

CIRCOGRAPH®

Non-Destructive Eddy Current Testing of Long Products
such as Wires, Bars and Tubes



The Company

FOERSTER is a global technology leader for non-destructive testing of metallic materials. One of the "Hidden Champion" companies, FOERSTER operates worldwide with an extensive network of ten subsidiaries plus qualified representatives in more than 60 countries and works closely with its customers.

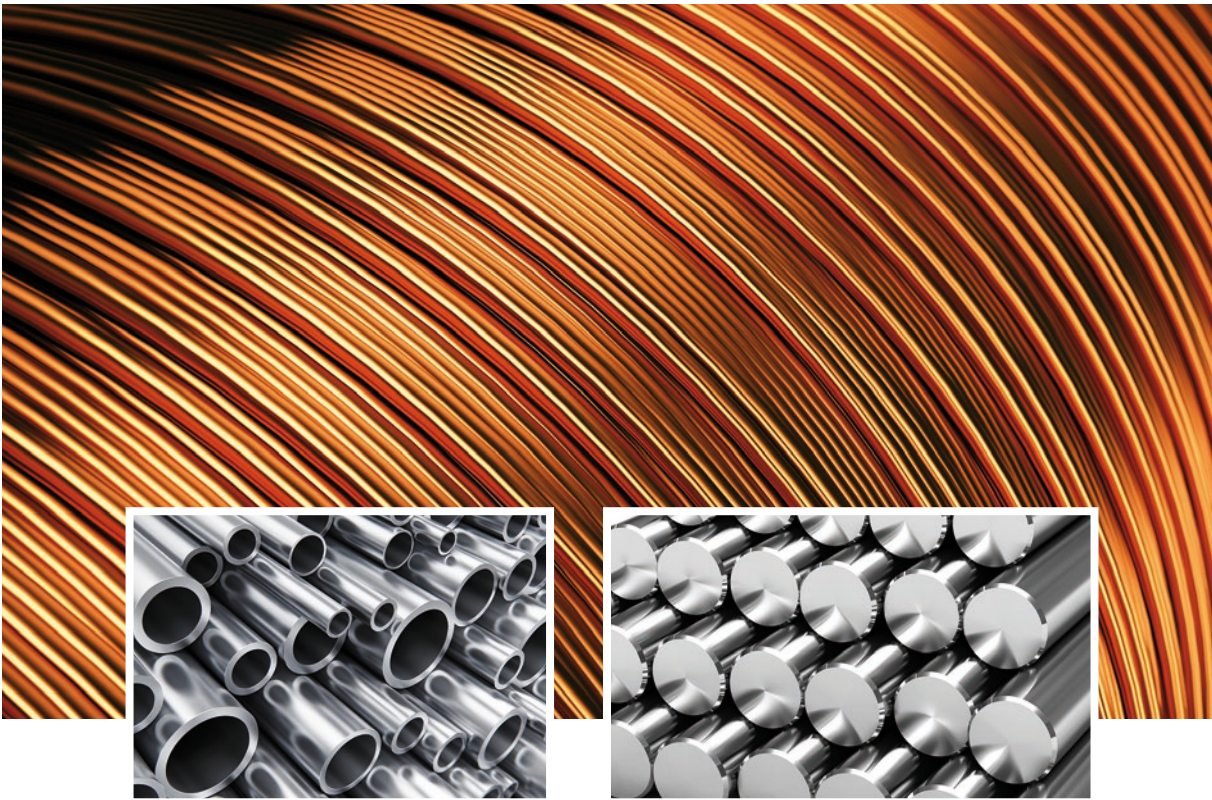
FOERSTER Division Test Systems (TS)

Division TS specializes in developing and manufacturing technical systems for the automated, non-destructive testing of metallic long products and heavy plates. Electromagnetic methods such as eddy current and flux leakage testing, ultrasound and inductive heat flow thermography are used to inspect these semi-finished products for defects that are invisible to the naked eye.

These systems are made for the metal producing and metalworking industries, where tubes, wires, bars, billets, rails, profiles, metal sheets and similar items are produced on rolling mills, drawing lines, welding lines or processed in various finishing operations. FOERSTER products perform many critical test applications during these processes.



