ANGLE MEASUREMENT DEVICES FROM RSF ELEKTRONIK MEET ALL THESE REQUIREMENTS!

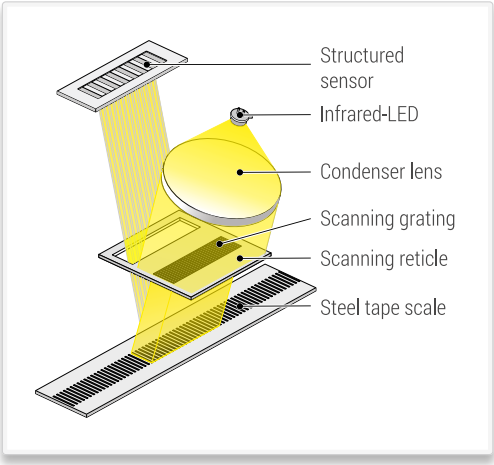
SCANNING PRINCIPLE

The modular angle measurement device MSR 45 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 quality sinusoidal signals which are highly insensitive to possible contaminations.

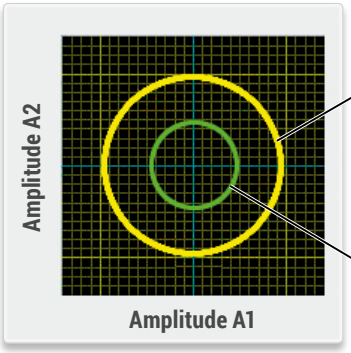
The regulation of the LED ensures a constant signal amplitude, guaranteeing stability in the case of temperature fluctuations as well as with long-run operation.



ACCURACY

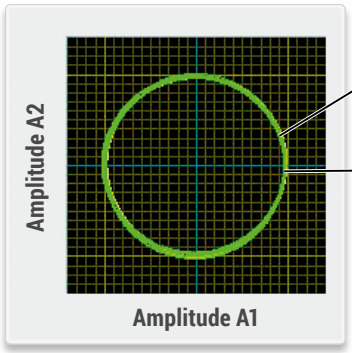
Effect of contamination on the quality and amplitude of scanning signals

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



1 Scanning signals without signal stabilization - steel tape scale clean

2 Scanning signals without signal stabilization - steel tape scale contaminated

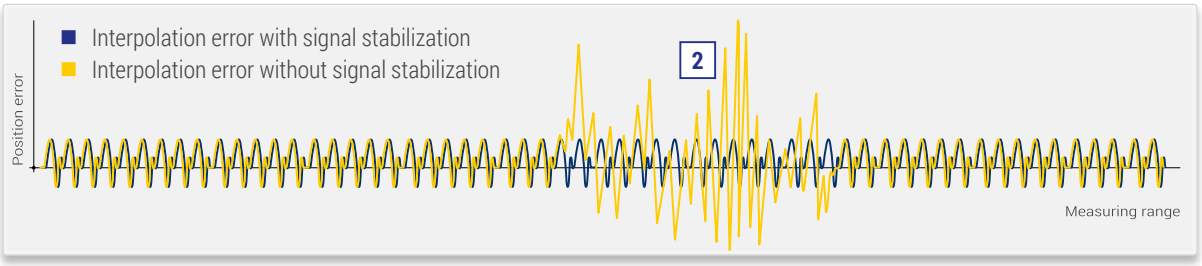


1 Scanning signals with signal stabilization - steel tape scale

2 clean and contaminated

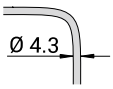
Effect of contamination on the intepolation error

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



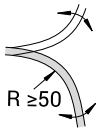
SHIELDING, PIN ASSIGNMENT

Shielded PUR-cable

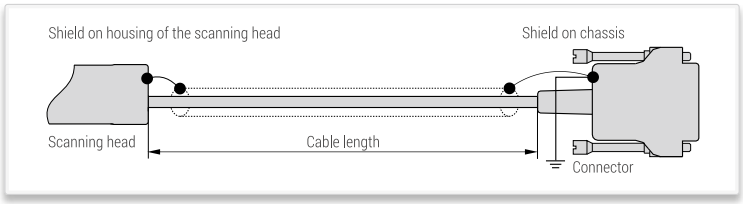


Bending radius fixed mounting

Bending radius continuous flexing



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

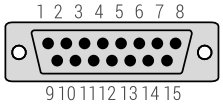


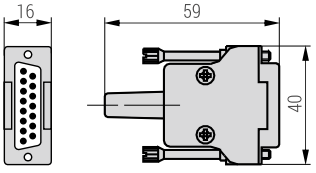
15-pin D-sub

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	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 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.
- Pins or wires marked "occupied" or "nc" must not be used by the customer.

