Product Information

CIRCOGRAPH®
Sensor Systems

Ro 20 / Ro 35 / Ro 65 / Ro 130
6.452 / 6.453 / 6.460 / 6.461

proof.

Index

Application

The sensor systems Ro 20 / Ro 35 / Ro 65 / Ro 130 operate on the basis of eddy current principle in accordance with ISO 15548. They permit a highly sensitive, no-contact testing with electronic clearance compensation of ferromagnetic, austenitic and non-ferromagnetic round material (wire, bar, tube) for mainly longitudinally oriented defects in combination with testing and evaluation electronics CIRCOGRAPH DS and a suitable transport mechanics. They provide a defect detectability upwards from approx. 30 µm depth* for longitudinally oriented surface defects and a high testing speed up to 6 m/s with 100% coverage of surface.

The test material has to pass the sensor system centrically and with low vibration. This can be achieved by direct integration into the production facility or testing line. In both cases FOERSTER offers support and is able to provide comprehensive guidelines.

The sensor systems Ro 20 / Ro 35 / Ro 65 / Ro 130 cover a material diameter range from approx. 2 to 130 mm. Test material temperatures up to +80 °C are permitted. The surface conditions should be free of scale and protruding burr, preferrably with a bright surface and a straightness of less than 2 mm/m.

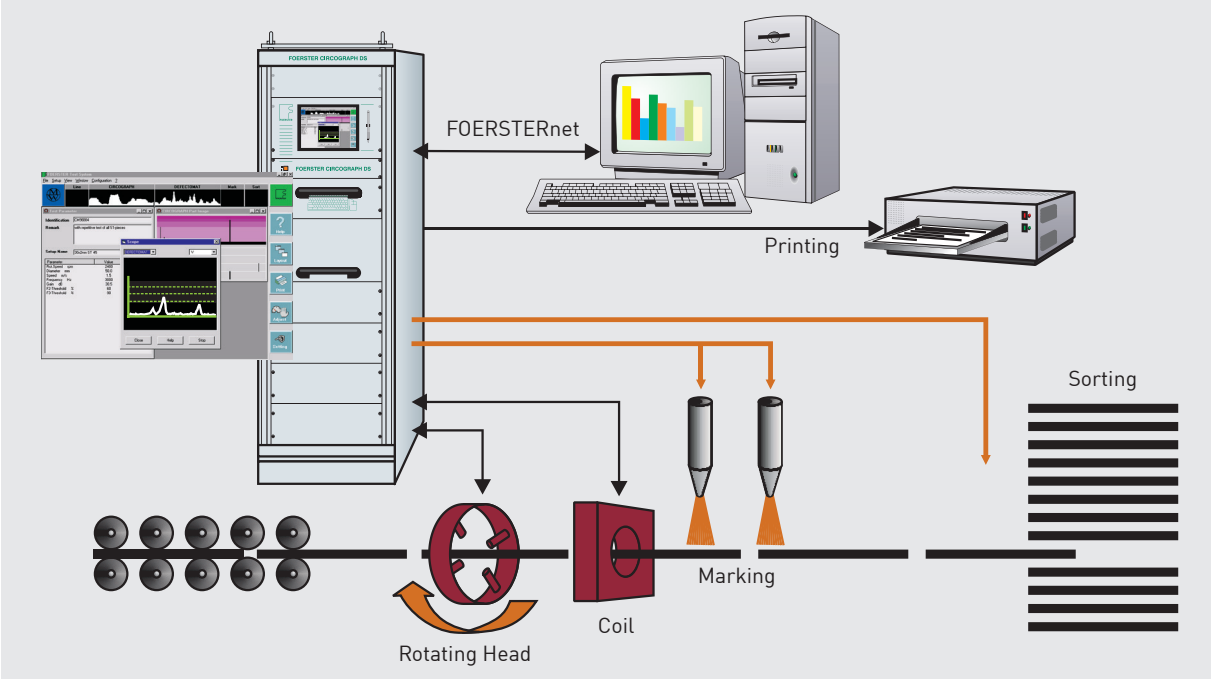


Fig. 1: Application CIRCOGRAPH with DEFECTOMAT channel for piece testing

** for further information please see chapter Flaw Detection Limit*

Operating Principle

The rotating probes rotate at a small distance at a high speed around the longitudinally moving test part and scan its surface without contact and in a helical manner. The rotating probes are point-shaped and at all times capture only a small area of the entire surface. Each material defect that the probe scans is a major disturbance in comparison to the relatively small area of material detected. Therefore, the rotating probe detects very small material defects with high resolution (Figure 2). Moreover, long-stretched material defects provide a signal at each overrun of the rotary probe so that the error is displayed in its full length. (Figure 3).

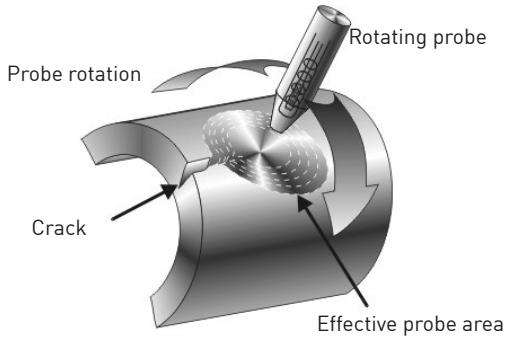


Fig. 2: Rotating probe at material defect

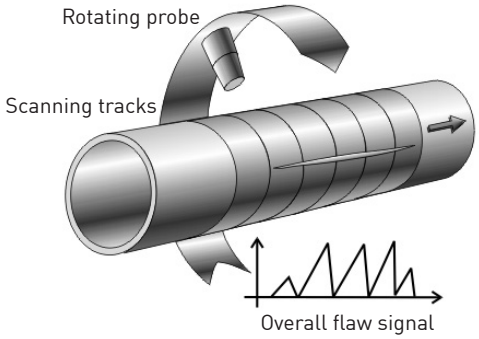


Fig. 3: Scanning tracks and defect signal

With the correct test speed, the scanning tracks of the probe lay gaplessly next to each other so that the material surface is completely scanned. The maximum test speed is given by the rotational speed, number of probes and the track width of the probe.

