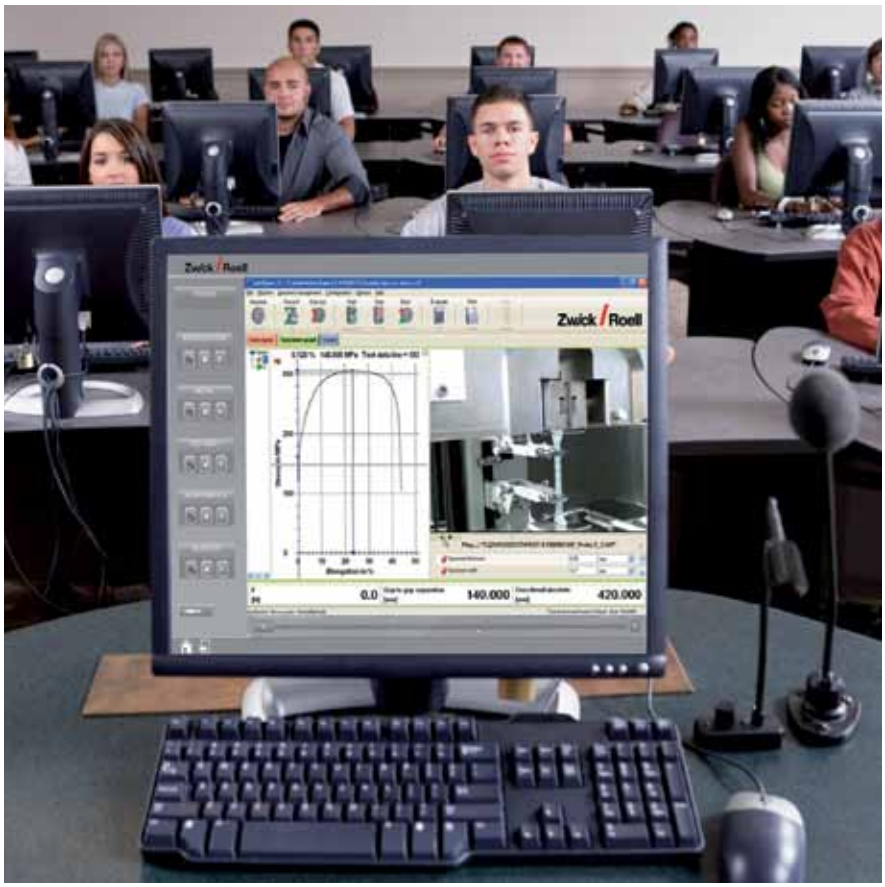
Zwick / Roell

Testing Systems

Solutions for Academia



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Intelligent Testing

Zwick / Roell

With passion and expertise

‚Passion in customer orientation!' Ask what our company philosophy is and that is our reply. Proof that these are not just empty words can be found in the fact that over a third of our employees are engaged in service and support.

As a family-run company with a tradition going back 150 years we attach great importance to honesty and fairness. Over the years a spirit of close collaboration based on mutual trust has developed between our customers, partners, suppliers and employees - something we all value highly.

„Global loops" center square at Zwick headquarters in Ulm, Germany

The foundation for a successful partnership: innovative employees, innovative products!

Always at your service

Our headquarters in Ulm alone have over seven hundred employees, many having been there for years or even decades. Their knowledge, skills and commitment are the reason behind the Zwick Roell Group's worldwide success.

More than 30% of our staff work in service and support. When our customers need us, we are there - in over 50 countries around the world.

The right solution

We can supply the right solution – for both static materials testing and for the various forms of fatigue testing. We have solutions for hardness testing, for impact testing and for melt index determination.

And if a solution turns out not to be right, our experts will find one that is, from the smallest adaptation to a fully automated testing system.

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Research and training solutions for academia

A substantial proportion of the development of new materials and technologies takes place in academic institutes. As a consequence a great deal of effort is invested in academic research and training around the world, both to increase competitiveness and to enable an adequate response to global challenges such as climate and environmental protection.

Zwick is also a long-standing supporter of these endeavours.
A specialist team with wide experience of the particular requirements of academic research and institutes is ready to provide specialized expertise and creativity as and when required. From planning your laboratory, to solving a complicated testing situation, to finding a support partner from our worldwide network – whatever it is, you've come to the right place!

Challenges imposed by new materials on research and materials testing

A current issue relating to the development of new materials is the reduction of energy consumption and the associated reduction of CO^2 emissions. To achieve this, lighter materials or materials with guaranteed mechanical properties at high temperatures are required. Flexible, reliable testing systems are essential for the development of these new, modern materials.

The successful completion of countless projects in the fields of research and training is confirmation that Zwick is the right partner for your requirements. Zwick has a long record of working with academic institutes and testing organizations to develop special testing applications. This collaboration consistently leads to the development of successful products, contributing to Zwick's pre-eminent position.

Fig 1: testXpert Education Module

Fig 2: Laboratory at University for Science and Technology Shanghai (USST)

Fig 3: AFRC, Advanced Forming Research Centre, University of Strathclyde: High-temperature testing (static and dynamic)

Zwick / Roell

Varied Applications for Higher Education

Zwick is active in more than 20 different sectors, with testing systems to suit all of them.

With its own applications laboratory and trained specialists in all relevant fields, Zwick can provide sophisticated solutions for any application.

Many of the testing applications used in these sectors were developed in collaboration with universities. This close co-operation ensures that Zwick is actively involved in current developments.

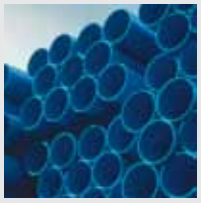
In this way Zwick contributes to the exchange between industry and higher education.

Zwick's many patents testify to our innovative drive.

In addition to this commitment to universities, Zwick is represented on numerous international standards committees, where our state-of-the-art expertise is applied to standardized industrial applications.

This wide-ranging experience from a broad spectrum of applications can be used to advantage in your laboratory.