Pin assignment (view on pins)





OUTPUT SIGNALS

SINUSOIDAL VOLTAGE SIGNALS 1 Vpp

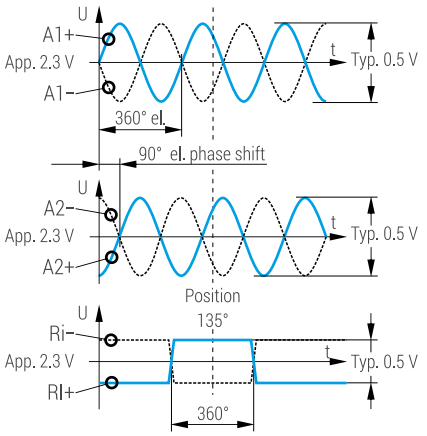
(drawing shows "positive counting direction")

Power supply: +5 V ±10 %, max. 130 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 impendance Zo = 120 Ω between A1+ to A1− resp. A2+ to A2−)

Reference pulse
(differential voltage RI+ to RI−):
Useable component 0.2 up to 0.85 V; typical 0.5 V
(with terminating impedance Zo = 120 Ω between RI+ to RI−)

Advantages:
- 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°. Output signals either can be „single ended" or line driver „differential" (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 amin 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)

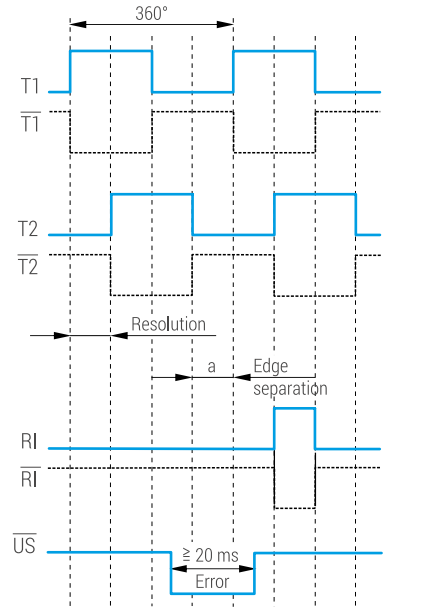
To prevent counting errors, the controls/DRO's must be able to process the resulting edge separation.

Example:
a_{min} = 200 ns, 10 m cable
200 ns - 10 ns - 10 x 0,2 ns - 10 ns = 178 ns.

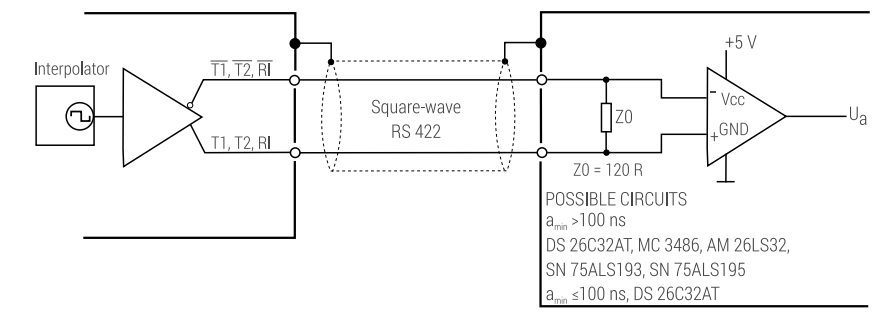
Power supply: +5 V ±10 %, max. 140 mA (unloaded)

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

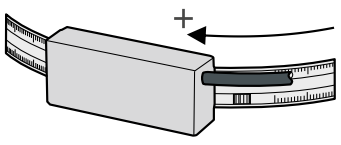
Square-wave signals „differential"



Recommended line receiver circuit

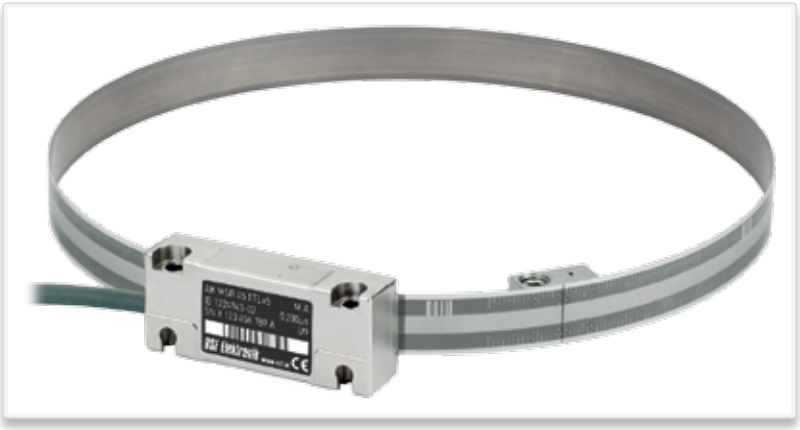


Rotation direction



MSR 45 MOR

- Full-circle version with clamping element
- Steel tape scale
- Grating pitch: 200 µm
- Easy mounting due to large mounting tolerances
- High rotational speed
- Integrated subdividing electronics: up to times 100