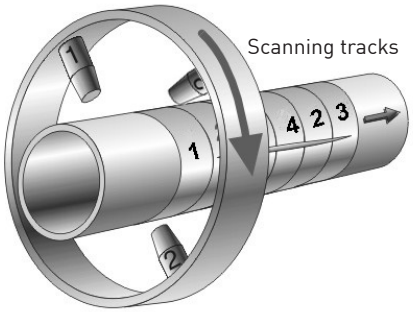


Abb. 4: Scanning tracks with four probes (90° offset)

With two probes offset by 180° and / or four offset by 90°, the scanning tracks lie without gaps or overlap when the test part is advanced by two or four track width per rotation. The signals received by the probes are transferred to the test electronics for evaluation by the sensor system. The field current for the supply of the probes and the probe output signals are transferred without contact by rotary transformers.

Mechanical Construction

In general a complete CIRCOGRAPH test system consists of:

- Testing and evaluation electronics
- Motor control
- Sensor system
- Cables and accessories

Testing and evaluation electronics

Fig. 5: CIRCOGRAPH DS

Motor control

An external motor control is required for powering the drive. The motor control does not only supply the required voltages and currents but also contains the required switching and safety facilities (motor protection switches, EMERGENCY-STOP, protection against self-starting after power failure and a fast braking device).

The following types are available:

MOC E: Basic version for all rotating heads with fixed rotating speed (9000 rpm at Ro 20, 4500 rpm at Ro 35), the deceleration time for the switched-off rotating head may be reduced for Ro 20 und Ro 35 using the manual brake system.
Dimensions W=250 mm, H=375 mm, D=150 mm.

MOC EV: For an increased rotating speed up to 18000 rpm at Ro 20 continuously adjustable.
Dimensions W=600 mm, H=1200 mm, D=300 mm.

MOC S: For an increased fixed rotating speed of 9000 rpm at Ro 35, switchable to half rotating speed. Dimensions W=600 mm, H=1200 mm, D=300 mm.

MOC SB: Motor control for Ro 65 and Ro 130 with electrical motor brake, switchable to half rotating speed. Dimensions W=600 mm, H=1200 mm, D=300 mm.

MOC SB-S: Motor control for Ro 65 and Ro 130 with electrical motor brake, switchable to half rotating speed, with speed monitoring. Dimensions W=600 mm, H=1200 mm, D=300 mm.

Fig. 6: Motor control MOC S

Sensor system

Four different sizes of sensor systems are used in the material diameter range 2 to 130 mm.

Sensor system Ro 20 /F:	Material diameter range 2 to 20 mm
Sensor system Ro 35 L/P:	Material diameter range 2 bis 35 mm
Sensor system Ro 65:	Material diameter range 5 bis 65 mm
Sensor system Ro 130:	Material diameter range 10 bis 130 mm

The operator front needs to be selected as right or left in the order.

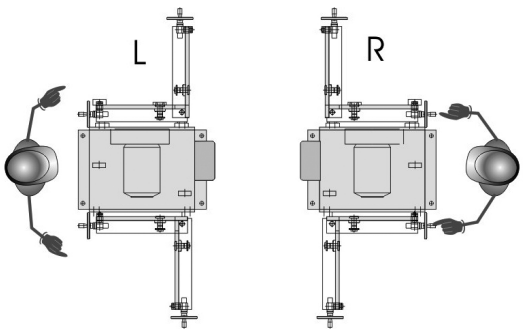


Fig. 7: Selection of the operator front

The sensor system consists of the following main components:

Test head
Test heads consist of an eddy current probe with field, measuring and clearance windings which are installed in a precise mechanical holder. Two types exist:

1. **In pin design at Ro 20 and Ro 35 P** the test heads are full cast.

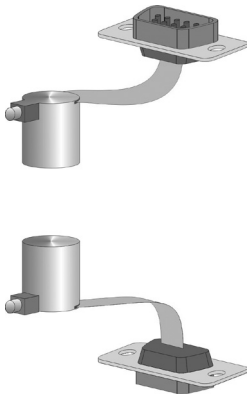


Fig. 8: Test heads in pin design

2. **In lever design at Ro 35 L, Ro 65 and Ro 130** the test heads are mass-compensated and can be swiveled about a fixed bearing pivot pin. The tension spring can be transposed, so that a LIFT-OFF-function controlled by rotational speed will be available.

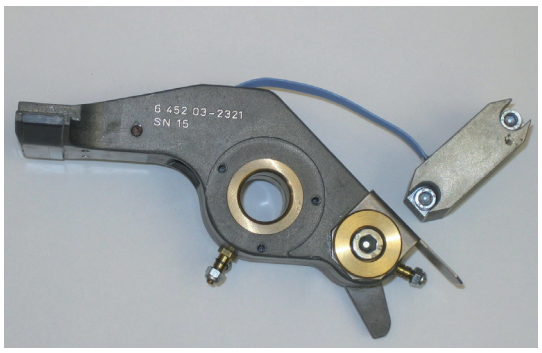


Fig. 9: Test head in lever design

Number of test heads, scanning track width, rotating speed and test speed are mathematically correlated. The chapter “Speed tables” describes the correlation and gives typical examples for the selection.

Rotating head electronics

The rotating head electronics amplifies the probe signals and the field current. It is installed in a robust housing on the side of the bearing housing. The test signals from the probes are transmitted to the testing and evaluation electronics, such as CIRCOGRAPH DS.

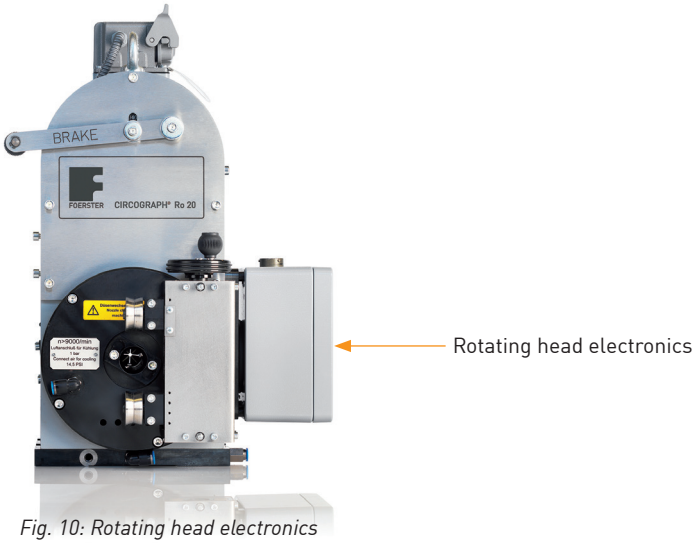


Fig. 10: Rotating head electronics

Rotor

The rotor consists of a hollow shaft, the rotor disc and the movable part of the rotating transmitter. The rotor is driven by the motor using a profile flat belt. The rotating disc holding the test heads is mounted on the hollow shaft along with the wear-free rotating transmitter for the field signals, test signals and clearance signals. A pivot-mounted spiral disc with an actuating gear and automatic blocking facility is fitted in the rotating disc for precise and simultaneous test head diameter adjustment. The rotating transmitter transmits the field current for the rotating probes from the stator to the rotor and, in the opposite direction, transmits the test signal to the test electronics for evaluation.