Testing Semi-Finished Products with CIRCOGRAPH®



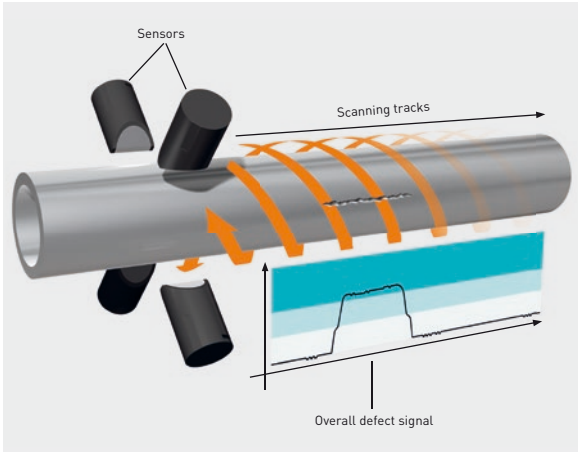
Making Quality Visible

Increasing quality requirements in the production of semi-finished products make sensitive testing of the material necessary. The eddy current method for non-destructive testing of the material surface has become standard for continuous quality assurance. The modular test systems from FOERSTER allow for uncomplicated integration into the production line. Diverse documentation and evaluation options enable to record the results quickly and easily.

In combination with the well-proven and highly sensitive FOERSTER sensors, complete systems are installed which ensure reproducible testing. FOERSTER always has individual customer needs in mind in order to achieve optimal results.

Eddy Current Testing with Rotating Sensors

In eddy current testing with a rotating head, the sensors move at high speed around the longitudinally moved test material. The material surface is scanned without contact in a helical manner for longitudinal defects, which are shown over their entire length. Due to the small dimensions of the individual sensors, a very high sensitivity is achieved even for smallest defects.



Principle of Eddy Current Testing with Rotating Sensors

CIRCOGRAPH® DA



Multi-Channel Eddy Current Testing at the Highest Level

With the CIRCOGRAPH DA, FOERSTER sets new standards in non-destructive eddy current testing of long products such as tubes, bars and wires. CIRCOGRAPH DA offers unsurpassed reproducibility at high test speeds by combining advanced digital electronics with sophisticated system architecture. Its modular system setup and the resultant expansion possibilities guarantee maximum versatility for fulfilling ever-changing test requirements. Equipped with the latest technology and intelligent details, the CIRCOGRAPH DA can also be integrated into existing production lines.

Digitization takes place directly at the sensor. In order to reduce possible interferences from the outside, the signal paths of the analog test signals have been reduced to a minimum. System modules are connected with industrial Ethernet cables which can be flexibly arranged. I/O interfaces to the production line can be freely configured and expanded. Operation is controlled via the new software DEFECTOTEST DA.

Advantages of the CIRCOGRAPH® DA

- Modular system layout offers maximum flexibility for meeting customer-specific requirements
- CIRCOGRAPH rotating heads allow for contactless testing with test speeds up to 6 m/s
- Expansion and system optimization possible at any time
- Optional extension with DEFECTOMAT sensor systems
- Up to 256 test channels in real time (without multiplexing)
- Digitization right at the sensor
- Compatible with all FOERSTER sensors
- Test frequencies continuously adjustable from 1 kHz to 1 MHz in 100 Hz steps
- Patented digital speed shift filter: dynamic adjustment of the filter's position to the test speed
- Easy touchscreen operation
- Multi-user operation interface
- Context-sensitive online help
- Generation of individual test reports
- Archiving of all test results
- Quality testing according to international norms: ASTM, API, DIN, ISO and JSA-JIS, among others

Highest Detection Sensitivity and User-Friendly Operation



Digitization for Improved Test Quality

The sensors of the CIRCOGRAPH DA system are directly connected to the TEST SYSTEM DA, which first digitizes the analog signal and then transmits it via Ethernet to the LINE SYSTEM DA. All data required for the evaluation of test results are available immediately. The close proximity of the TEST SYSTEM DA to the sensor (= short analog signal paths) minimizes the influence of electromagnetic interferences, resulting in superior test quality.

Well-Protected

The LINE SYSTEM DA and the operation PC are mounted in a compact, 19" cabinet of protection class IP54. Besides the high-resolution touchscreen display, additional input devices such as a keyboard or mouse can also be connected.

Easy-to-Use DEFECTOTEST® DA

The operator-friendly DEFECTOTEST DA software is clearly structured and intuitive to use. The modern interface relies on visualization to facilitate operation, clearly separating operator controls and screen elements. Large, easy-to-use buttons enable fast touchscreen input, while consistent color-coding of displayed information aids comprehension and helps prevent operator errors.