SCANNING HEAD: 200 µm grating pitch

Model			MSR 45 1Vpp	MSR 45 TTLx5	MSR 45 TTLx10	MSR 45 TTLx50	MSR 45 TTLx100
System resolution [°]			Dep. on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			Dep. on external interpolation	10	5	1	0.5
Signal form			~ 1 Vpp	⎍	⎍	⎍	⎍
Integrated interpolation			--	Times 5	Times 10	Times 50	Times 100
Max. output frequency			90 KHz	--	--	--	--
Edge separation a_{min}			--	500 ns	500 ns	200 ns	200 ns
Lines	Shaft diameter [mm]	System accuracy *	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]
2 400	152.70	± 80"	200	200	200	200	200
2 500	159.07	± 80"	200	200	200	200	200
3 600	229.15	± 60"	200	200	200	200	200
5 000	318.34	± 40"	200	200	200	200	144
7 200	458.50	± 30"	200	200	200	200	100
10 000	636.88	± 20"	150	150	150	144	72
10 800	687.85	± 20"	139	139	139	133	67
14 400	917.19	± 15"	104	104	104	100	50
18 000	1 146.54	± 15"	83	83	83	80	40

* Without mounting, additional deviations due to mounting and bearing of the measured shaft, are not respected.
Further line rates or higher rotational speed on request.

GRADUATION CARRIER

Scale unit: MOR = Steel tape scale with clamping element.

Reference mark (RI): 25 mm from scale-joint (see drawing), additional reference marks separated by n x 100 mm.

Accuracy of the grating pitch (stretched): ±30 µm/m.

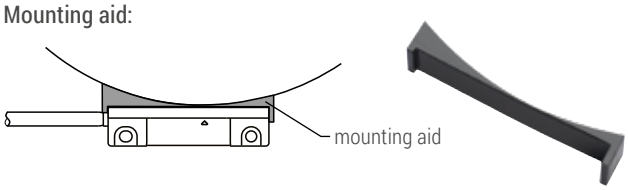
Operating temperature range: 0 °C up to +60 °C
(Coefficient of expansion of the shaft between 9 x 10^{-6} K^{-1} and 12 x 10^{-6} K^{-1}).

Temperature range of storage: –20 °C up to +70 °C.

RoHS-conformity: The MSR 45 rotary 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.

OPTIONAL ACCESSORIES

Mounting aid:

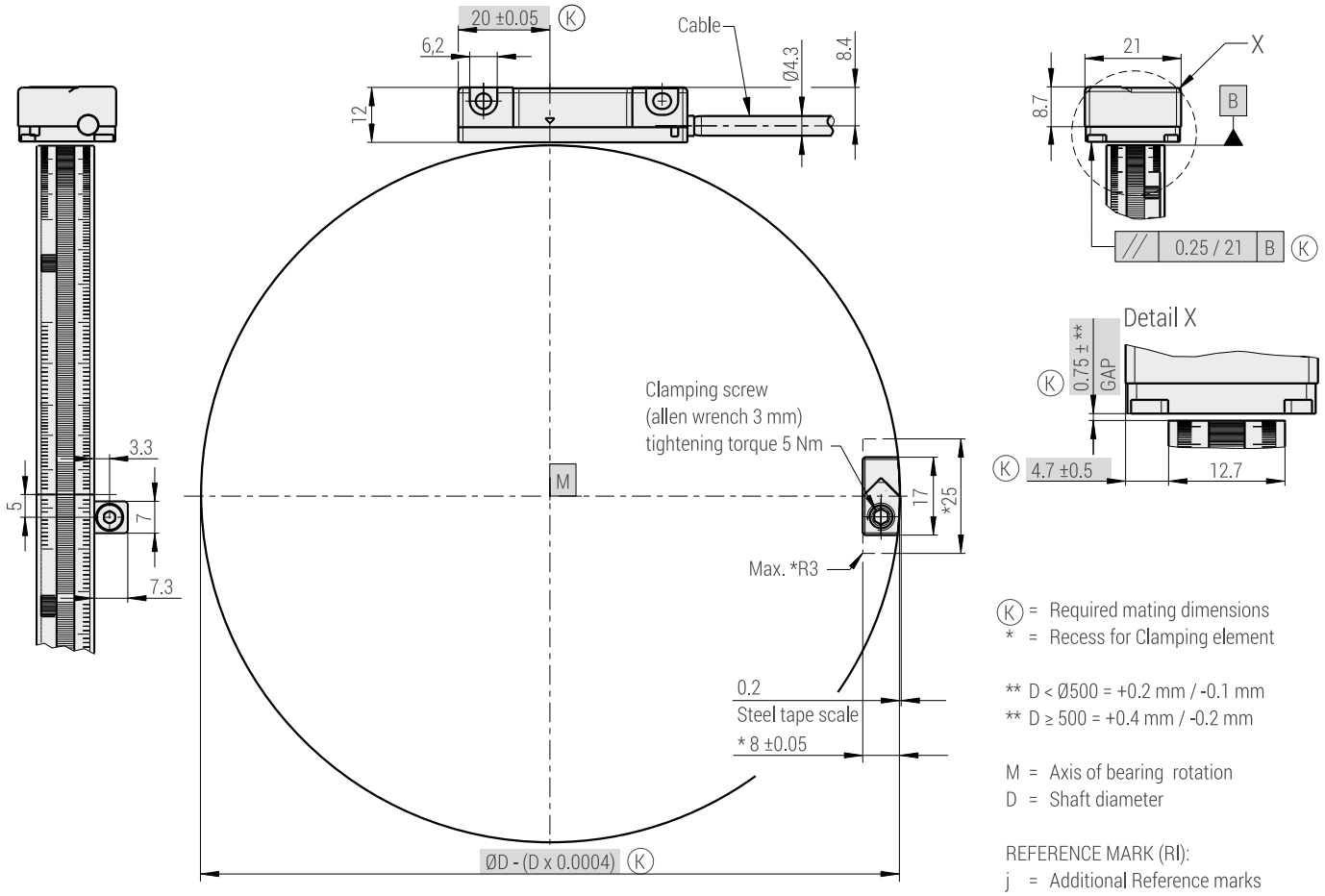


Installation kit:

External testing device PWT 100:

- Function control counting signals and reference impulse.

DIMENSIONS, MOUNTING TOLERANCES



Ⓚ = Required mating dimensions
* = Recess for Clamping element

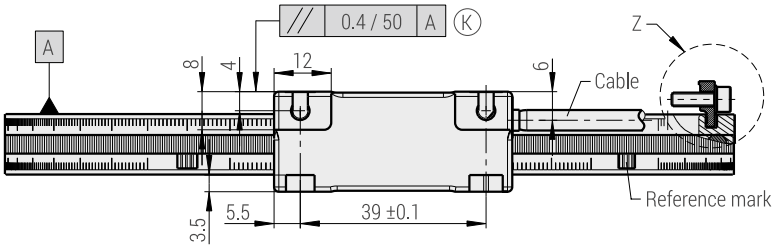
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 = +0.4 mm / -0.2 mm

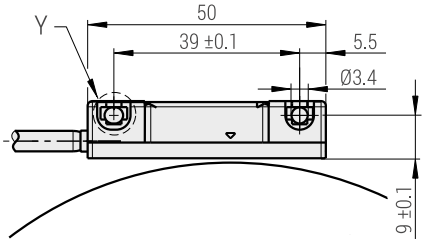
M = Axis of bearing rotation
D = Shaft diameter

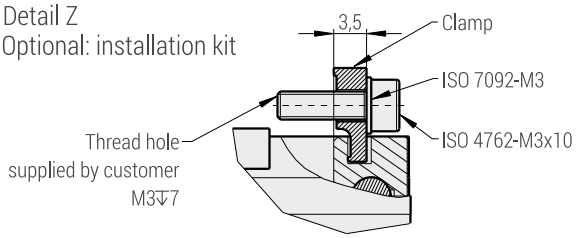
REFERENCE MARK (RI):
j = Additional Reference marks separated by n x 100 mm

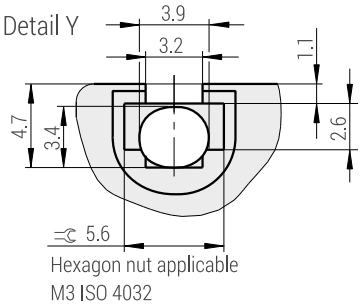
Weight (approx.):
- 20 g/m steel tape scale
- 12 g clamping element