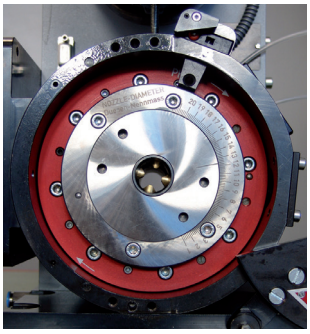


Fig. 11: Rotating disc at Ro 20

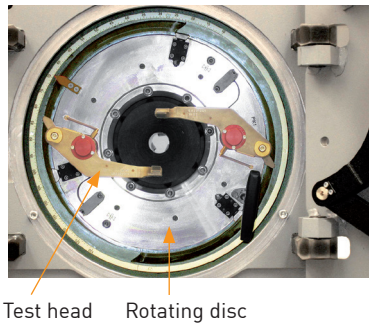


Fig. 12: Rotating disc at Ro 130

Roller guide
Roller guides are recommended if the drivers for conveying the material cannot be installed directly in front and behind the sensor system.

The roller guides have two advantages:
1. **In set-up mode,** a calibration sample with reference defects can be used outside the testing line, and the test electronics can be easily adjusted, since the rotating probes of the test errors are periodically scanned and the signal is quasi-statically displayed.

2. **In test mode,** the roller guides improve centricity, in particular with smaller sizes, and damp vibrations.

The roller guides are mounted at the rotating head on entry and exit side. The diameter adjustment is done by hand wheel.

At Ro 20 and Ro 35 the roller guides are equipped with rollers. At Ro 65 and Ro 130 resilient triple roller guides are used.

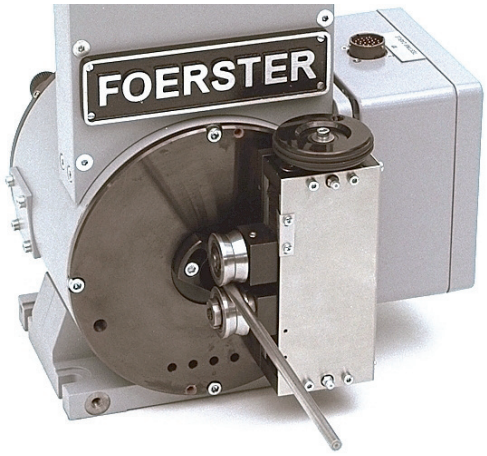


Fig 13: Roller guide equipped with rollers

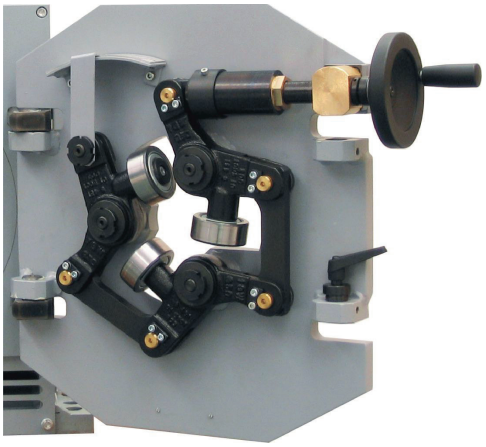


Fig. 14: Triple roller guide

Protective Nozzles
Protective nozzles protect the test heads from damage, particularly during entry and exit of test material. The nozzles are available in the nominal diameter from 2 to 135 mm. They limit the maximum eccentricity of the test material within the test zone to a narrow degree within which the distance compensation can compensate for the sensitivity fluctuations.

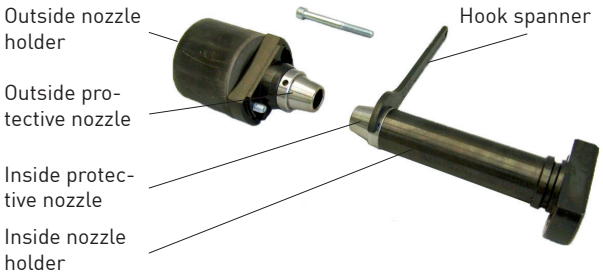


Fig. 15: Protective nozzle and nozzle holder standard

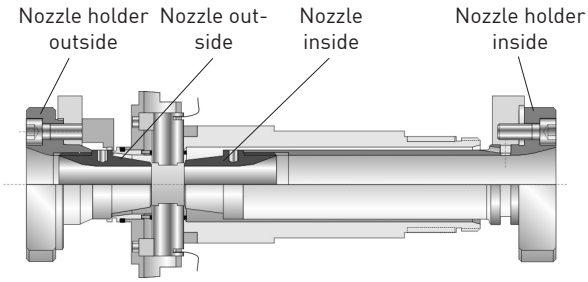


Fig. 16: Principle of protective nozzles and nozzle holder standard

The protective nozzles robust for Ro 35 L and Ro 65 are recommended at **usage in drawing machines.**

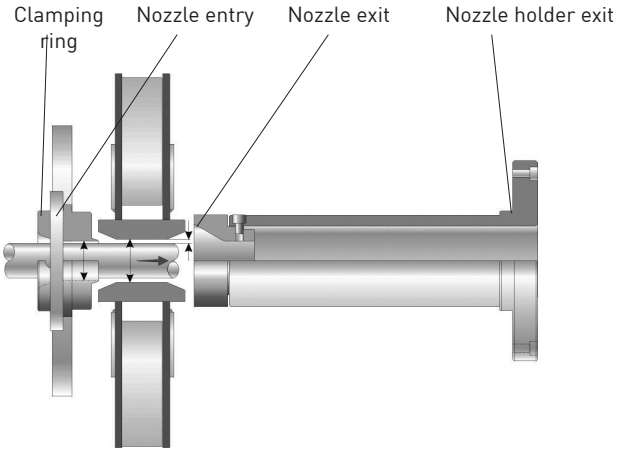


Fig. 17: Principle of protective nozzles and nozzle holder robust

Precisions guides are recommended **for testing short parts, small bars or copper tubes** with Ro 20 and Ro 35 P. Additional narrow-tolerance guide cores in the entry and exit area, near to the test heads, improve the guidance and reduce test material vibrations during throughput.