Industry Overview


Plastics


Metals


Automotive


Medical


Textiles


Paper


Composites


Mechatronics


Building Materials


Aerospace

Testing of Metals


Tensile test


Sheet metal testing


High-temperature testing


Hardness testing


Pendulum impact test


Biaxial testing


High-speed testing


Fracture mechanics

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Testing of Plastics

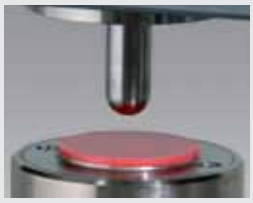

Tensile test


3-point flexure test


Compression test


Hardness testing


Impact testing

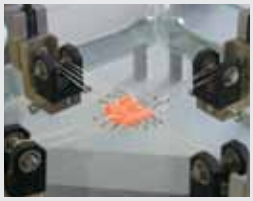

Puncture test


Extrusion test


Fatigue testing

Testing of Other Materials


4-point flexure test of cardboard


Biaxial test on artificial tissues


Viscosity test


Fatigue testing of a rotor blade


Fatigue testing of asphalt

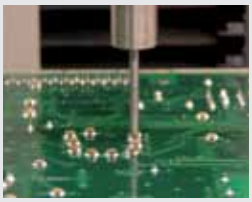

Shear test of wood


Tensile test of textiles


Compression test of springs


Testing of syringes


Horizontal testing of catheters


Testing of soldered pins


Testing of actuators

Zwick Roell

Zwick Modular System for Individual Testing Requirements

Static Testing Machines


Material testing machines


Sheet metal testing machines


Torsion testing machines


Biaxial testing machines

Dynamic and Fatigue Testing Machines


Servo-hydraulic testing machines


Vibrophores


Pedulum impact testers


Drop weight testers

Testing Instruments


Hardness testers


Vicat testers


Nanoindenters


Extrusion plasto-meters

Testing Software / Measurement and Control Electronics


Testing software


Electronics

Load Cells, Specimen Grips, Extensometers etc.


Load cells


Specimen grips


Contact measuring systems


Non-contact measu-ring systems


Temperature chambers


High-temperature furnaces


Specimen prepa-ration


Automation

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Static Testing Machines

Table-top models - AllroundLine
Several different table-top machines are available for standard tests in a load range up to 150 kN. They possess two columns constructed of patented aluminium hollow profiles. These are light, extremely rigid and act both as lead-screw guides and protection.

The AllroundLine table-top models can be provided with a free-standing support frame, enabling the test area to be positioned at the optimum height for the operator or the application. This allows the machine to be operated conveniently from a sitting position with completely free leg-space, making the system well-suited to operation by wheelchair-users.

Floor-standing models - AllroundLine
Floor-standing models with electro-mechanical drives are available in a load range from 100 kN to 2,500 kN and are often used for tensile and compression tests on materials specimens or structural components.

The extremely stiff load frame design featuring two or four guide-columns ensures optimum conditions for exact alignment of test axes.

The load frames can be equipped with one or two test areas, while the lower crosshead can be supplied as a mounting platform for component testing. For torsion tests the load frame is equipped with torsiondrive plus testControl II and appropriate sensors.

The AllroundLine table-top models are available up to 150 kN, the floor-standing models with electro-mechanical drives are available in a load range from 100 kN to 2,500 kN

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testControl II measurement and control electronics and testing software testXpert II

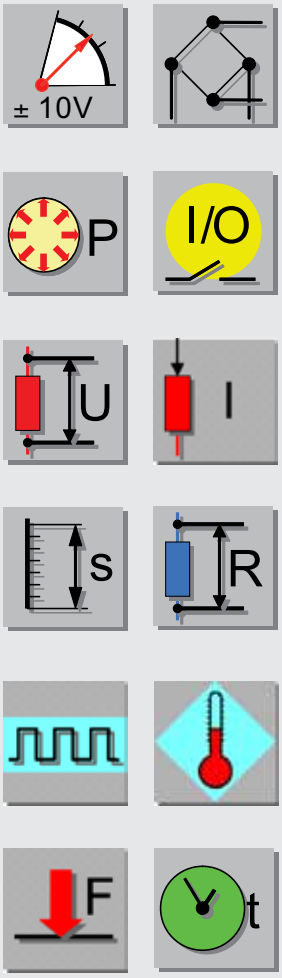
testControl II is 100% 'Made by Zwick' and is ideally suited to all testing requirements. Analog measured values are sampled at a rate of 400 kHz and processed at a measurement data rate of 2,000 Hz, resulting in a resolution of up to 24 bits, enough for even the most detailed review and evaluation of measured values.

State-of-the-art control algorithms implemented in testControl II's firmware make testing extremely simple, whether displacement, stress or strain-controlled.

As well as state-of-the-art measurement signal preparation technology, testControl II provides all the interfaces additionally required for research and development. External measurement amplifiers, 0 to 10 V analog and other signals can easily be connected to testControl II.

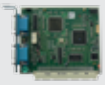
testControl II system overview

Measurement signals



Zwick module bus

USC module
e.g. for load cells



CAN module
e.g. for automatic extensometers

INC module
e.g. for digital clip-on extensometers

I/O module
e.g. for transducers and switches

NIexpress card
- 8 x 16 bit analog In
- 2 x 16 bit analog Out
- 24 digital I/O 5 V TTL

O - IO V analog signal

NI USB
- 16 x 16 bit analog In
- 4 x 16 bit analog Out

Strain-gage integration

Strain-gage box
- direct connection to testControl II
- up to 4 measuring points (depending on vacant slots)
- can be used as control channel

HBM
- multipoint measuring point ≥ 4
- additional signals incl. pressure, resistance, current etc.

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Signal processing

All signal acquisition is completely time-synchronous. A special feature for academic research: a National Instruments DAQ card can be plugged in directly on the testControl II mainboard via a standardized PCI Express interface.

Measurement amplifiers

HBM or National Instruments external measurement amplifiers can be connected to the testControl II PC via the USB or Ethernet interface. Measured values are synchronized to testControl II via a special HW cable.

Future-proof

testControl II measurement and control electronics are the future-oriented platform required for research and development.

Advantages

Maximum accuracy
Maximum measured-value accuracy combined with large measuring range thanks to high (24-bit) resolution and A/D converter with 400 kHz sampling.

High measured value rate
Synchronous measured-value acquisition-rate of 2 kHz (regardless of number of measurement channels) for fast measurements combined with maximum reproducibility.

Adaptive controller
Automatic setting of all control parameters enables exact approach to target positions. Changes in specimen properties are compensated for online.

AC drives
The powerful, low-maintenance AC drive enables cyclic tests to be performed at maximum speed up to nominal load – with no waiting times between tests

Synchronism
All signal acquisition by testControl II is time-synchronous. This applies to signals acquired directly via testControl II and also to those acquired via external measurement amplifiers.

testXpert II
All test data are available online in testXpert II for additional processing. All functions for evaluation, export or data processing in general are available.