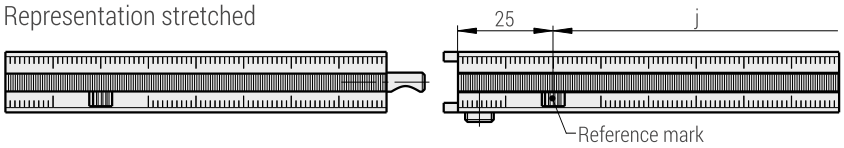
+ 17 g (scanning head without cable)





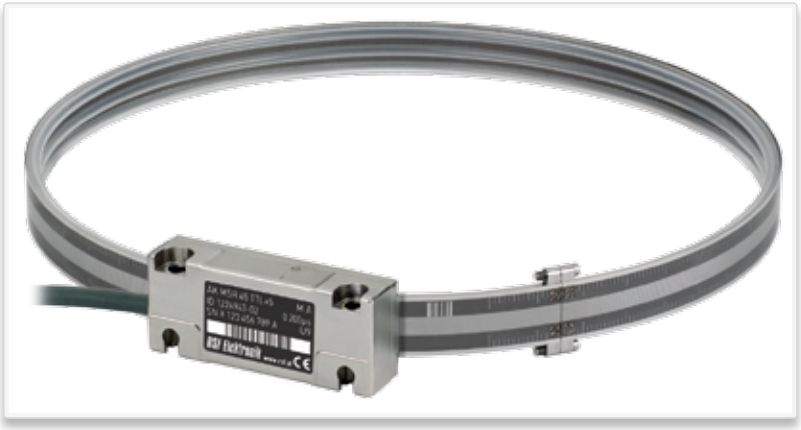






MSR 45 MER

- Full-circle version with clamping element
- Steel tape scale with elastic layer compensates Ø-change of the shaft (ΔDmax. ±0.2 mm)
- Grating pitch: 200 µm
- Easy mounting due to large mounting tolerances
- Hight rotational speed
- Integrated subdividing electronics: up to times 100



SCANNING HEAD: 200 µm grating pitch

Model			MSR 45 1Vpp	MSR 45 TTLx5	MSR 45 TTLx10	MSR 45 TTLx50	MSR 45 TTLx100
System resolution [°]			Dep. on external interpolation	360° / Lines x 20	360° / Lines x 40	360° / Lines x 200	360° / Lines x 400
System resolution [µm]			Dep. on external interpolation	10	5	1	0.5
Signal form			~ 1 Vpp	⎍	⎍	⎍	⎍
Integrated interpolation			--	Times 5	Times 10	Times 50	Times 100
Max. output frequency			90 KHz	--	--	--	--
Edge separation a_{min}			--	500 ns	500 ns	200 ns	200 ns
Lines	shaft diameter [mm]	System accuracy *	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]	Max. rotational speed [min^{-1}]
2 400	146.99	± 400"	200	200	200	200	200
2 500	153.35	± 350"	200	200	200	200	200
3 600	223.38	± 250"	200	200	200	200	200
5 000	312.51	± 200"	200	200	200	200	144
7 200	452.57	± 150"	200	200	200	200	100
10 000	630.82	± 100"	150	150	150	144	72
10 800	681.75	± 100"	139	139	139	133	67
14 400	910.93	± 75"	104	104	104	100	50
18 000	1 140.12	± 50"	83	83	83	80	40
20 000	1 267.44	± 50"	75	75	75	72	36

* Without mounting, additional deviations due to mounting and bearing of the measured shaft, are not respected.
Further line rates or higher rotational speed on request.

GRADUATION CARRIER

Scale unit: MER = Steel tape scale with elastic layer and clamping element.

Reference mark (RI): 25 mm from scale-joint (see drawing), additional reference marks separated by n x 100 mm.

Accuracy of the grating pitch (stretched): ±30 µm/m.

Operating temperature range scanning unit: 0 °C up to +60 °C .

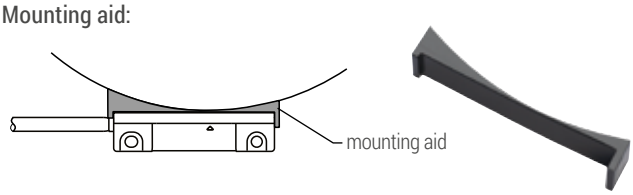
Operating temperature: Range of temperature is dependent on the coefficient of the expansion of the shaft.
Max. Ø difference of the shaft to steel tape scale: ΔD ±0.2 mm
(steel tape scale α= 10.5 x 10^{-6} K^{-1}).