Quick Modernization of Existing Test Systems

Since the CIRCOGRAPH DA is modular and compatible with all FOERSTER sensors, it is simple to switch components or update existing FOERSTER test systems. The easy-to-handle components are quickly installed, ensuring speedy resumption of production. An extension with a DEFECTOMAT sensor system, for example for leak testing, is simple and uncomplicated. All that needs to be done is to connect an additional cable between the CIRCOGRAPH DA and the TEST SYSTEM DA. This allows constant adaptation to changing test tasks.

CIRCOGRAPH® CI/DI



Compact Test Systems for Applications with High Throughput

The two-channel test systems CIRCOGRAPH CI and CIRCOGRAPH DI are particularly used in combination with the rotating head Ro 20 P. Due to their compact dimensions, the test systems are ideally suited for the eddy current testing of rods and tubes with a small material diameter of 2 – 20 mm directly in the production process. The material is tested for longitudinal surface defects at various stages of the cold forging and drawing process. Thanks to the high variety of functions, flexible use is possible in almost any production environment.

Advantages of CIRCOGRAPH® CI/DI

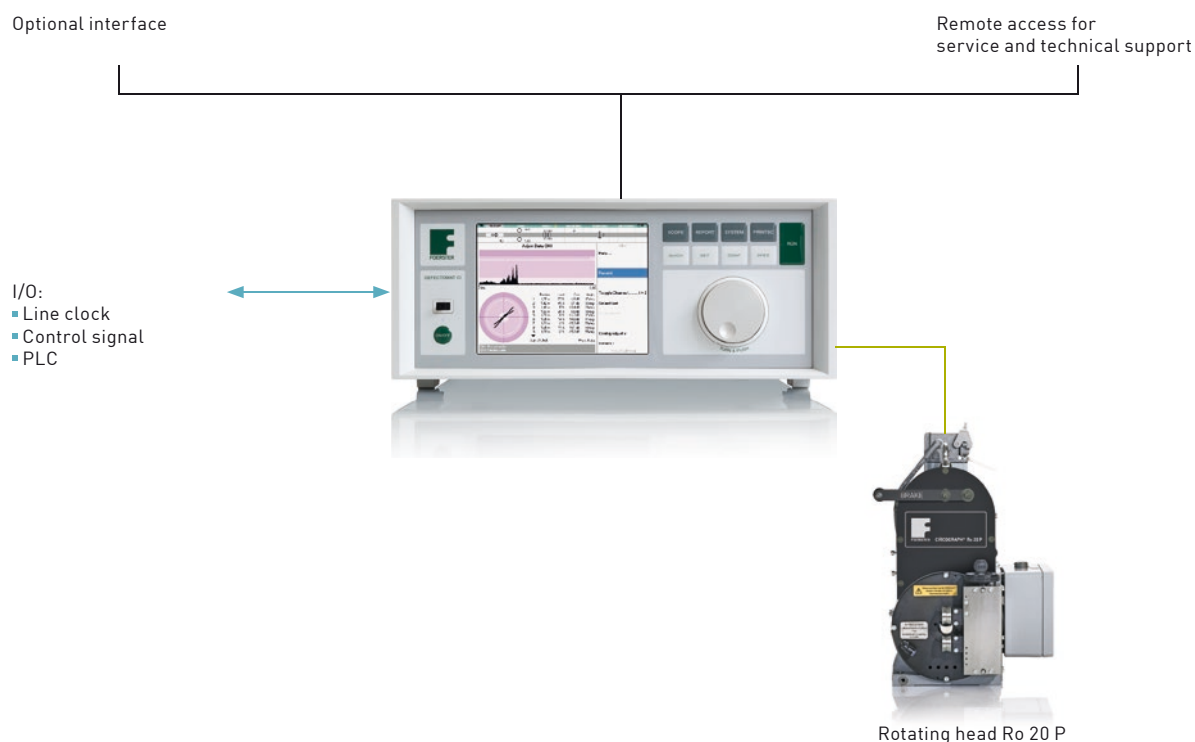
- Two test channels
- Clearance compensation, to compensate for the distance changes from sensor to test piece
- Clearance compensation easily adjustable
- Frequency range from 30 kHz – 1 MHz
- Optimized filters for testing with rotating heads
- Visualization of both channels, with the respective clearance signal
- I/O line interface for sorting and marking
- Ethernet connection

Base Model CIRCOGRAPH® DI

The DI series by FOERSTER has been developed for basic applications in non-destructive testing of semi-finished products. All necessary functions are integrated in the compact system. Operation and setting of the DEFECTOMAT DI, as well as the archiving of test results, is easily conducted at an external PC connected via Ethernet.