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testXpert II – Intelligent and Reliable

With testXpert, Zwick has set the standard for intelligent and sophisticated materials testing software used for the most in-depth research applications. By using testXpert II you will reap the benefits of more than 80 years' experience of materials testing and over 20,000 successful testXpert installations worldwide.

The special All-In Suite Education package gives you access to all available testXpert II programs, features and options.

Below are some of the functions which have proved particularly valuable in both research and training.

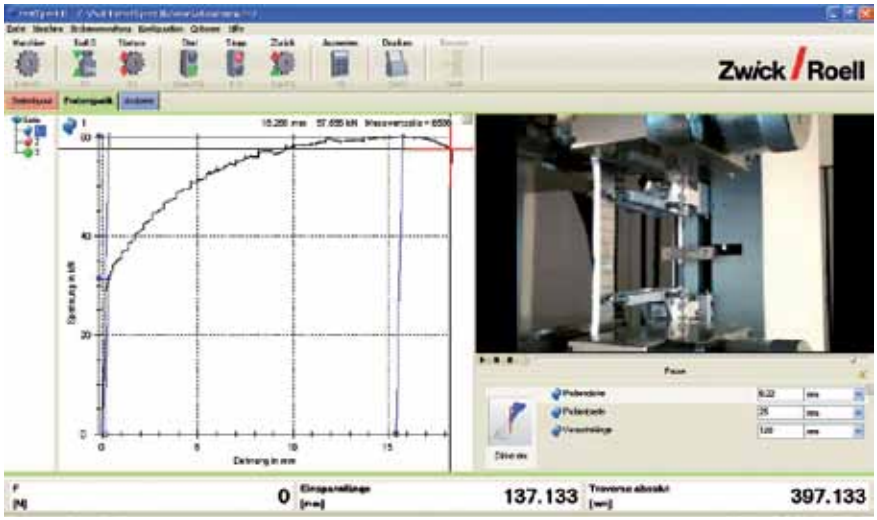

Fig 2: testXpert II with synchronized video

Prepared Standard Test Programs

For almost every international testing standard, testXpert II contains a ready-made standard test program. Students can be sure of testing in compliance with standards during their training and will gain a better understanding of the standard in question by working with this standard test program.

Synchronized Video Recording

A test can be recorded with an ordinary video camera and the video images synchronized with the test data from the testing machine.

When the video is played back inside testXpert II, a crosswire highlights the associated point on the x-y curve.

Result Evaluation

In addition to calculating standard results the results editor provides easy access to all typical algorithms. Easy-to-follow software-wizards are guiding you to define new reference values, maxima, slopes or peak values.

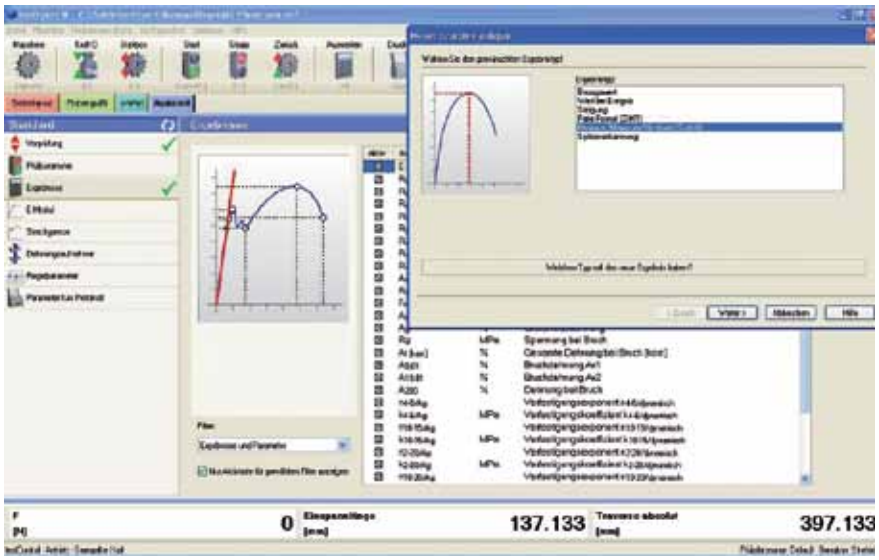

Fig 1: Result assistant in testXpert II

ZIMT Integrated Macro Language

ZIMT (Zwick Interpreter for Materials Testing) is a flexible programming language which is integrated into testXpert II and which gives you access to all test data and many other functions, making it easy to produce your own calculations, displays and macro functions.

The ZIMT editor offers syntax highlighting and context-sensitive help.

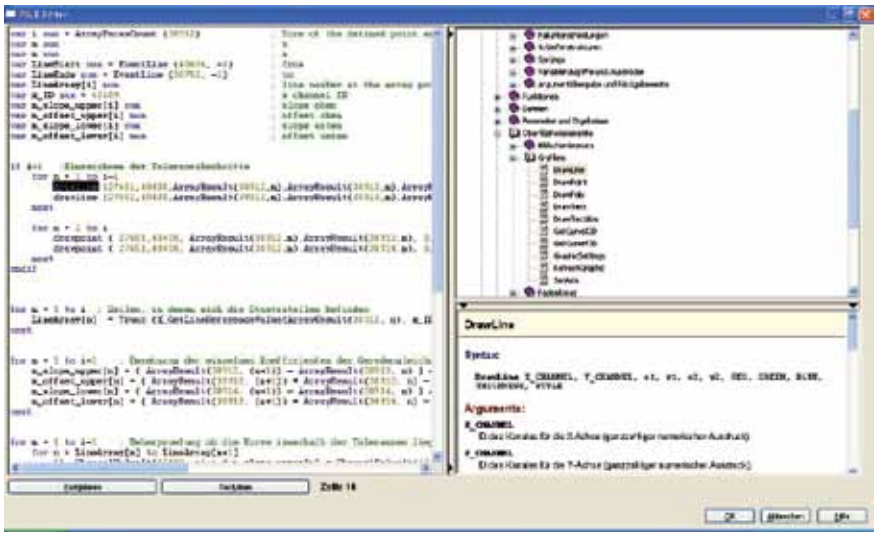

Fig 2: testXpert II ZIMT-Editor

Free Sequence Programming

Research in particular often calls for a freely programmable testing machine. testXpert II's graphic sequence editor is an extremely powerful tool, allowing you to program desired test sequences using a graphic user interface using simple function blocks based on a flowchart principle.