Temperature range of storage: –20 °C up to +70 °C.

RoHS-conformity: The MSR 45 rotary 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.

OPTIONAL ACCESSORIES

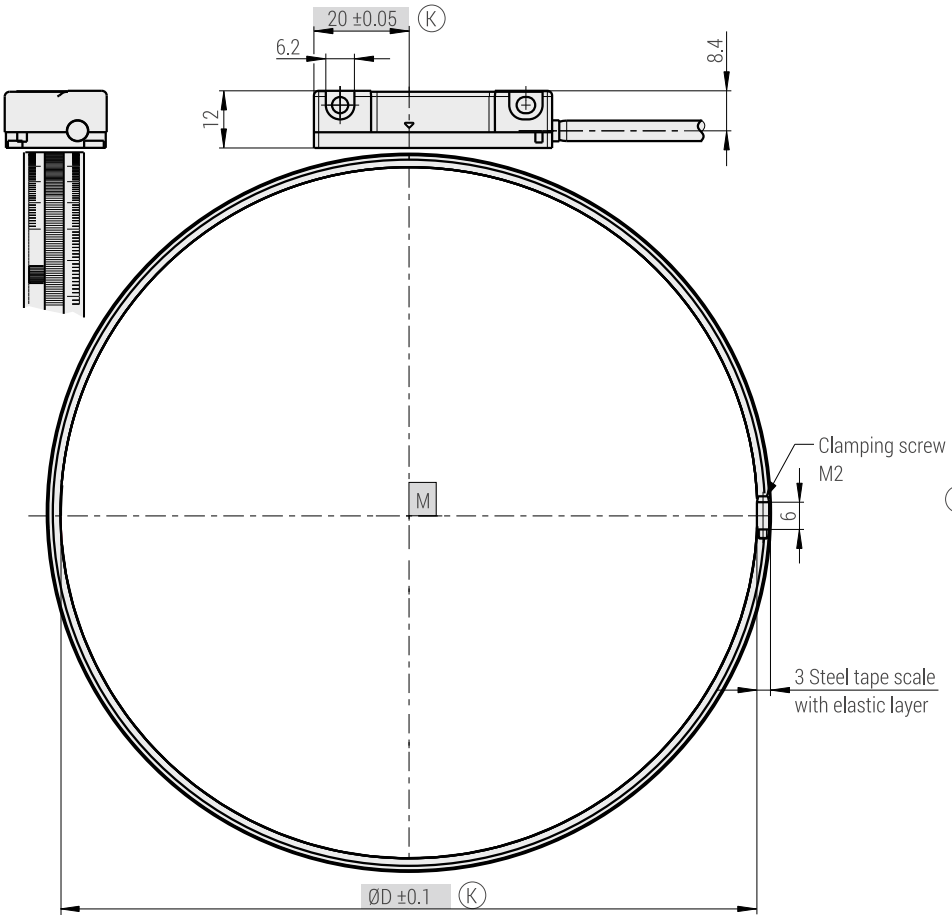
Mounting aid:

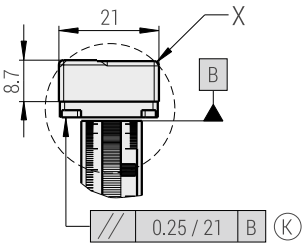


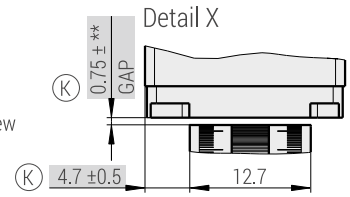
External testing device PWT 100:

- Function control counting signals and reference impulse.

DIMENSIONS, MOUNTING TOLERANCES







Ⓚ = Required mating dimensions

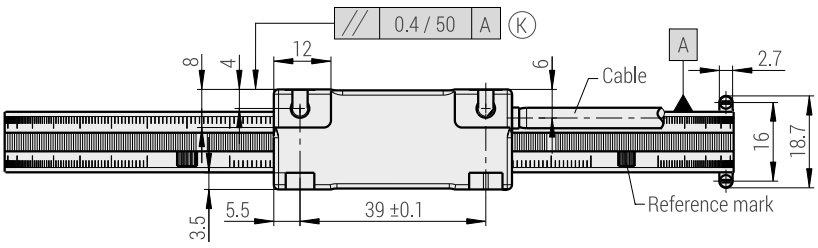
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 = +0.4 mm / -0.2 mm

