

METAL INDUSTRY / PLATE

Comprehensive ultrasonic quality inspection
in the manufacturing process.



Plate inspection	4 – 5
Fundamental solution	6
Customized solutions	7
New plant vs. existing production	8
Inline / Offline testing	9
Ultrasonic software	10
Test sequence & control	11
Technology	12 – 13
Solution provider	14 – 15



FOERSTER – Your expert for non-destructive testing

Ultrasound is a long-established testing method for quality monitoring in the steel industry. Automated ultrasonic testing (UT) is mainly used for evaluating high-volume products such as plates. The material can be quickly, non-destructively and reliably scanned for defects that are mostly internal – and therefore invisible. The product quality is then determined on the

basis of official or individually created test standards. In many cases, the test results also provide insights into the production process itself.

For over 70 years, FOERSTER has offered innovative test equipment and sensors for eddy current and magneto-inductive testing, as well as measuring systems for determining magnetic properties.

In 2014, our range was expanded to include UT systems through the acquisition of NDT Systems GmbH.

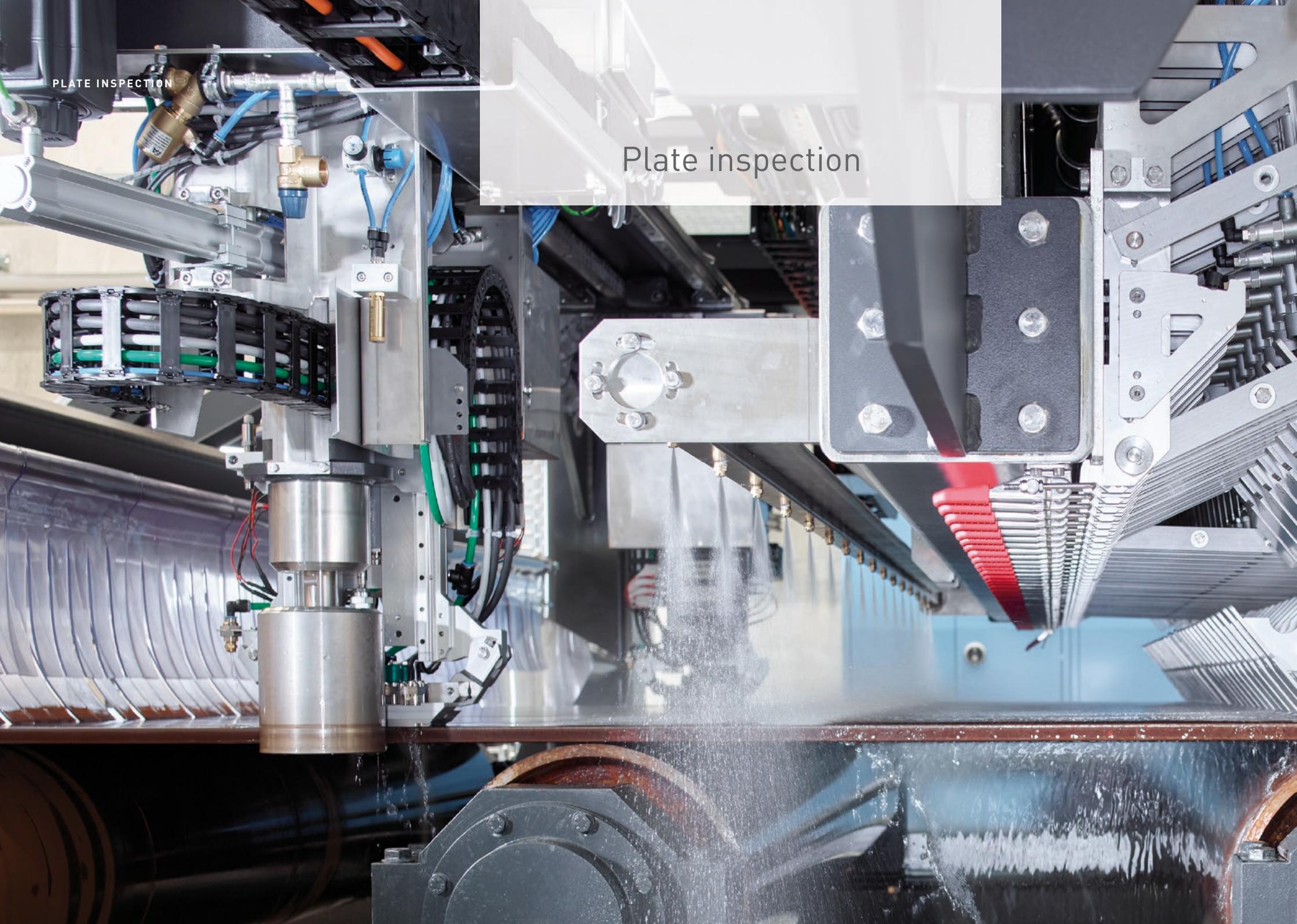
Today, we offer a large portfolio of technologies, testing equipment and sensors, to optimally support a wide variety of manufacturing processes and products. Our customers worldwide rely on the durability and robustness of FOERSTER.