Features of the CIRCOGRAPH® DI

- Operation PC can be provided by customer
- Intuitive operation software
- Price-optimized base system, optional expansion of functionality



More Convenience with CIRCOGRAPH® CI

The modern IT architecture of the CIRCOGRAPH CI allows it to be controlled directly at the device. All relevant parameters can easily be set by built-in function keys and a simple “turn-and-push” button. Keyboard, mouse and display can also be plugged into the instrument. Furthermore, a primary process computer for data exchange can be connected via Ethernet.

Test Protocols for Quality Documentation

Test protocols with corresponding test settings and results can be generated for each individual test piece or for a series of test pieces. Protocols can be designed individually and printed automatically, ensuring complete documentation.

Clear Presentation of the Production Process

All production information is displayed unambiguously on the high-resolution monitor. The status bar, for example, shows the current line speed as well as line outputs for marking and test piece sorting; from here, the operator can quickly extract all information concerning the current test. Structured data from test signals and test events are exported in real time and at line speed. As desired, the test signals can be displayed in V, |Y| or XY format.

Overview CIRCOGRAPH® Systems

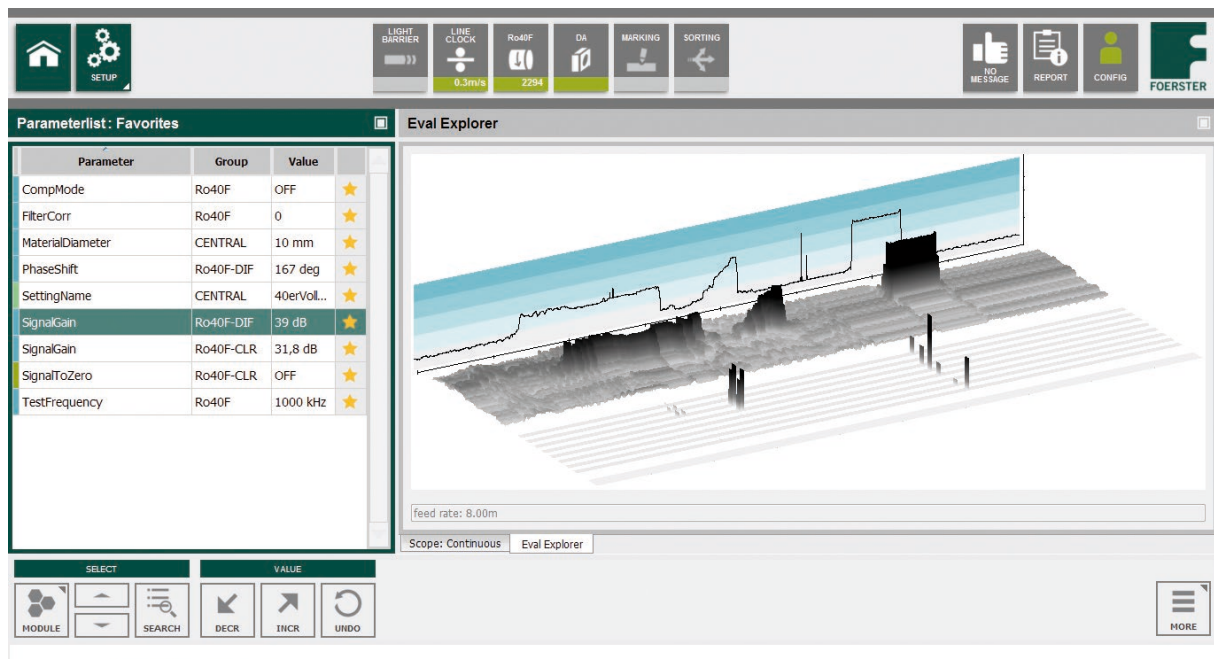
Diverse applications and varying production conditions require test electronics that are precisely tuned to the conditions at hand. To meet customers' needs, FOERSTER provides the following CIRCOGRAPH systems:

CIRCOGRAPH	DI	CI	DA
Channels (max.)	2	2	256
DEFECTOMAT channel	-	-	Option
GUI	-	✓	✓
Database	-	-	✓
Line function	✓	✓	✓
Reports	Option	✓	✓

Optionally, the functionality of the systems can be further expanded in order to fulfill additional or changing specifications:

CIRCOGRAPH	DI	CI	DA
Analog output	Option	Standard	Option
Phase-selective evaluation	Option	Standard	Standard
Cutting with sorting FIFO	Option	Standard	Standard
Small defect evaluation	Option	Standard	Standard
Automatic adjust	Option	Standard	Standard
Test reports	Option	Standard	Standard
Result investigation	Option	Option	Option
Software interface	Option	Option	Option
Result export	Option	Option	Option
FOERSTERNET	-	-	Option

New Software Features for CIRCOGRAPH® DA



With the new CIRCOGRAPH DA, FOERSTER is further pursuing the path of digitization. This means the signal path of the analog test signals has been reduced to a minimum. Thus, interferences from the outside are significantly decreased. The CIRCOGRAPH DA is operated via a touchscreen monitor. Further new software features ensure easy operation and visualization of the test signals.

Customizable User Interface Facilitates Work

The new task-oriented layout of the user interface clearly displays all relevant settings. Different operating situations, such as the preparation of orders or the evaluation of results in test mode, require different information. Therefore, each screen can be configured by the customer to his needs and saved as a "customer screen". In the "favorites screen", individually selected parameters for each task can be displayed separately.

Better Overview by Visualization of the Test Signals as C-Scan

The new product generation CIRCOGRAPH DA enables displaying of the test signals as a C-Scan. The signal sequence is shown as usual as the sum signal over the distance. The defect position is displayed in the longitudinal direction. Additionally, in the C-Scan view, the signals are now also displayed in the circumferential position. The operator is thus given a better overview of where and, above all, how the defect propagates on the material surface. For the first time, the C-Scan uses the defect history to draw conclusions about the cause of the defect in the manufacturing process. As a result, countermeasures can be taken early and processes can be optimized.