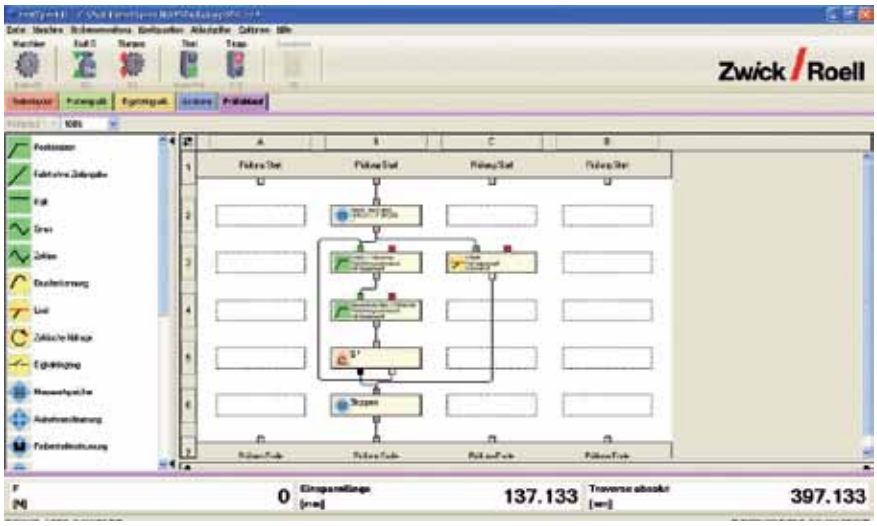

Bild 3: testXpert II graphical sequence editor program

Statistical Evaluations

All common statistical values are available for evaluation, with an integrated option for displaying them as a histogram.

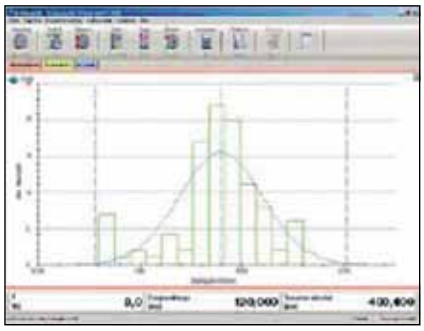

Fig 1: testXpert II histogram

Comprehensive Export Interfaces

All data from testXpert can be exported very simply via standardized software interfaces to all common windows applications. The testing machine can also be linked to NI LabVIEW and its comprehensive options via testXpert II – an ideal combination.

Below is a selection of programmes with which testXpert II data can be synchronized:

- LabView
- MS Excel, Access, Word
- SAP
- Oracle
- ASCII

Zwick / Roell

Load cells

Load cells must satisfy the most exacting quality requirements.

The basis for this is calibration to ISO 7500-1 or ASTM E4 performed in-house at Zwick. DAkkS, COFRAC or NAMAS re-calibration can be performed by our field-service engineers, ensuring that you can always rely on your testing machine.

But Zwick load cells can do much more than this. Automatic identification combined with integrated zero-point and sensitivity adjustment ensure that any load cell can be used with any testing machine.

Temperature compensation means that measuring is largely independent of the current ambient temperature.

Fig. 2. Every load cell is calibrated by Zwick as soon as it is put into service on a testing machine

This all takes place over an extremely wide measuring range, within Accuracy Class 0.5 or 1.

Xforce HP and P load cells offer a linearity better ± 1% already from 0.1 % of their full scale force.

Fig. 1: Load cell from the Xforce range employing multiple beams

Fig. 3: Xforce HP model using the ring-torsion measurement principle

Extensometers

Deformation measurement, from which strain is derived, is a core function of materials testing. Zwick's comprehensive range of extensometers can basically be divided into contact and non-contact systems.

There are in addition still very many applications which employ strain gages applied directly to the specimen.

Contact extensometers

Special mention in this category goes to automatic systems such as makroXtens and multiXtens, which independently set an assigned gage length and automatically attach to the specimen at the correct time, eliminating many operator-dependent measurement uncertainties.

Non-contact extensometers

Predominant in this group are optical systems, which offer the advantages of automatic contact systems, but without specimen contact.

This opens up new areas of application, such as very sensitive specimens or very high temperatures. With our laserXtens system, deformation can be measured at up to 1,200 °C through a window in a furnace.

Fig. 3: Mechanical measurement, automatic attachment: makroXtens

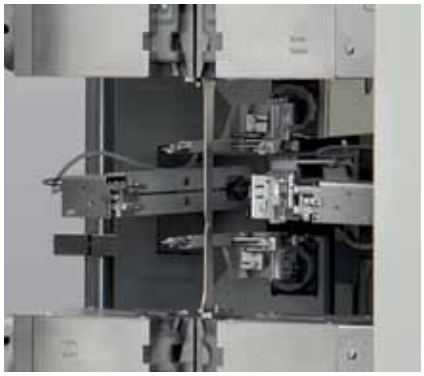

Fig. 4: multiXtens extensometer

Fig. 1: videoXtens non-contact extensometer

Fig. 2: Non-contact extension measurement with laserXtens, also suitable for micro-specimens

Fig. 5: Strain gage connected directly to testControl II via a pre- configured in-line switchbox

Dynamic and fatigue testing machines

Servo-hydraulic testing machines are all-purpose machines for materials and component testing under pulsating or alternating loads with periodic or random signals. Quasi-static and rapid loads are also easily applied.

Servo-hydraulic testing actuators are extremely flexible in use. Locating the test frame on a T-slotted platform produces an ideal test arrangement for component testing.

Fatigue testing

The S-N curve is an important starting point for many durability calculations for components which are to be loaded to their tensile strength and fatigue limits. The aim here is to design components so that they reliably perform their intended function for the planned length of time at a minimum weight.

High-speed testing

The majority of tensile, compression and shear tests are performed under quasi-static loading at deformation rates of around 0.01 1/s. In practice, materials and components are subjected to significantly higher loading rates in service; many mechanical properties are dependent on the loading rate, however. Special servo-hydraulic drives allow strain rates of a few hundred s-1 to be attained, depending on the length of the specimen, as required for numerical calculation of crash safety.