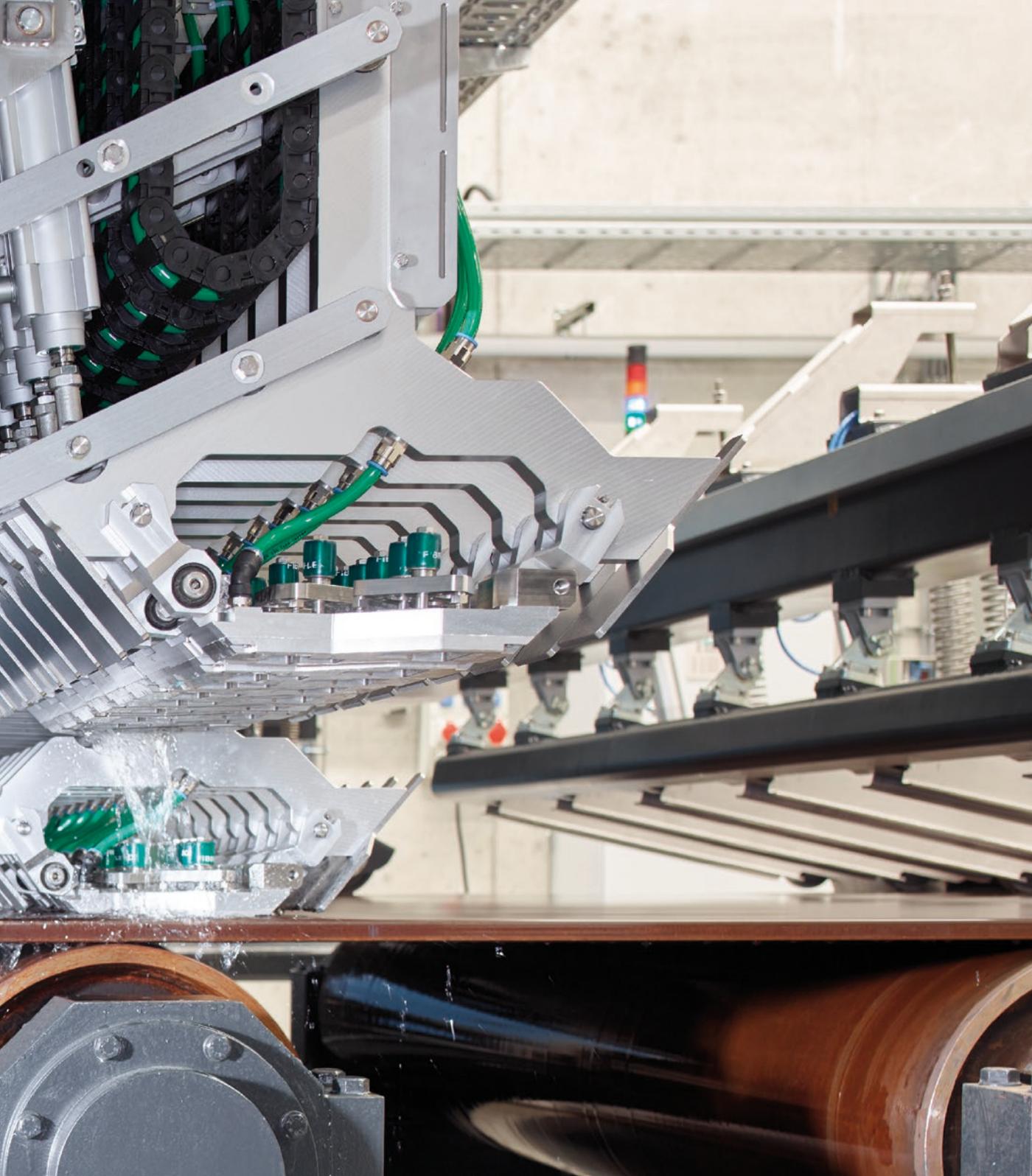


Courtesy of SMS group GmbH

PLATE INSPECTION

Plate inspection



**The FOERSTER system for plate inspection**

The PLATEPROOF testing system examines hot rolled plates in a single pass for internal defects such as laminations. The inspection includes the entire plate width, including longitudinal and transverse edges.

Following the ultrasonic inspection, the automated assessment software compares the detected flaws against official or individually created test standards. This determines whether or not these flaws must be recognized as defects requiring registration and documentation in the inspection report.

Thanks to its modular, compact design, the system can be integrated into either existing or newly planned production layouts. The clear and intuitive user interface for system control is easy to navigate, quickly enabling highly effective operation of the test system. Serviceability is simplified through the use of modern components, accessible design and a reduction to the absolute minimum in the number of parts requiring maintenance.

Everything you need for reliable ultrasonic testing

PLATEPROOF enables high-performance, non-destructive testing of your plates via ultrasound. It combines modern ultrasonic electronics – to detect flaws in the test material – with a robust and maintenance-friendly system design. Everything about the system is made to withstand the harsh operating conditions that are typical of rolling mills.

PLATEPROOF's design represents the culmination of our staff's many years of expertise, acquired through their continual support of numerous plate testing systems worldwide, as well as the manufacturing thereof.