Sensors for the Most Demanding Test Requirements



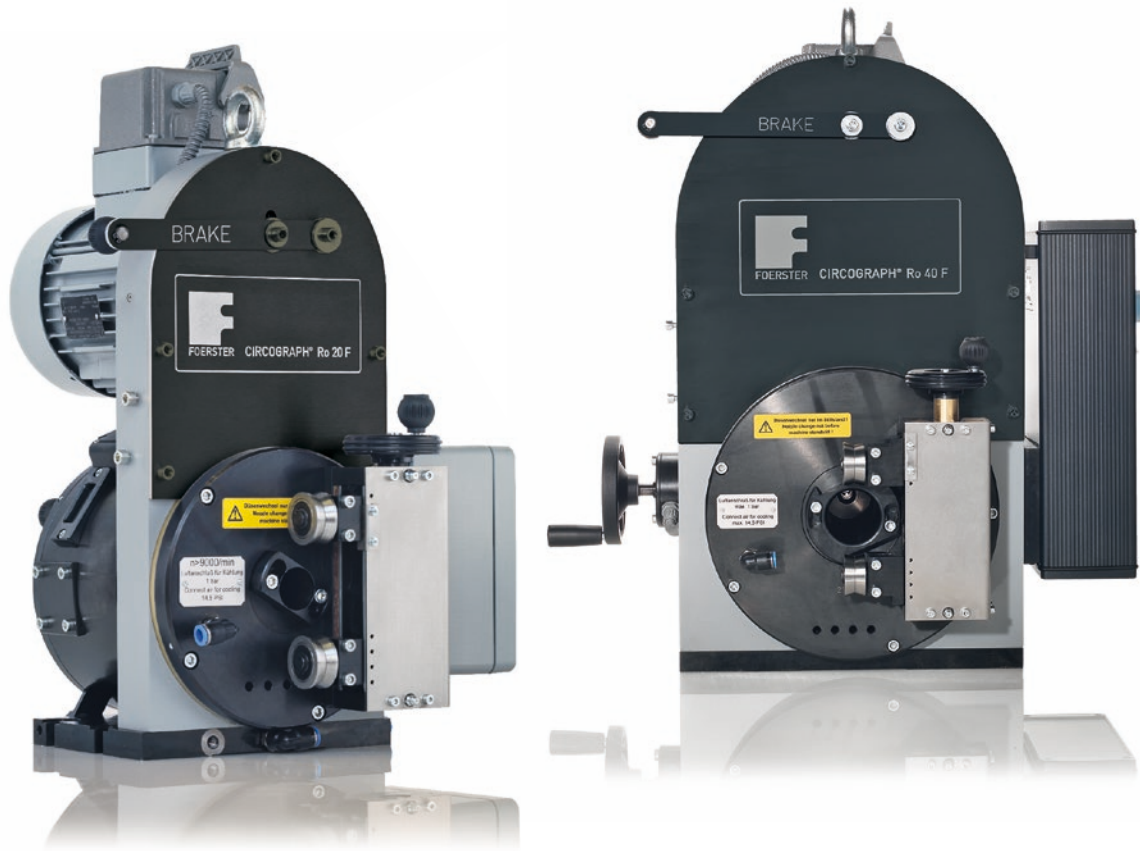
High-Quality Sensors – Made in Germany

To provide the appropriate sensor technology for every customer need, FOERSTER is continuously developing new and innovative solutions. FOERSTER is able to offer an extensive portfolio of sensors suited to a wide range of forms and dimensions to ensure precise defect detection on such semi-finished products as wires, bars, profiles or tubes.

Firmly established and in use for decades, these sensors have been delivering reproducible test results for dependable quality and process control. With the CIRCOGRAPH rotating heads by FOERSTER, both finest wire with 2 mm material diameter as well as bars with 130 mm diameter can be tested. With the clearance compensation of the CIRCOGRAPH rotating heads, even oval-shaped spring wire can be reliably tested.

Special solutions with stationary sensors and rotating test material for particularly large diameters are also possible. FOERSTER has developed the multi-channel rotating heads Ro 20 F and Ro 40 F especially for applications requiring high throughput speeds. Together with the test electronics, complete systems are created, tailored to the respective test task and perfectly integrated into the customer's production line.

Multi-Channel CIRCOGRAPH® Rotating Heads



Detection of Longitudinal Defects Over Their Entire Length

Applications such as the rewinding of tubes in copper tube production or wire drawing require a rotating sensor system that can cope with the high throughput speed. The rotating heads Ro 20 F and Ro 40 F were specially developed for such applications. The powerful, multi-channel rotating heads are designed for tubes, rods and wires with a material diameter of 2 – 40 mm. They allow for sensitive detection of longitudinal defects in the material surface. Defects starting with a depth of approx. 30 µm can be displayed in their full length and with high resolution.

High Throughput Speed for Higher Productivity

The four sensors in the test head are installed offset by 90°. As a result, the throughput speed can be increased to 6 m/s, thus significantly improving production. The same center height of the Ro 20 F and the existing Ro 20 P sensor system guarantees easy replacement of the rotating head in the test line.

Convincing Advantages

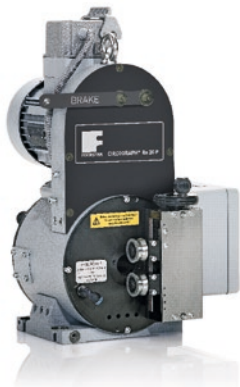
- Sensitive detection of longitudinal surface defects starting from a depth of approx. 30 µm
- For testing ferromagnetic, austenitic and nonferromagnetic round material (tubes, rods, wires)
- Sensor system consisting of four sensors offset by 90°
- Test heads available with 1.5 mm / 2.5 mm / 5 mm track width (analogous to sensor system Ro 20 P)
- Modular design enables easy replacement in existing lines

Technical Data

- Material diameter range
 - 2 - 20 mm (Ro 20 F)
 - 2 - 40 mm (Ro 40 F)
- Throughput Speed (5 mm track width):
 - 6 m/s (Ro 20 F)
 - 3 m/s (Ro 40 F)

CIRCOGRAPH® Rotating Heads

For round material of 2 – 130 mm diameter, four rotating heads are available. For larger dimensions, special solutions with stationary sensors and rotating test material are possible.