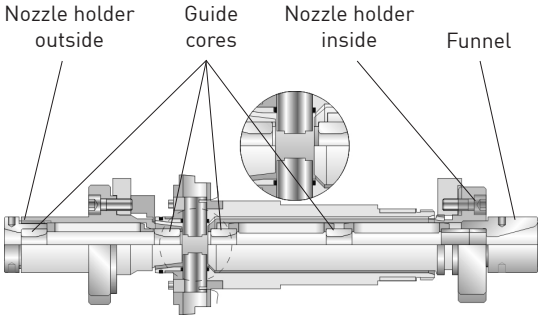


Fig. 18: Principle of precision guide using guide cores

Recommendations to figure the nozzle diameter for obtaining good test results are given on the basis of empirical values, depending upon test material diameter:

Nominal diameter d [mm]	Grading of protective nozzles d_1 [mm]
Test material at Ro 20 / Ro 20 F	
2 – 4	d + 0,1
4 – 10	d + 0,2
10 – 14	d + 0,3
14 – 20	d + 0,4
Test material at Ro 35 P	
2 – 8	d + 0,1
8 – 15	d + 0,5
15 – 38,5	d + 1,0
Test material at Ro 35 L	
5 – 8	d + 0,1
8 – 15	d + 0,5
15 – 35	d + 1,0

Nominal diameter d [mm]	Grading of protective nozzles d_1 [mm]
Test material at Ro 65	
5 – 6	d + 0,2
6 – 7	d + 0,3
7 – 8	d + 0,4
8 – 14	d + 0,5
14 – 30	d + 1,0
30 – 65	d + 1,5
Test material at Ro 130	
10 – 14	d + 0,5
14 – 30	d + 1,0
30 – 130	d + 1,5

The protective nozzles can be selected more precisely depending on the test diameter if the quality of the guidance is sufficiently precise. This can improve the test results.

Oil Air Lubrication (only at Ro 20 / Ro 20 F)
Lubrication is recommended to obtain a higher life cycle of the bearing for the hollow shaft by preventing intrusion of dirt. Two screw connections are inside the housing of the rotating head to connect to the supply line of the Oil Air Lubrication. The assembly of the Oil Air Lubrication has to be fixed externally. The compressed air supply has to be 4 – 6 bar. For standard operation, the bearing of the rotating head has a lifetime grease lubrication. The bearing for Oil Air Lubrication can be delivered ex works. The oil viscosity has to match the ISO class VG 32 to VG 100.

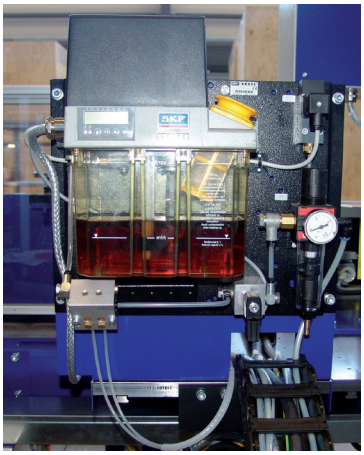


Fig. 19: Oil Air Lubrication

Technical Data

	Sensor system Ro 20 / Ro 20 F	Sensor system Ro 35 P/L	Sensor system Ro 65	Sensor system Ro 130
Test material diameter range	2 - 20 mm Ø	2 – 38.5 mm Ø (P) 5 – 35 mm Ø (L)	5 - 65 mm Ø	10 – 130 mm Ø
Rotating speed	9000 or up to 18000 rpm	4500 or 9000 rpm	3000 or 6000 rpm	1500 or 3000 rpm
Max. declaration time (dependent on rotating speed)			approx. 30 sec. with braking, approx. 360 sec. without braking	approx. 40 sec. with braking, approx. 360 sec. without braking
Test heads	2 with one probe each and an offset by 180° / 4 with one probe each and an offset by 90°	4 with one probe each and an offset by 90°	2 with two probes each and an offset by 180°	2 with two probes each and an offset by 180°; optional also 8-channel
Probe track width	1.5 mm, 2.5 mm or 5 mm	1.5 mm, 2.5 mm or 5 mm (P) 2.5 mm or 5 mm (L)	2.5 mm, 5 mm or 10 mm	2.5 mm, 5 mm or 10 mm
Max. Test speed for gap-less testing (dependent on rotating speed and probe track width)	3 m/s (Ro 20) 6 m/s (Ro 20 F) (at track width 5 mm)	3 m/s (at track width 5 mm)	2 m/s (at track width 2 x 5 mm)	1 m/s (at track width 2 x 5 mm)
Dimensions	see dimension drawing			
Weight	approx. 50 kg / approx. 60 kg	approx. 110 kg	approx. 220 kg	approx. 370 kg
Power supply	Three phase current 3 x 400 V for the drive (possibly adapted via an isolating transformator)			
Nominal power of Three-phase motor	P = 0.55 kW	P = 1.8 kW	P = 1.8 kW	P = 2.5 kW
Typical bearing life time (dependent on operating conditions and rotating speed)	3500 – 5000 hours respectively 5000 – 7000 hours at oil air lubrication	5000 – 7000 hours		
Ambient temperature	+ 5 °C to + 45 °C			
Relative humidity	max. 95%, condensation not permissible			
Weight of optional roller guide	approx. 3.2 kg	approx. 3.8 kg	approx. 70 kg	approx. 90 kg

Specification of Test Material

Test material	Ferromagnetic, austenitic and nonferromagnetic round material (wires, rods and tubes)
Surface	Free from loose scale; Free from protruding burrs, peels, chips and pikes.
Condition of the ends	Burr-free and parted perpendicular to the test axis; Without deformation of the cross-section.
Straightness tolerance	Straightness < 2 mm/m
Temperatur of test material	5 – 80 °C

Flaw Detection Limit

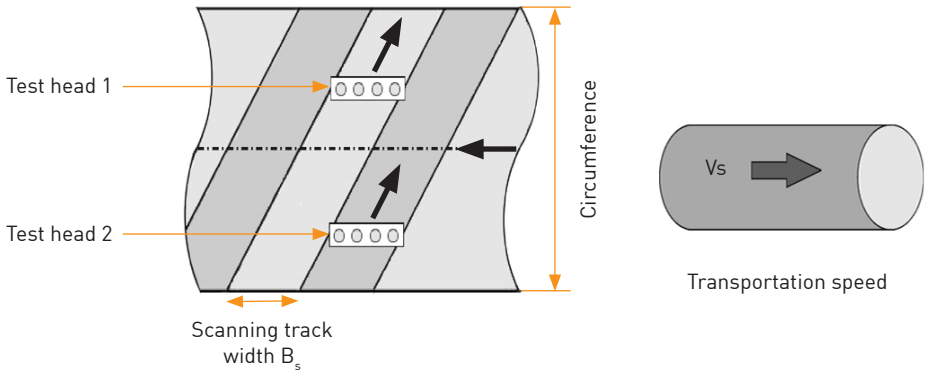
The limit is dependent on the noise level. This level is influenced by the surface of the test material, by the surface roughness, magnetic inhomogenity, as well as guiding and transportation. Defect detection is not reliably reproducible, or is limited to a great extend in the case of improper surface condition, such as burrs.