Fig. 1: Zwick Vibrophore for high testing frequencies (up to 300 Hz) in resonance, classical HA 100 servo-hydraulic testing machine, HTM 5020 high-speed testing machines (50 kN and 20 m/s)

Zwick / Roell

testControl II and testXpert® R for servo-hydraulic testing systems

testXpert Research assists the user in defining, evaluating and documenting tests. The workflow-oriented design divides test set-up and performance into sensible steps, making software operation as intuitive as possible.

In addition to individual control algorithms, the testControl II firmware features 10 kHz measured-value acquisition rate and control frequency and 24-bit resolution with 400 kH sampling rate, ensuring ample test data and optimum control quality.

Standardized PID controllers plus an expanded peak-value controller are available. User-specific control algorithms can be developed, for example with Matlab, while open export interfaces allow data exchange with all common formats such as Excel etc.

testControl II with testXpert® R and testXpert® II

With testControl II as the measurement and control electronics, testXpert Research and testXpert II can in principle be used for operation on both electro-mechanical and servo-hydraulic testing machines. This allows all quasi-static tests such as tensile, compression or flexure tests to be performed on a servo-hydraulic machine and enables all typical dynamic software functions to be used on an electro-mechanical machine. This combination opens up completely new applications, making each Zwick materials testing machine even more versatile.

A testing system for dynamic and quasi-static tests

Servo-hydraulic testing machine for dynamic and quasi-static tests

Electro-mechanical testing machine for quasi-static tests and applications with special control requirements

Zwick Roell

Low cycle fatigue (LCF) tests with testXpert® R

This test program is used for strain-controlled determination of low-cycle fatigue in metals in accordance with ASTM E606. A triangular wave-form with constant amplitude is generally used as the set value. Sine signals are also possible.

testXpert Research has all the functions required for detailed evaluation of test results.

Freely configurable recording of test cycles provides ample data for accurate determination of all effects such as work hardening or softening.

Fig. 1: LCF test at high temperature with extensometer attached

Fracture mechanics tests with testXpert® R

Two test programs are available for determination of the principal fracture mechanics properties; one for determining critical stress intensity factor K_{1C} as per ASTM E399, the other for crack growth dA/dN as per ASTM E647.

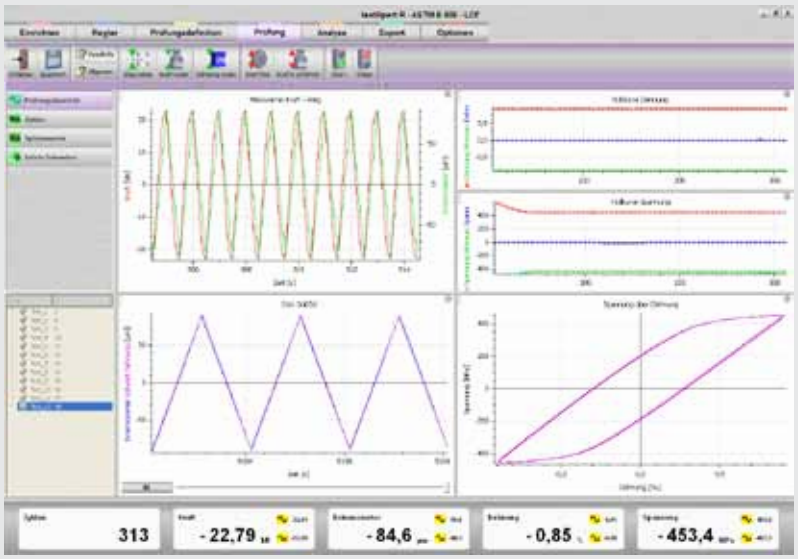

Fig. 2: LCF test, showing hysteresis loops, failure envelope and set/actual value

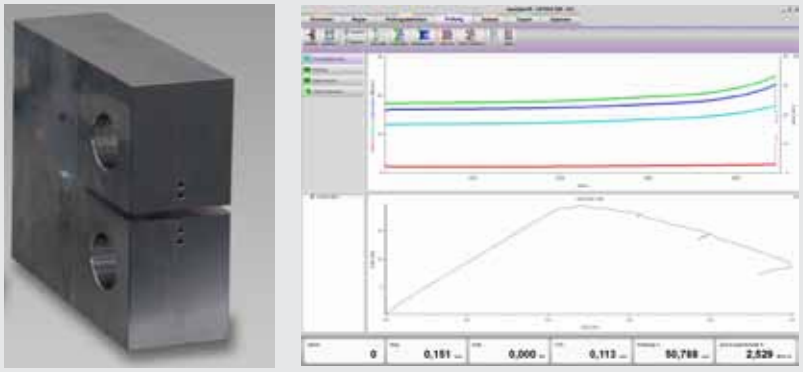

Fig. 3: CT specimen, pre-cracking specimen and travel up to break with testXpert Research

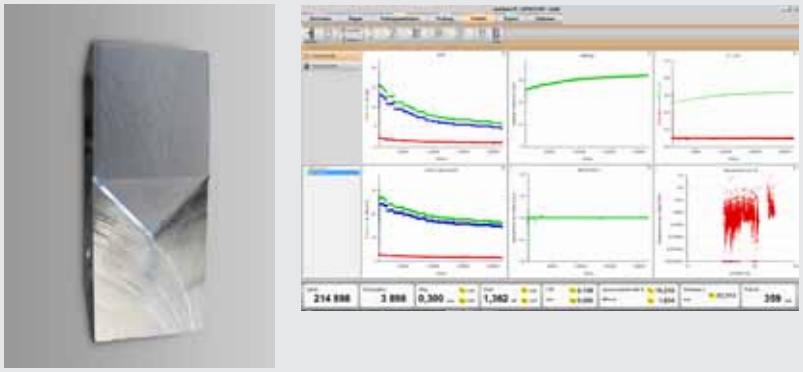

Fig. 4: Fractured specimen, display showing force, crack length, R+a/W, stress intensity, crack growth and crack growth per dK

Zwick / Roell

testXpert® R Sequencer – the graphical block editor

testXpert Research Sequencer testing software is a graphical block editor for intuitive compilation and performance of simple or complex test sequences.

As many blocks as required can be parameterized. Definitions of set-value functions from ramp, sine and triangle/trapezoid are possible with freely selectable start directions.

Control-path switching between individual blocks is possible and blocks can be linked to each other via sequence loops. The test sequence is completed in the order shown on the screen. Limits plus tolerance ranges can be set. Test-data acquisition with peak values (failure envelope) and hysteresis is possible, while the test-data grid can be freely specified.