Rotating Head Ro 20 P

Small and compact, the rotating head Ro 20 P is designed for material diameters of 2 – 20 mm. It is equipped with two probes in pin design. A maximum test speed of 3 m/s with two probes of 5 mm track width and 18,000 rpm is achievable. The Ro 20 P can be operated with the dual-channel CIRCOGRAPH DI.

The field of application of the Ro 35 L is preferably in the drawing line, where the nature of the ends during threading and extension can cause difficulties, since the lever can avoid material contact.



Rotating Head Ro 65

Designed for material diameters of 5 – 65 mm, the Ro 65 is equipped with two probes. A maximum test speed of 4 m/s is achievable with 2 probes à 2 x 10 mm track width and 6,000 rpm. For use in drawing lines for diameters up to approx. 50 mm, a robust special versions of the protective nozzles exists.



Rotating Head Ro 35 P and Ro 35 L

Rotating heads Ro 35 P and Ro 35 L are designed for material diameters from 2 – 35 mm (L) / 2 – 38,5 mm (P). They are optionally equipped with two or four probes in pin (P) or lever version (L). The maximum test speed is 3 m/s with continuous sampling at 9,000 rpm and four probes with 5 mm track width. The Ro 35 P is mainly used in the bright steel area for the testing of bars with good finished ends and in copper tube winders.



Rotating Head Ro 130

The rotating head Ro 130 was developed for material diameters of 10 – 130 mm and is optionally equipped with two or four test heads in lever design. A maximum test speed of 4 m/s can be achieved with four probes à 2 x 10 mm track width and 3,000 rpm.

Application-Specific Sensor Systems



Sensor Solutions for Special Applications

Each application requires the best possible test system to ensure a reproducible testing performance. Therefore, FOERSTER also offers test systems for special applications. Furthermore, application-specific individual solutions for special applications are developed on customer request.

In addition to the presented rotating heads for testing wires, tubes and rods, FOERSTER has a special sensor system for testing profiles and flat material.

Sensor System CIRCOSCAN

The CIRCOSCAN rotating discs are particularly suitable for scanning profile material such as rails and flat material. With the rotating discs, the critical zones on rails and square billets can be reliably examined for longitudinal defects. As a result, defects can be detected early and countermeasures can be taken. For the detection of transversal surface defects, the test electronics can be additionally extended by a DEFECTOMAT channel. The material is scanned by shape-adapted segment coils, which also test the material for surface defects by means of eddy current.



Sensor system CIRCOSCAN

Application Lab and Trainings



Application Lab

In order to provide its customers with comprehensive technical advice, FOERSTER runs its own in-house application lab. Equipped with the latest test equipment, the lab is ideally suited for solving new customer-specific application scenarios. Using material provided by the customer, various tests are carried out. Based on test results, the best possible solution is defined both for the technical equipment as well as for the parameter setting. FOERSTER application specialists possess in-depth industry knowledge. They provide comprehensive support to find the best possible solution, also directly on-site.

Training

FOERSTER training courses focus on the practice-oriented application of FOERSTER test electronics and sensor systems, as well as the configuration of important parameters for adapting the systems to the test procedures and tasks at hand; in-depth training courses for service and maintenance are also offered. The training content can be modified to suit individual customer's needs and delivered on-site, directly at the test line.

Global Service



High-Quality Requirements for Service

When it comes to FOERSTER test instruments, customers can count on top quality. In order to meet these expectations, an experienced service team and highly skilled engineers are available for on-site service and maintenance projects and, as necessary, prompt and effective assistance.

Worldwide Reach

FOERSTER is a global company. A network of ten subsidiaries and qualified representatives in more than 60 countries guarantees close proximity to customers and rapid response. At the company headquarters in Reutlingen, international service engineers attend regular training courses to enhance their technological know-how; this in turn ensures uniform service quality – worldwide.

Available Around-the-Clock

Problems often occur outside normal working hours. For that reason, an additional 24/7 emergency hotline is available throughout the year, so that FOERSTER service specialists can initiate a systematic error analysis on the telephone. For software installation or configuration queries, remote access provides a quick solution, allowing a device to be quickly functioning again.

foerstergroup.de



Worldwide Sales and Support Offices



Headquarters

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

Subsidiaries

- Magnetische Pruefanlagen GmbH, Germany
- FOERSTER Tecom, s.r.o., Czech Republic
- FOERSTER France SAS, France
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- FOERSTER (Shanghai) NDT Instruments Co., Ltd., China
- FOERSTER Japan Limited, 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.

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