Defect type:	Longitudinal surface defects
Defect detection:	Dependent upon surface roughness, test defects may be detected • starting from 30 µm at Ro 20 / Ro 35 • starting from 80 µm at Ro 65 / Ro 130

Speed Tables

The test speed is calculated according to the following formula:

Test speed v_s = Scanning track width B_S x Number of probes x Rotating Speed



Two test head types are available:

- **N** for testing bright material
- **DF** for testing rough rolled steel

Speed table for sensor system Ro 20

Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type	
0.45		2 PK / 1.5	N	6.460.01-2015
0.9			DF	6.460.03-2015
0.75		2 PK / 2.5	N	6.460.01-2025
1.5			DF	6.460.03-2025
1.5		2 PK / 5.0	N	6.460.01-2050
3.0			DF	6.460.03-2050
n=9,000 rpm				
n=18,000 rpm				

Speed table for sensor system Ro 20 F

Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type	
0.9		4 PK / 1.5	N	6.460.04-2015
1.8			DF	6.460.06-2015
1.5		4 PK / 2.5	N	6.460.04-2025
3.0			DF	6.460.06-2025
3.0		4 PK / 5.0	N	6.460.04-2050
6.0			DF	6.460.06-2050
n=9,000 rpm				
n=18,000 rpm				

Speed table for sensor system Ro 35 P

Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type	
0.45		4 PK / 1.5	N	6.461.01-2015
0.9			DF	6.461.03-2015
0.75		4 PK / 2.5	N	6.461.01-2025
1.5			DF	6.461.03-2025
1.5		4 PK / 5.0	N	6.461.01-2050
3.0			DF	6.461.03-2050
n=4,500 rpm				
n=9,000 rpm				

Speed table for sensor system Ro 35 L

Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type
0.75		4 PK / 2.5	6.461.21-2025
1.5			
1.5		4 PK / 5.0	6.461.21-2050
3.0			
n=4,500 rpm			
n=9,000 rpm			

Speed table for sensor system Ro 65

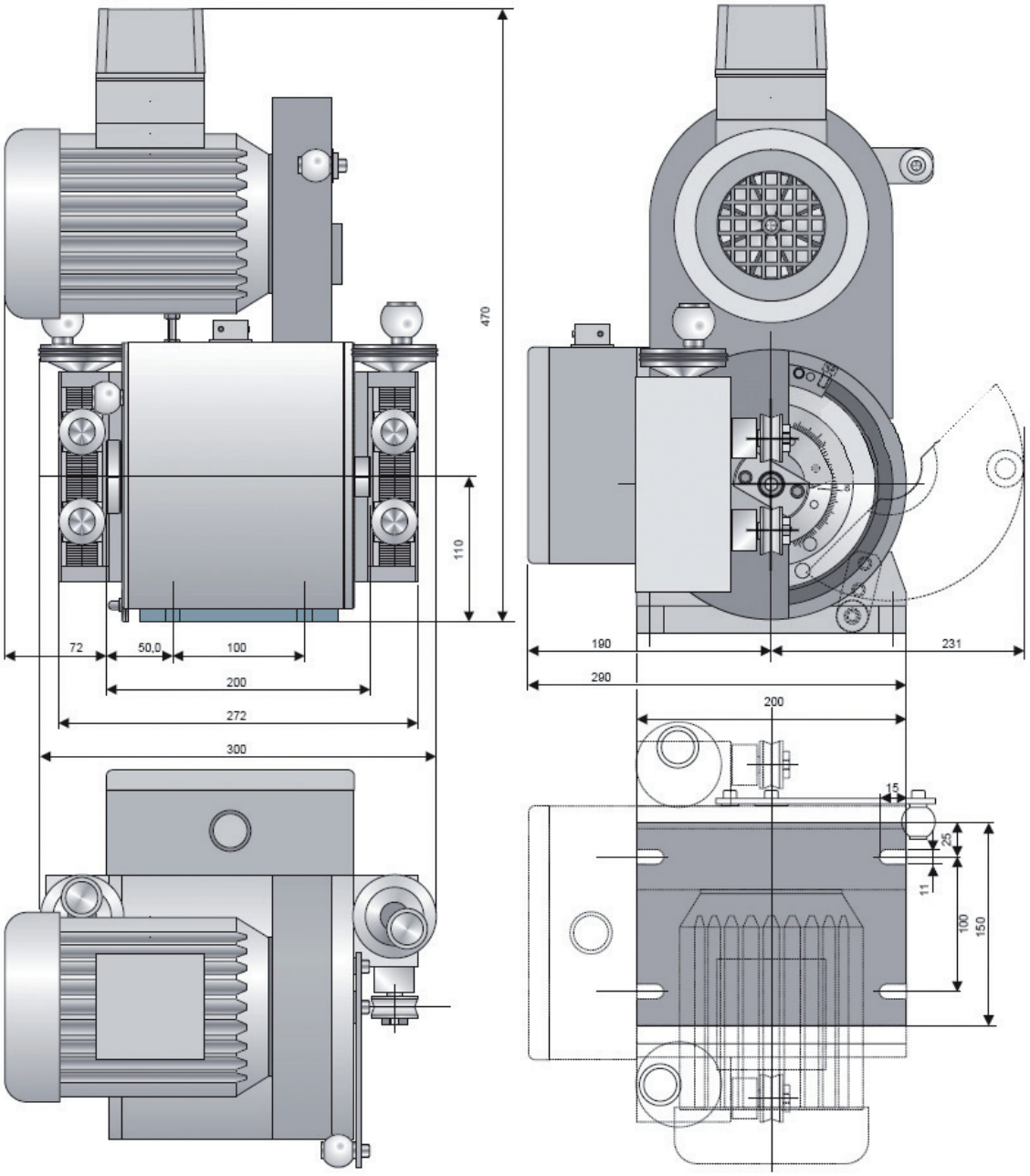
Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type	
0.5		2 PK / 2 x 2.5	N	6.452.01-2311
1.0			DF	6.452.03-2311
1.0		2 PK / 2 x 5.0	N	6.452.01-2321
2.0			DF	6.452.03-2321
2.0		2 PK / 2 x 10	N	6.452.01-2331
4.0			DF	6.452.03-2331
n=3,000 rpm				
n=6,000 rpm				