This forms the foundation for the outstanding performance features incorporated into the PLATEPROOF system:

- **High system availability** – through the use of proven and robust modules with powerful modern components.
- **Testing in a single test run** – through individual adaptation to the specific plate dimensions, whether operated inline or offline.
- **High test volume** – due to fast test cycles for each plate. The short cycle times are achieved through an optimized control sequence using the latest Siemens control technology.
- **Highly sensitive flaw detection with good reproducibility** – thanks to modern ultrasonic electronics.
- **Automatic quality assessment of the plates**, as well as logging by the evaluation software, according to official or individually defined test standards.
- **Re-evaluation of plates** – based on stored test data.





The individualized testing system for special requirements

Our service promise goes well beyond just providing testing solutions. On request, we can offer any customer a solution individually tailored to their needs. In addition to providing reproducible proof of product quality, modern testing equipment generates valuable information that can be used to improve products and processes, in order to stop defects at their source.

As a result, our PLATEPROOF testing system opens doors to premium markets, helps you to secure your orders, and reduces competitive pressure. For this challenging task, FOERSTER is on your side.

Our customers say

“The second success is that (we) are using the UT data/ results to feed back into (our) steel producing. The data/ results from the UT have helped (us) make changes to (our) melting and casting processes. ... and it has been an invaluable tool to adjust (our) upstream processes.”