Fig. 1: Servo-hydraulic testing machine with high-temperature furnace

Fig. 2: Test sequence definition (block programming)

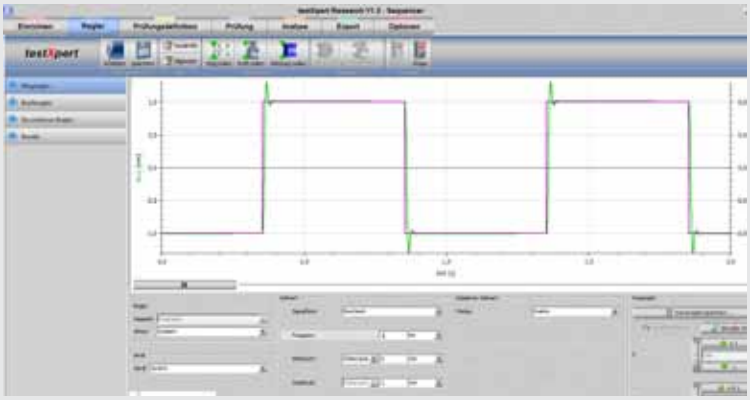

Fig. 3: Controller optimization with set-actual value oscilloscope

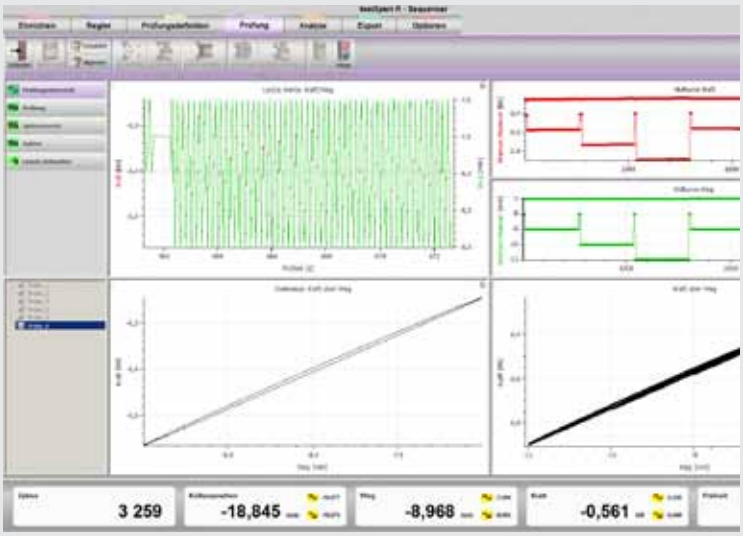

Fig. 4: Measured value display

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Additional testing applications

Tests at different temperatures

The purpose of optimization of materials at high temperatures is to increase the efficiency of heat engines. Thermodynamics tell us that the maximum efficiency of such a machine increases at (1 T_{min} /T_{max}). In a gas turbine, temperatures up to 1,500 °C occur at the first-stage turbine vanes. The development of such high-temperature materials requires highly accurate knowledge of mechanical properties at these temperatures.

On the other hand, materials must also be characterized at very low temperatures - for use in aerospace applications or for storing liquid hydrogen, for example.

Medical engineering in particular uses many materials in a medium at 37 °C or employs special shape-memory alloys such as nitinol for manufacturing stents; these must be tested under defined temperatures or temperature sequences.

Fig. 3: Tensile test at 70 °C with optical strain-measurement

Fig. 1: Fatigue test at high temperature

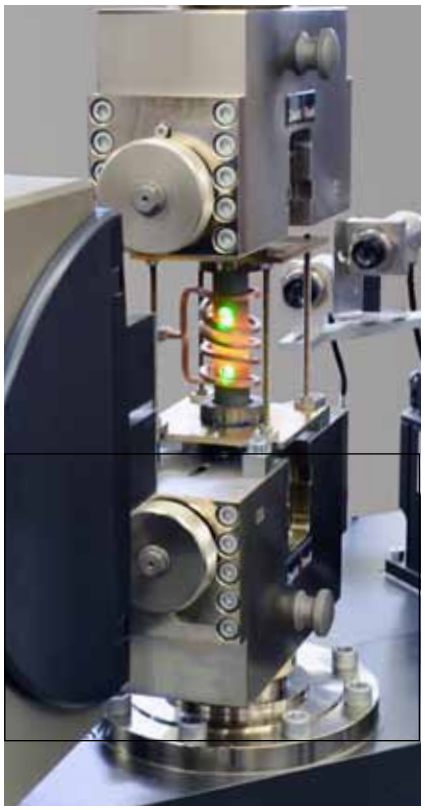

Fig. 2: Test with induction heating coils and laser extensometer

Fig. 4: Tensile test at 37 °C (+ water-bath) with video extensometer

Zwick / Roell

Tests under multiaxial stress states

There is an increasing need for test data from multiaxial loads to enable better simulation of real, multidimensional loading conditions for components.

In practice, a number of different test assemblies have proved effective in providing a better description of the three-dimensional loading state, consisting of normal and shear stresses.

Various approaches, with stresses and torsion superimposed in multiple axes, are employed.