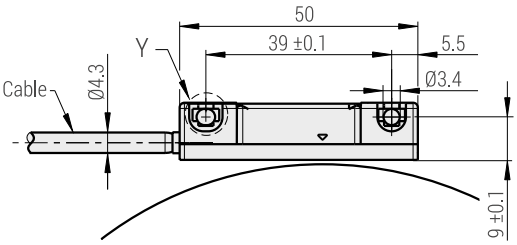
M = Axis of bearing rotation
D = Shaft diameter

REFERENCE MARK (RI):
j = Additional Reference marks
separated by n x 100 mm

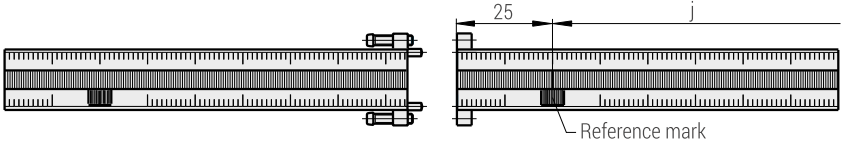
Weight (approx.):
- 45 g/m steel tape scale with elastic layer
- 2,5 g clamping element

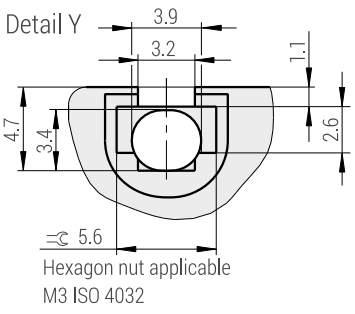
+ 17 g (scanning head without cable)





Representation stretched





MSR 45 MKS

- Segment version
- Steel tape scale with adhesive tape
- Grating pitch: 200 µm
- Easy mounting due to large mounting tolerances
- High circumferential speed
- Integrated subdividing electronics: up to times 100

SCANNING HEAD: 200 µm grating pitch

Model	Output signals	Integrated interpolation	Max. circumferential speed [m/s]	Max. output frequency [kHz]
MSR 45 1 Vpp	~ 1 Vpp	--	15.0	75
				Edge separation a_{min}
MSR 45 TTLx5	⎍	Times 5	15.0	500 ns
MSR 45 TTLx10	⎍	Times 10	9.6	500 ns
MSR 45 TTLx50	⎍	Times 50	4.8	200 ns
MSR 45 TTLx100	⎍	Times 100	2.4	200 ns

GRADUATION CARRIER

Scale unit:
MKS = Steel tape scale with adhesive tape.

Possible shaft diameter:
- Ø ≥150 mm to Ø 400 mm, scale-segment pre-bent in factory,
- Over Ø 400 mm, scale-segment is not pre-bent.

Reference mark (RI):
- Any position of reference mark (see drawing),
- Additional reference marks separated by n x 100 mm.

Accuracy of the grating pitch (stretched): ±30 µm/m.

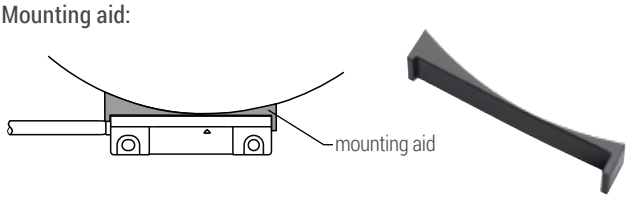
Operating temperature range: 0 °C up to +60 °C.

Temperature of storage range: –20 °C up to +70 °C.

RoHS-conformity:
The MSR 45 rotary 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.