Whenever we customize a testing system, we keep in mind not only the requirements of the test itself but also external factors such as environmental conditions. The high detection sensitivity for internal defects and the reproducibility of the quality assessment form the core of the inspection. Modern ECHOSCAN ultrasonic electronics and specially adapted probes make a significant contribution to this.

In addition, FOERSTER offers customized solutions for individual testing tasks such as:

- **High alloy steel testing:** Our application laboratory determines the testability of individual alloys.
- **Testing of clad plates:** Our application laboratory is also at your disposal for feasibility studies around this task.
- **Testing of step plates** with changing thickness profile.
- **Detection of surface defects such as cracks on transverse edges.** The testing is implemented according to your own requirements or based on test specifications.

Such versatile options increase the system's utility: Even special plates can be efficiently and reliably examined in the course of regular ultrasonic quality assurance.

Individually planned and perfectly integrated

In modern plate rolling mills, automated ultrasonic testing (UT) plays an integral part in quality assurance. Our FOERSTER testing systems support you in reproducibly verifying your product quality, while they simultaneously provide insights into the manufacturing process – allowing you to make optimizations to keep defects from forming in the first place.

Our modular system concept simplifies the integration of the testing system into your planned production layout. In addition to precisely matched hardware components, individual software interfaces allow connection to higher-level systems for process automation and control (Level 1), as well as for process management and reporting (Level 2).

Whatever the final system configuration, all PLATEPROOF systems combine very good test sensitivity with high test speed. Test results are automatically evaluated according to known official standards or your own individual test standards. The robust mechanical and electrical components have long service lives, thus ensuring system availability – which, when taken together with the stable test sequence control, in turn ensures high test throughput. Our experienced FOERSTER service engineers are at your disposal for installation and commissioning of your test systems. Of course, the commissioning procedure is planned in close cooperation with you. We at FOERSTER have many years of

expertise in the design, construction and commissioning of a wide variety of testing systems. As your reliable partner, we look forward to helping you get the production in your rolling mill started up smoothly.

FOERSTER: Experienced partner for the integration of testing systems into existing production layouts

When integrating a new ultrasonic plate testing system into an existing production layout, a wide variety of requirements must be taken into account. Often, the challenge lies in finding the right place in the

production process that offers sufficient installation space. At the same time, the new plate inspection system must allow as many plates as possible to continue along their specified path without detours. Our proven, modular plant concept offers you full flexibility in your choice of testing and service sides. And the PLATEPROOF system's reduced space requirement greatly simplifies finding a good location for it. For long-term, trouble-free use of the system, we offer you individualized services in addition to spare and wear parts. Our competent service department will be pleased to assist you.



Courtesy of SMS group GmbH



Inline testing

Inline testing systems, i.e. those placed directly in the central material flow of the production line, are often used for controlling the quality of plates even before they reach the shearing line.

Testing coverage across the plate's width is supplemented by 'edge inspection carriages.' Depending on where the system is placed, the cut edges can be included within the inspected area, so that no edge remains untested on the finished plate.

High testing speeds and efficient test sequence control make the system ideally suited for inline use.

Offline testing

Offline testing systems are located outside the central material flow and are mostly used for quality control of cut plates.

For maximum testing coverage, the cut transverse edges are also inspected by the edge inspection carriages, in addition to the longitudinal edge areas.

Making quality visible

The quality of the tested material can only be determined by evaluating the resultant UT data against criteria from norms or individually defined standards. Based on these criteria, the detected defects are determined to be either above or below the limit at which they must be assessed and recorded as defects.

This important and responsible task is performed by our specialized ultrasonic software, which has proven itself through years of use in industrial settings.

The test data are evaluated and a corresponding inspection report is generated automatically upon completion of the test. The results are then displayed to the system operator.

For this purpose, the assessment software presents a graphical overview of the entire plate as C-, B- and D-scans showing all detected defects as well as the result data. In addition to the plate data and the evaluation result, the report includes the underlying inspection standard and detailed information on the defects.