Fig. 2: Biaxial testing machine with superimposed torsion

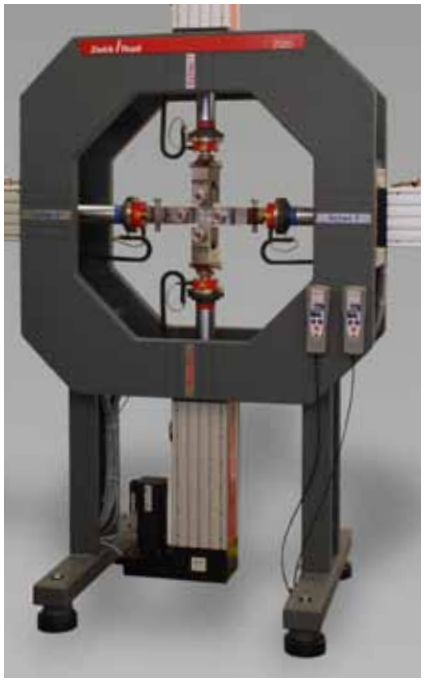

Fig. 4: 30 kN biaxial testing machine

Fig. 1: Tensiontorsion tests at high temperature

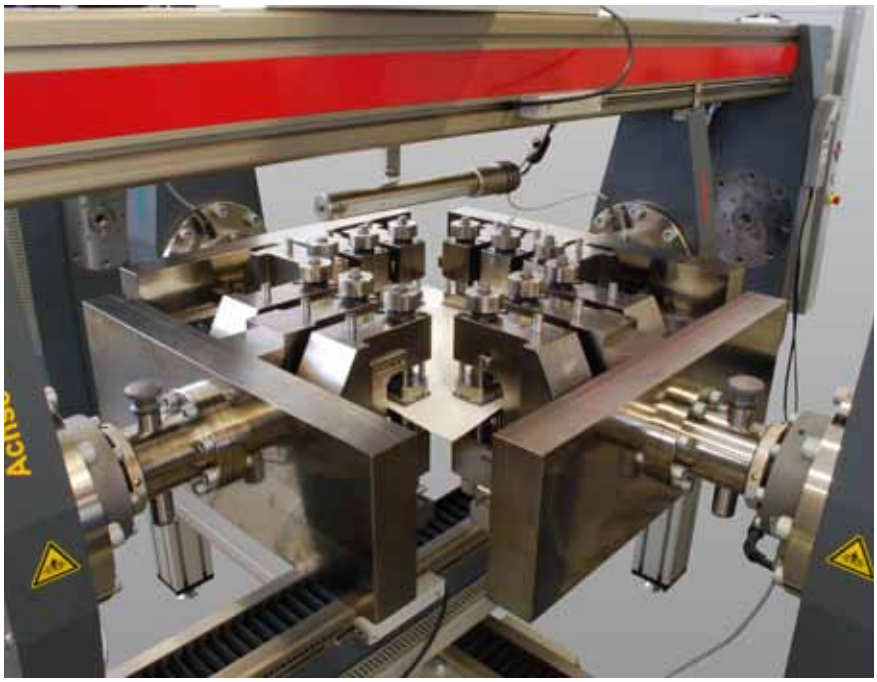

Fig. 3: Horizontal biaxial testing machine for geotextiles

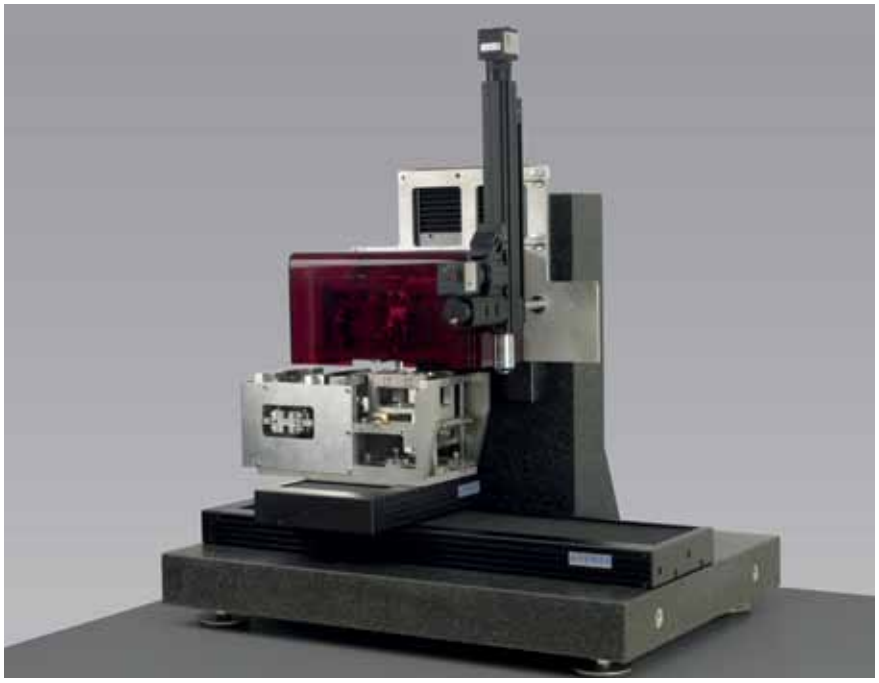

Fig. 1: UNAT- universal nanomechanical tester

Nanomechanical investigations

The characterization and analysis of the mechanical properties of surfaces and thin films and coatings in the lowest force ranges – microindentation as per EN ISO 14577.

With two completely independent measuring heads, the UNAT can be used to measure normal and lateral force displacement curves (lateral force unit LFU) with a resolution better than 1 nanometer. Both measuring heads can be used in the compression and tensile ranges. For the normal force unit a distinction can be made between two different force ranges – the high-load measuring-head (up to 2000 mN) and the low-load-measuring head (up to 200 mN).

Instrumented indentation test

Some years ago the classical hardness test methods such as Vickers, Rockwell and Brinell were augmented by an additional standardized method (ISO 14577, instrumented indentation test, Martens hardness).

The instrumented indentation test uses the measured values of test load and indentation depth during loading and unloading. In contrast to the classical methods, these are recorded and evaluated continuously. In addition to hardness values, indentation energy and indentation modulus can be derived from the curve chart. The method can be used for virtually any material and possesses a standardized hardness scale on which the various materials can be shown.

Fig. 2: Zwick ZHU2.5/Z2.5 hardness testing machine

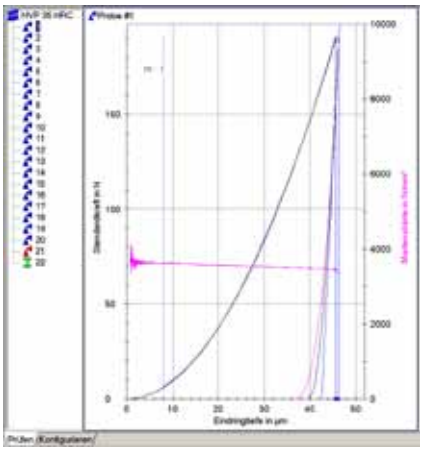

Fig. 3: Test results displayed in testXpert

Zwick / Roell

Solutions for Education

Education Module

The testXpert II Education Module is the ideal complement to classical teaching methods such as lectures, seminars and practical laboratory work.

In the first stage the principal types of test for various materials are presented in video sequences synchronised with test data from the materials testing machine.

On-screen captions provide information regarding what is taking place in the video at key moments.

Fig 1: The video picture and the data curves are exactly synchronized

In this way students receive a visual impression of a test reinforced by written explanations.