Speed table for sensor system Ro 130

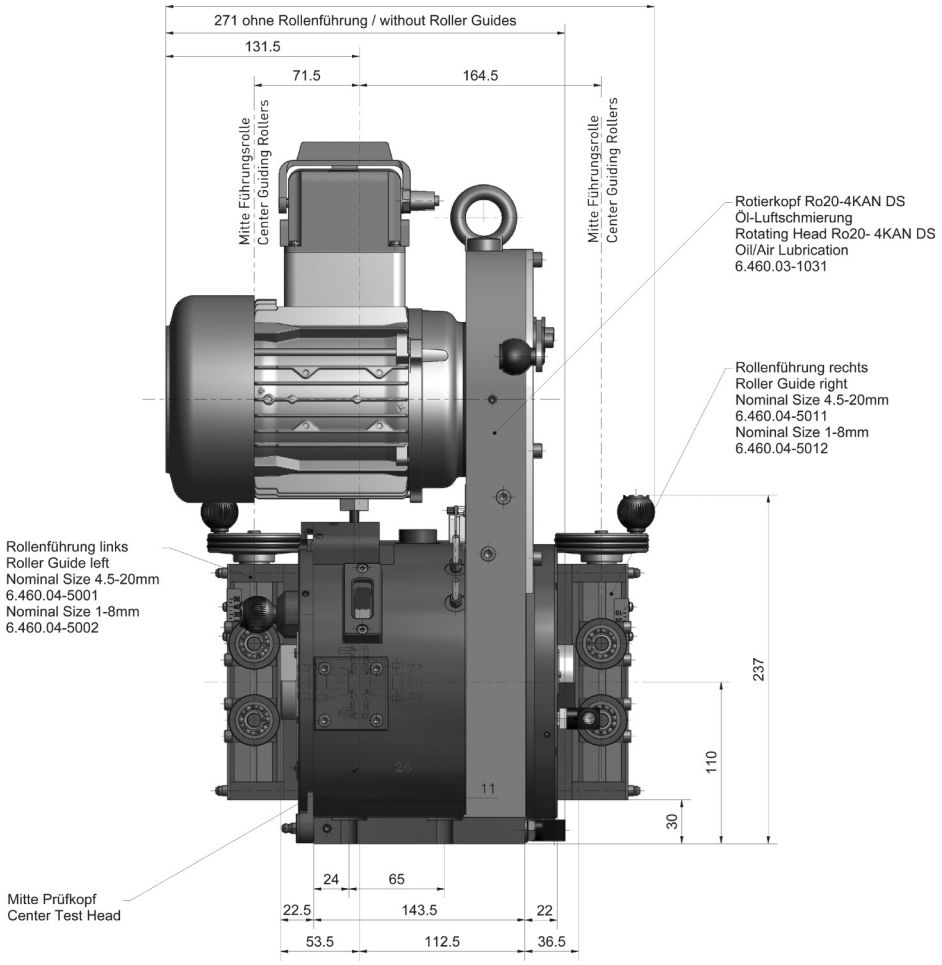
Maximum testing speed [m/s]	Decreasing sensitivity to short flaws	Track width B_s [mm]	Test head type	
0.25		2 PK / 2 x 2.5	N	6.453.01-2311
0.5			DF	6.453.03-2311
0.5		2 PK / 2 x 5.0	N	6.453.01-2321
1.0			DF	6.453.03-2321
1.0		2 PK / 2 x 10	N	6.453.01-2331
2.0			DF	6.453.03-2331
n=1,500 rpm				
n=3,000 rpm				