A large number of common international test standards for evaluating product quality is already built into the assessment software. In addition, the software allows you to create individual rules for quality evaluation.



Automatic testing for high test capacity

To achieve such high test capacity, the PLATEPROOF system's test sequence control and its data interface to the process control (Level 2) are efficient. This allows you to quickly swap out plate data and define which test standard to use.

Using a variety of sensors, the inspection groups for testing the edge areas and the plate body are controlled automatically. Some of the sensors track the plate as it proceeds through the system, while other sensors serve to protect the equipment from damage.

Starting the test sequence

The automatic test sequence starts once an incoming plate enters the first light gate. From this point on, the system communicates with the roller table control via the Level 1 interface and specifies the transport speed.

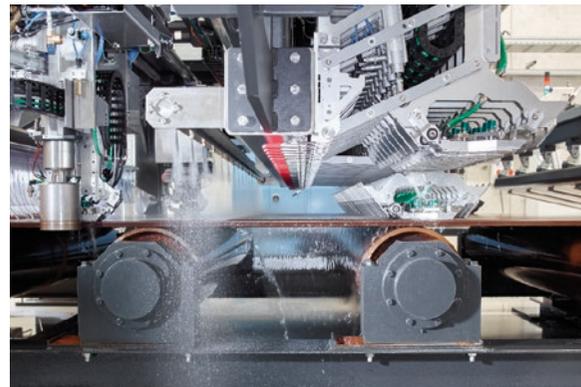


First, the plate must pass the height control to protect the system from mechanical damage. Exceeding the maximum height causes the test to be aborted. In the next step, a sensor measures the surface temperature to prevent heat damage. If the temperature is above the permissible range, the test is terminated.

As soon as the first odometer wheel touches down, the system begins tracking the position of the plate as it rolls through the test. This allows longitudinal coordinates to be assigned to the individual UT test shots. The lateral position of the plate on the roller table is registered via a plate position detector. This information is used for automated control of the inspection groups.

The ultrasonic testing

The edge inspection carriages reduce untested edge areas by actively following the longitudinal edges; in



the case of cut transverse edges, they can also be used to inspect the head and tail. This is followed by testing of the plate body. UT begins once the plate head reaches the edge inspection carriages, and it ends when the plate tail leaves the body testing unit. The UT data processing is carried out completely automatically.

End of the test sequence

Upon leaving the system, the plate travels past water wipers to remove the remaining coupling medium. The test sequence is completed once the plate tail passes through. The detected defects are then assessed according to the selected test standard, including logging and feedback via the Level 2 interface.



Ultrasonic method

Mode of operation liquid-coupled method

Ultrasonic testing (UT) is a non-destructive testing method for finding inhomogeneities in a material. It employs acoustic waves with a frequency above the range audible to humans: 'ultrasonic'. The typical frequencies used for testing metallic materials are in the MHz range.

The most common way to generate ultrasonic waves is by means of the inverse piezoelectric effect. This exploits the property of some materials that change their geometric dimensions when an electrical charge