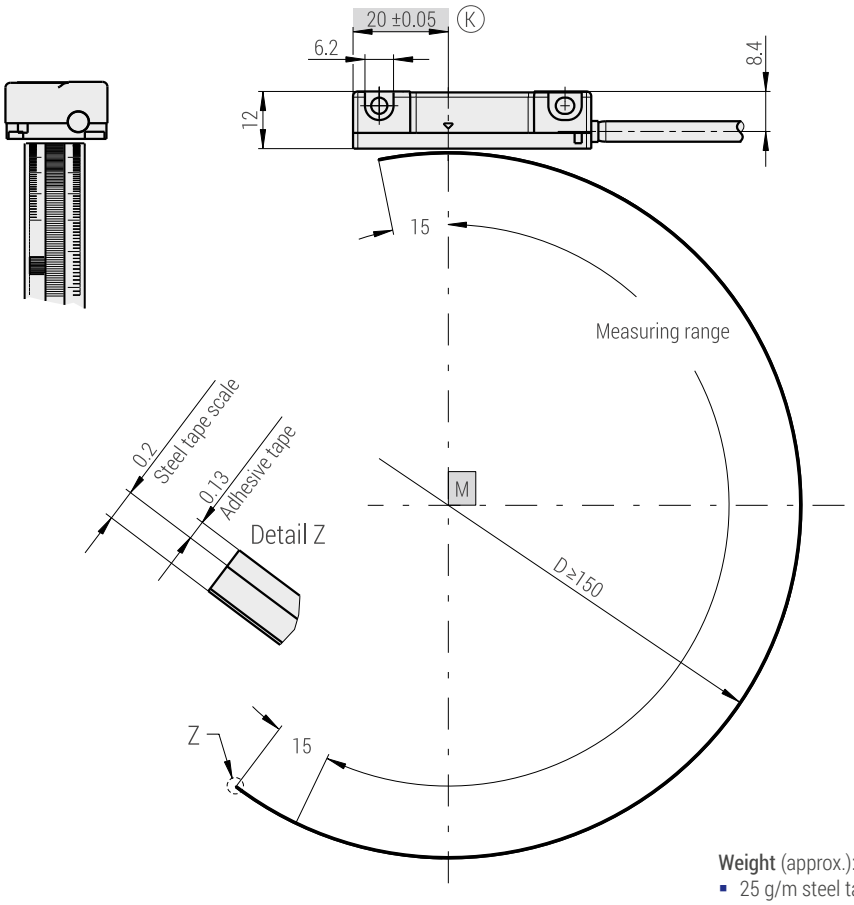
OPTIONAL ACCESSORIES

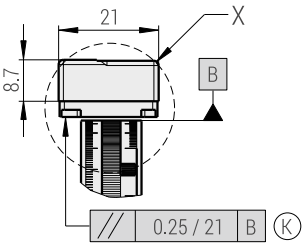
Mounting aid:

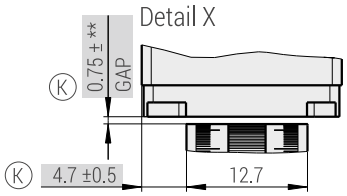


External testing device PWT 100:
- Function control counting signals and reference impulse.

DIMENSIONS, MOUNTING TOLERANCES







Ⓚ = Required mating dimensions

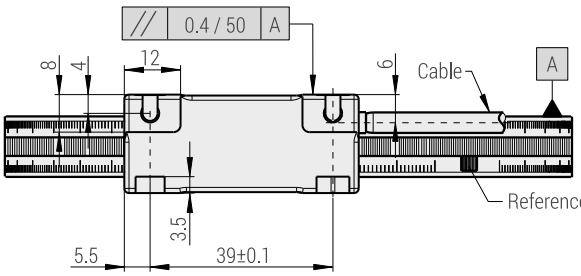
** D < Ø500 = +0.2 mm / -0.1 mm
** D ≥ 500 + 0.4 mm / -0.2 mm

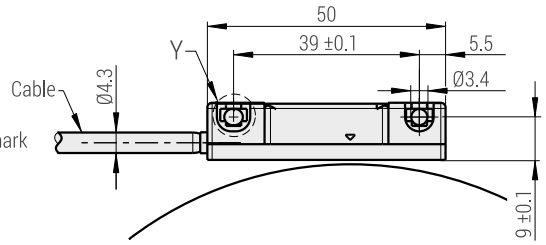
M = Axis of bearing rotation
D = Shaft diameter

Weight (approx.):
- 25 g/m steel tape scale

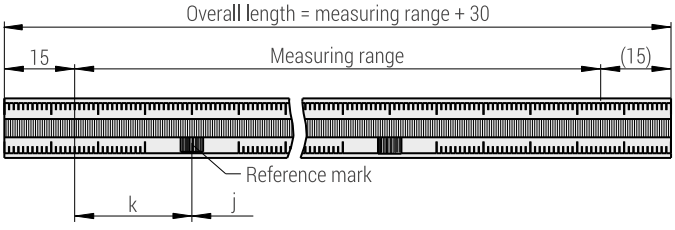
+ 17 g (scanning head without cable)

REFERENCE MARK (RI):
k = Any position of Reference mark from the beginning of measuring length
j = Additional Reference marks separated by n x 100 mm

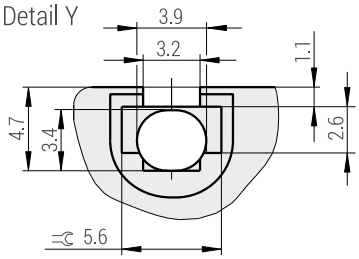




Representation stretched



Detail Y



Hexagon nut applicable
M3 ISO 4032

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

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