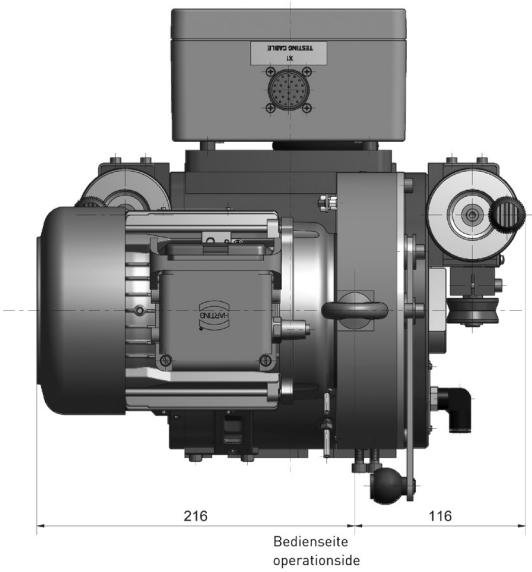
Dimensions

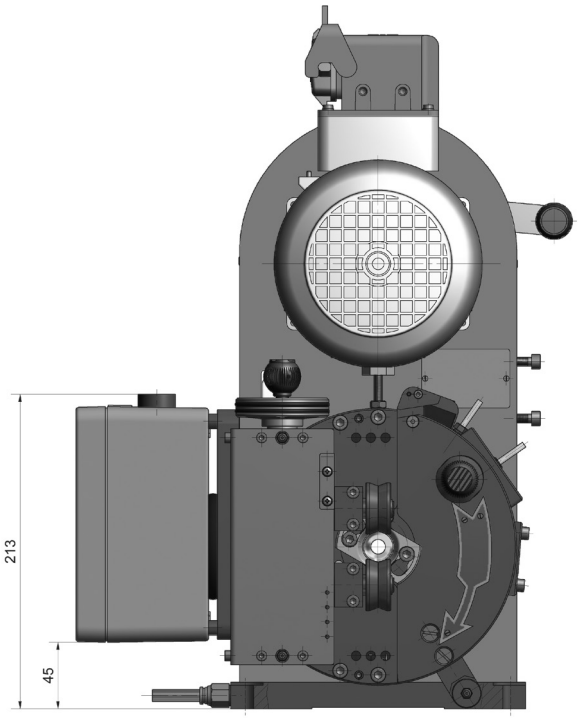
Sensor system Ro 20



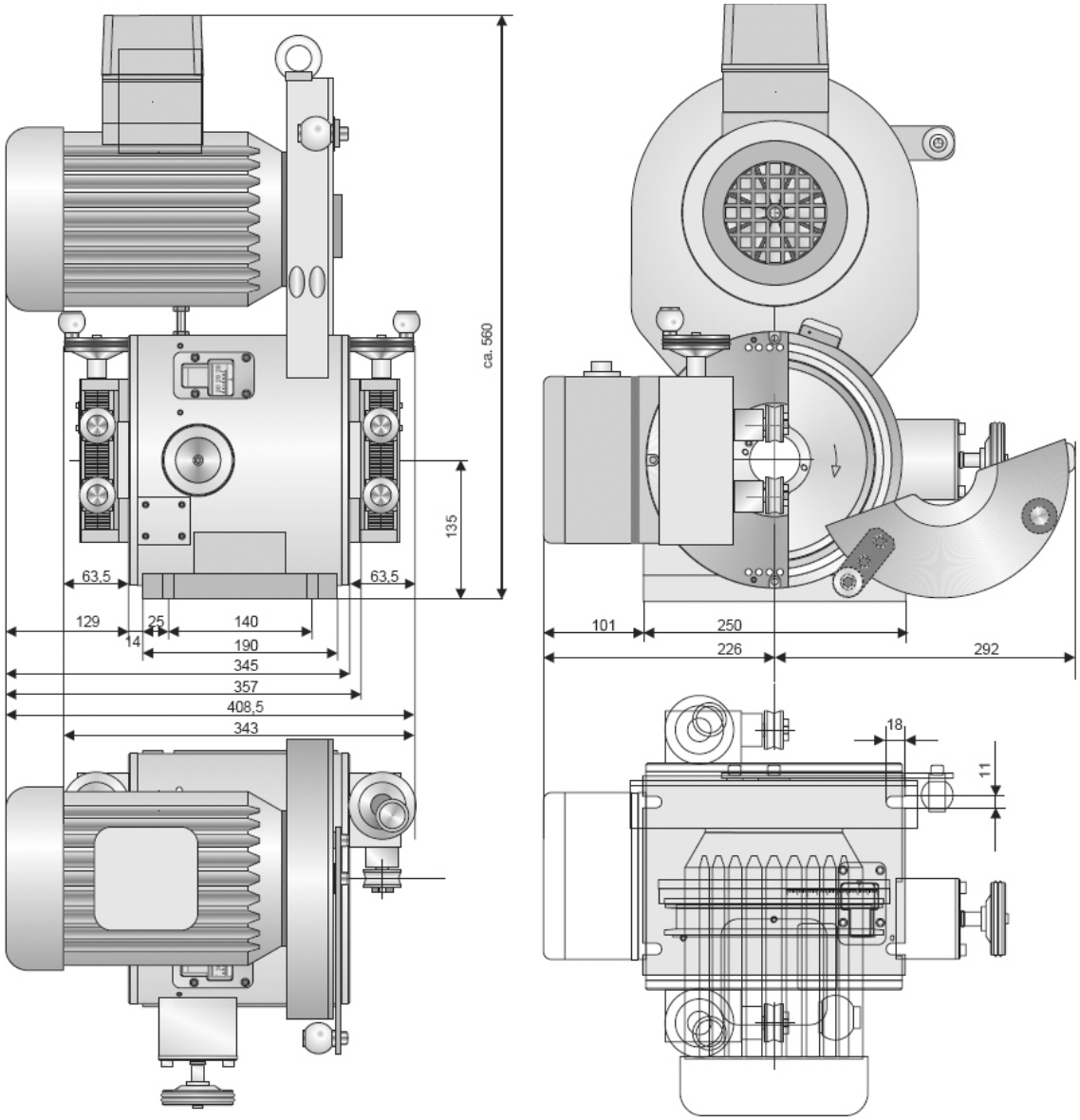
Sensor system Ro 20 F



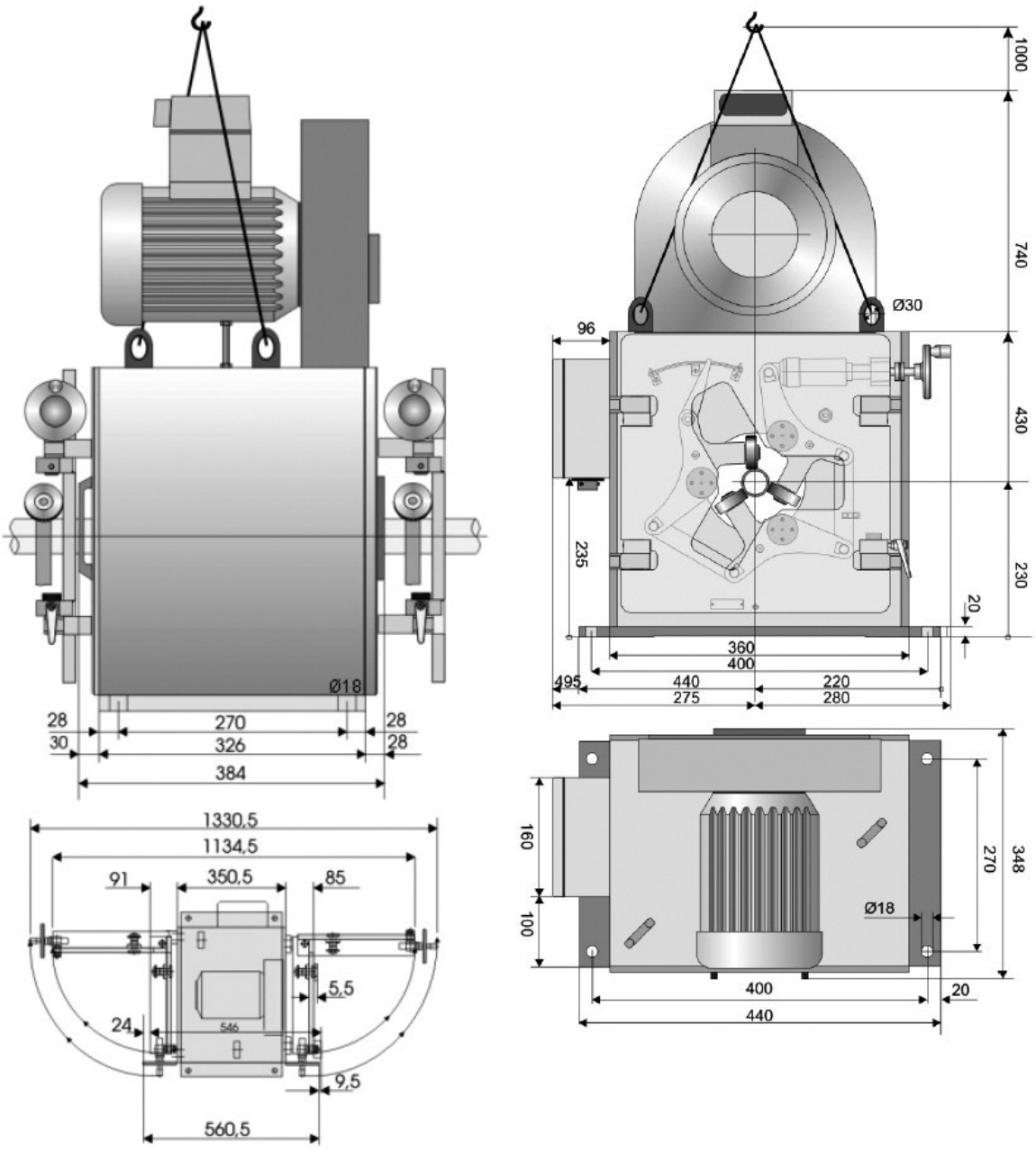




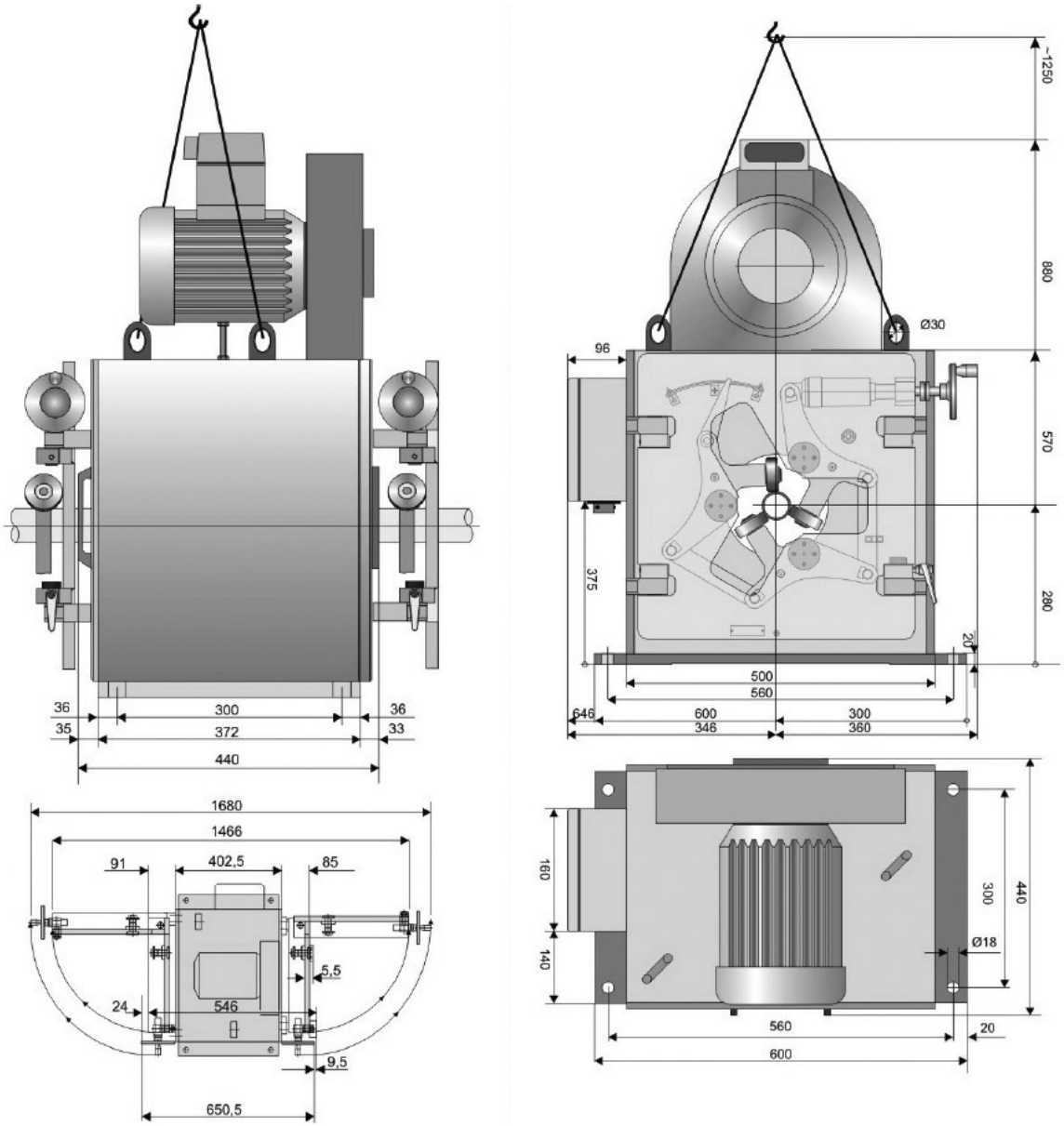
Sensor system Ro 35



Sensor system Ro 65



Sensor system Ro 130



Notes

Notes

Product Information

Worldwide Sales and Support Offices

Headquarters

- Institut Dr. Foerster GmbH & Co. KG, Germany

Subsidiaries

- Magnetische Pruefanlagen GmbH, Germany
- FOERSTER France SAS, France
- FOERSTER U.K. Limited, United Kingdom
- FOERSTER Italia S.r.l., Italy
- FOERSTER Russland CJCS, Russia
- FOERSTER Tecom s.r.o., Czech Republic
- FOERSTER (Shanghai) NDT Instruments Co., Ltd., China
- FOERSTER Japan Co., Ltd., Japan
- NDT Instruments Pte Ltd, Singapore
- FOERSTER Instruments Inc., USA

The FOERSTER Group is being represented by subsidiaries and representatives in over 60 countries - worldwide.

Institut Dr. Foerster GmbH & Co. KG
Division Test Systems
In Laisen 70
72766 Reutlingen
Germany
+49 7121 140 0
info@foerstergroup.de

Reg.-Nr. 001159 QM08

Order-No. 1937758