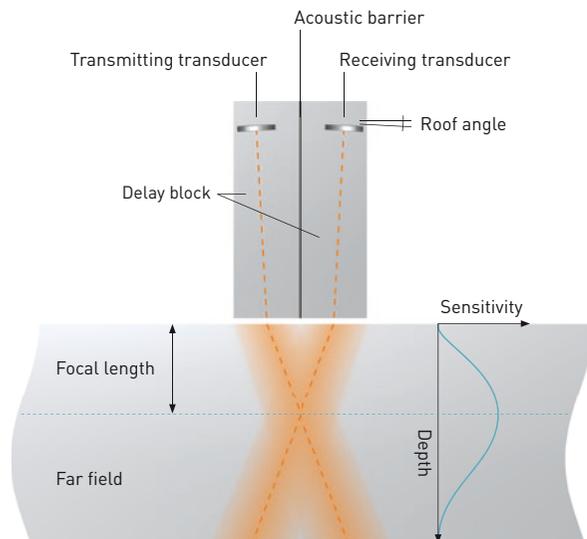


Figure 1

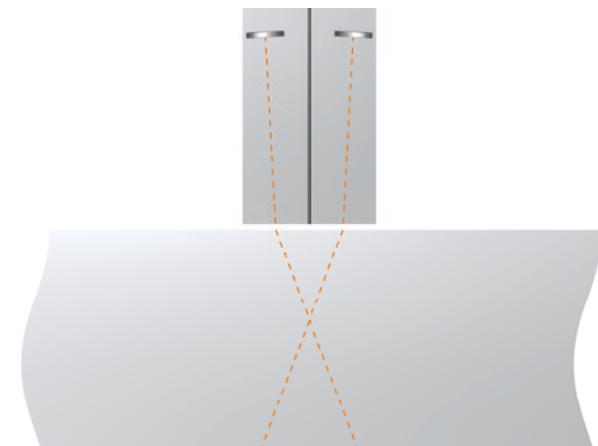
is applied. The piezoelectric element is the beating heart of an ultrasonic probe. For UT, the ultrasound generated in the probe must be transported to the material under test. Since the acoustic parameters of air are unsuitable for this, a coupling medium such as water or oil is used.

Testing with PLATEPROOF

So-called 'TR probes' are used for the automated testing of plates. These contain two transducers: a transmitter for generating and a receiver for recording the ultrasonic signals. The transmitter and receiver are separated by a sound barrier. The angle of the transducer's cap exerts an influence over its depth sensitivity. The highest sensitivity is achieved at the intersection of the acoustic axes of the transmitter and receiver.

The sound field describes the distribution of sound energy in the material; this is characterized by a near field, which merges into the far field. (Figure 1)

When testing workpieces without flaws, or 'reflectors', the ultrasound introduced by the transmitter is reflected at the back wall and picked up again by the receiver. (Figure 2)



A-scan

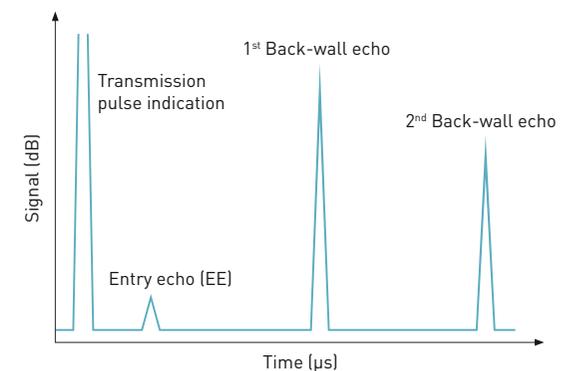


Figure 2

In the A-scan, the display shows the transmitter pulse followed by the entrance echo and the undisturbed backwall echo. Due to the weakening of sound as it passes through the material's structure, the amplitude of the regularly repeating backwall echoes falls steadily.