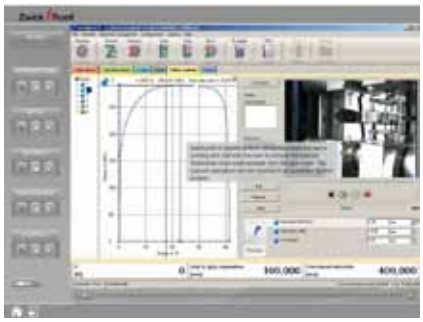

Fig 2: Speech bubbles explicate the video pictures

A short quiz after each video sequence reviews what has been learned.

The next step involves working with testXpert II – with all data available for detailed analysis.

Fig 3: Multiple-choice quiz questions

It is at this stage that teachers can integrate the testXpert II Education Module into their individual curriculum – with access to all testXpert II functions.

After completion of these steps students will be able to carry out tests independently using Zwick's unique

Fig 4: Analyse of the test data in testXpert II

Virtual Testing Machine (VTM). Many different materials and sensors can be simulated with the VTM, which can be enhanced using your own materials, making the testXpert II Education Module an ideal fit for your individual curriculum.

Fig 5: testXpert II with faded in virtual testing machine

The Virtual Testing Machine opens up completely new opportunities for virtual training.

You can use it to create your own virtual specimens and make these available to your students. If for example you wish to explain to your students the link between the carbon content of steel and its mechanical properties, simply prepare the relevant specimens for the VTM and let your students find the connection.

The Education Module is the ideal complement to your curriculum.

Zwick / Roell

Individual Offers for Universities

A comprehensive range of testing machines with favourable prices is now available to the higher education sector.

Make sure your university requests the special Zwick offers.

If your testing machine is primarily used for student training, you will be entitled to special conditions when ordering. The testXpert II Education Module and the testXpert II All-In-Suite Education are free for all your students when used with the machine.

Fig 2: Laboratory with Zwick machines at the NTU Singapore, school for mechanics and aerospace

References from Education and Training

Over 350 installations annually in R&D and training/education make this one of the most significant fields within the Zwick Roell Group. Future users can profit from the experience gained by Zwick in the past. Zwick frequently works in close collaboration with universities to find joint solutions to current issues.

Bild 3: Labor an der University for Science and Technology Shanghai (USST)

Fig 1: Education Laboratory at the Technical University of Dresden

Fig 4: Laboratory with Zwick equipment at the Technical University of Nanjing

Zwick Science Award

A considerable part of the development of new materials and technologies takes place in universities. Zwick supports well-known institutes around the world with special testing solutions for a wide range of applications.

The Science Award reflects Zwick's aim of promoting and rewarding innovative material research. Every year Zwick presents an award for the most innovative use of a materials testing machine in scientific work. The closing date for submissions is always the end of the year; full additional information is available at www.zwick.com/scienceaward.

Fig. 2: Zwick supports scientific research to the tune of €8,000 annually. Full details of the Science Award are on the Internet and at www.zwick.com/scienceaward

Zwick Science Award applications

Fig. 1: 1st place 2009, „Extrusion of complex preforms for microstructured optical fibers", University of Adelaide

Fig. 3: 1st place 2011, „Fracture thoughness of locust curticle", Trinity College, Dublin

Fig. 4: 2nd place 2011, „Biaxial tensile testing apparatus" Nihon University

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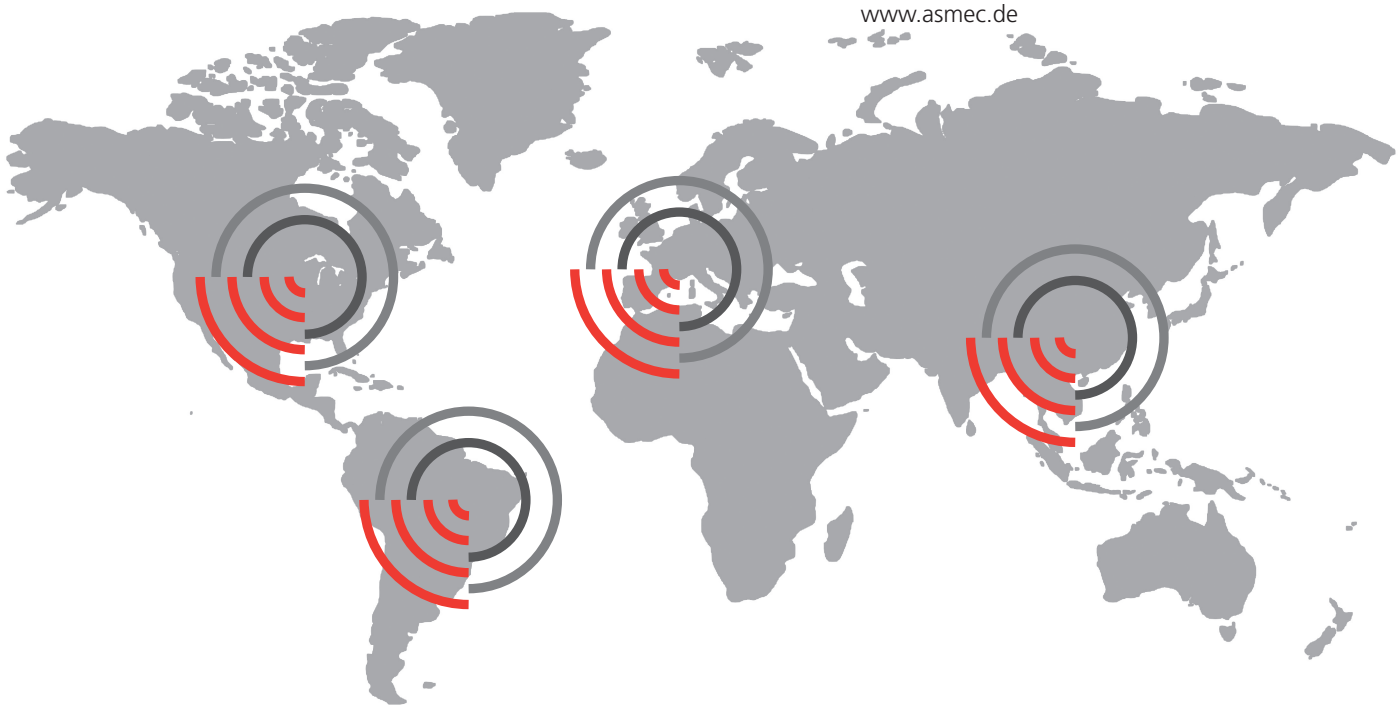

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