A-scan

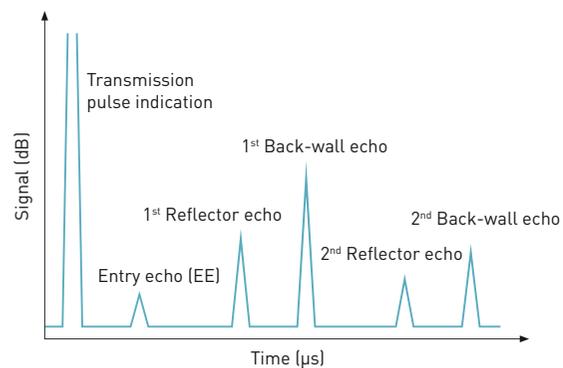


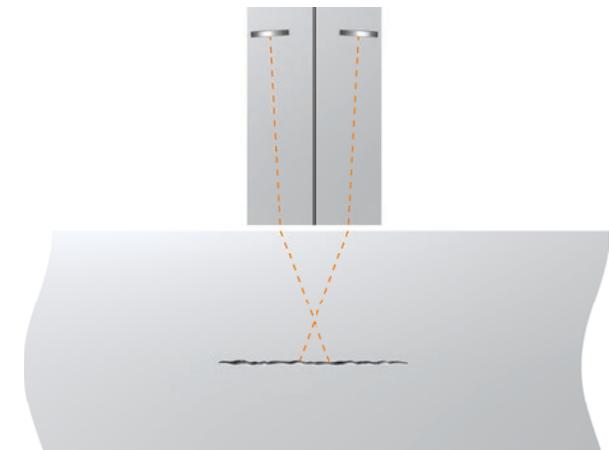
Figure 3

Reflectors that are smaller than the diameter of the transmitted acoustic beam reflect only part of the acoustic energy. The remaining part of the beam passes through the workpiece to its back wall and is reflected there. (Figure 3)

In addition to the backwall echo, the A-scan also shows the echo of the reflector with repetitions. Due to the partial reflection of the sound energy at the reflector, the backwall echo is reduced in amplitude.

Reflectors that are larger than the diameter of the transmitted acoustic beam reflect all the acoustic energy. The back wall is completely covered by the reflector. (Figure 4)

In this case, the A-scan shows only the repeating echo of the reflector. The obscured back wall produces no signal.



A-scan

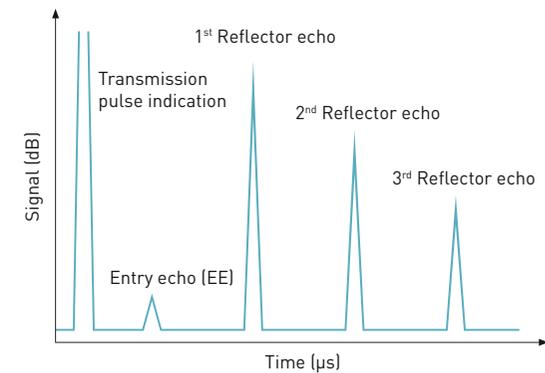


Figure 4

SOLUTION PROVIDER

FOERSTER offers solutions
for all your technologies



PLATEPROOF model unit

Our ultrasonic specialists will happily assist you with end-to-end technical advice. In our Technikum, there is a PLATEPROOF model unit available for carrying out an array of tests on customer-provided samples. Based on the test results, an optimal solution is then defined, both for the technical equipment and for the parameter settings. Our specialists draw on a wide range of expertise, so they can provide deep support in finding specific solutions to complex questions.

We offer the following services:

- Application consulting
- Execution of feasibility studies
- Development of customized solutions



Training

To help you get the most out of your test equipment from day one, we offer comprehensive product training for operators and users. Our training courses focus on the practical handling of FOERSTER test electronics and sensor systems. In addition to teaching the fundamentals and basic hands-on use, the courses explore the most important parameters for adapting a given instrument to the respective test line and test task. In-depth training for service and maintenance is also offered. The training content can be individually adapted to your requirements and conducted either directly on site at the respective test line or at our training center in Reutlingen, as desired.



Service

When it comes to FOERSTER test equipment, our customers count on top quality. In order to meet these expectations, a team of experienced service technicians and highly qualified engineers is available for onsite service and maintenance projects and, as necessary, for prompt and effective problem solving.

Issues often arise outside normal working hours. For this reason, our 24-hour emergency hotline can be reached 365 days a year. Our FOERSTER service specialists can even initiate systematic error analysis over the phone. When software installation or configuration questions come up, remote access can help clear up problems immediately, so your system is quickly ready for use again.





Institut Dr. Foerster GmbH & Co. KG

In Laisen 70 | 72766 Reutlingen | Germany
+49 7121 140 0 | info@foerstergroup.com

foerstergroup.com

Headquarters

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

Subsidiaries

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