



Accredited laboratory

Services of the physical-technical test laboratory



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Your laboratory team

We are at your side – right from the start

Independent of the origin, if it is a Böllhoff product or a product from a different manufacturer, the accredited Böllhoff test laboratory is the right contact for physical-technical testing in every phase of your product's life cycle within the scope of

- Product development
- Quality assurance
- Tests according to national, international and customer-specific standards
- Initial sample tests
- Damage claims
- Complaints



From left to right, front to back:

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Team leader PMÜ

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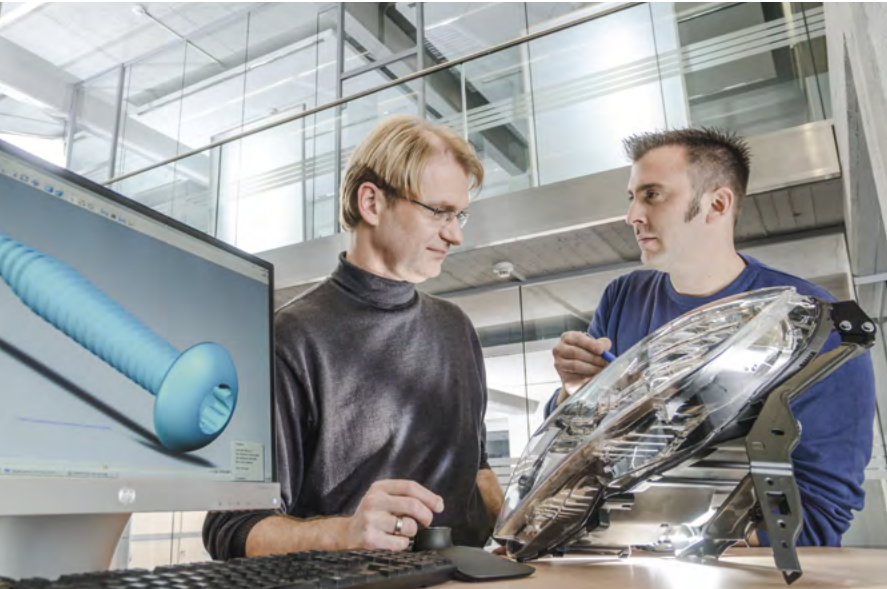
Peter Buschmann
Laboratory staff

Heinrich Fast
Laboratory staff

Andreas Jakobsche
Laboratory staff

Jörg Hohlbein
Laboratory staff

Quicker and better results based on professional cooperation



Accredited professionalism is a tradition at the Böllhoff laboratory.

For over 20 years, the laboratory has been meeting the highest requirements. New test procedures are added every year and the laboratory invests in test equipment with state-of-the-art technology.

Many interested customers take the opportunity to visit the laboratory to see the latest processes in action and to share Böllhoff know-how in mechanical joining technology.

Especially in the area of product development and application technology consulting, you benefit from the bundled expertise in combination with the accredited laboratory by:

- Quick definition of the task
- Exact and fitting development of the appropriate joining technology solution
- Prototype manufacturing in the laboratory's own prototype building unit
- Solution verification by determination of the mechanical and physical values
- Inclusion of practice-related conditions in the test
- Documentation of results according to standards

Technological lead through knowledge with the Böllhoff Academy

As part of the Böllhoff Academy, the physical-technical laboratory offers further training for Böllhoff employees and technical seminars for external participants. Our technical seminars are characterised by interesting lectures by experienced speakers, new impulses and approaches as well as many practical examples. This further training concept stands for excellent knowledge transfer to the professional environment and enables participants to ask individual questions.

There are specialist seminars on the following topics:

- Hardness tests in practice: Own samples can be prepared and tested as part of the training
- Microstructure and properties of heat-treated steel
- Classical and modern steel
- Hardening and tempering of steel
- Surface defects on fasteners
- Corrosion and corrosion protection of fasteners
- Damage analysis on fasteners
- Test methods on fasteners
- Auditor training for process audit heat treatment
- Basics of material technology for apprentices in a metal profession

Our seminars are addressed to:

- Engineers and technicians
- Staff in technical laboratories and operators of material test equipment
- Employees in quality management and in the steel processing industry
- Employees from purchasing, production and sales who deal with fasteners

At the end of the seminar you receive a certificate of attendance.

A selection of topics will be offered within the scope of specialist seminars every year. In-house trainings on chosen issues can be held on request at short notice at a location of your choice.



The Böllhoff test laboratory is accredited in accordance with **DIN EN ISO/IEC 17025:2018*** for:

- Mechanical-technological tests
- Metallographic tests
- Surface and dimensional tests on fasteners made of metallic material
- Examination of low and high-alloyed steels using optical spark emission spectrometry
- Salt spray testing

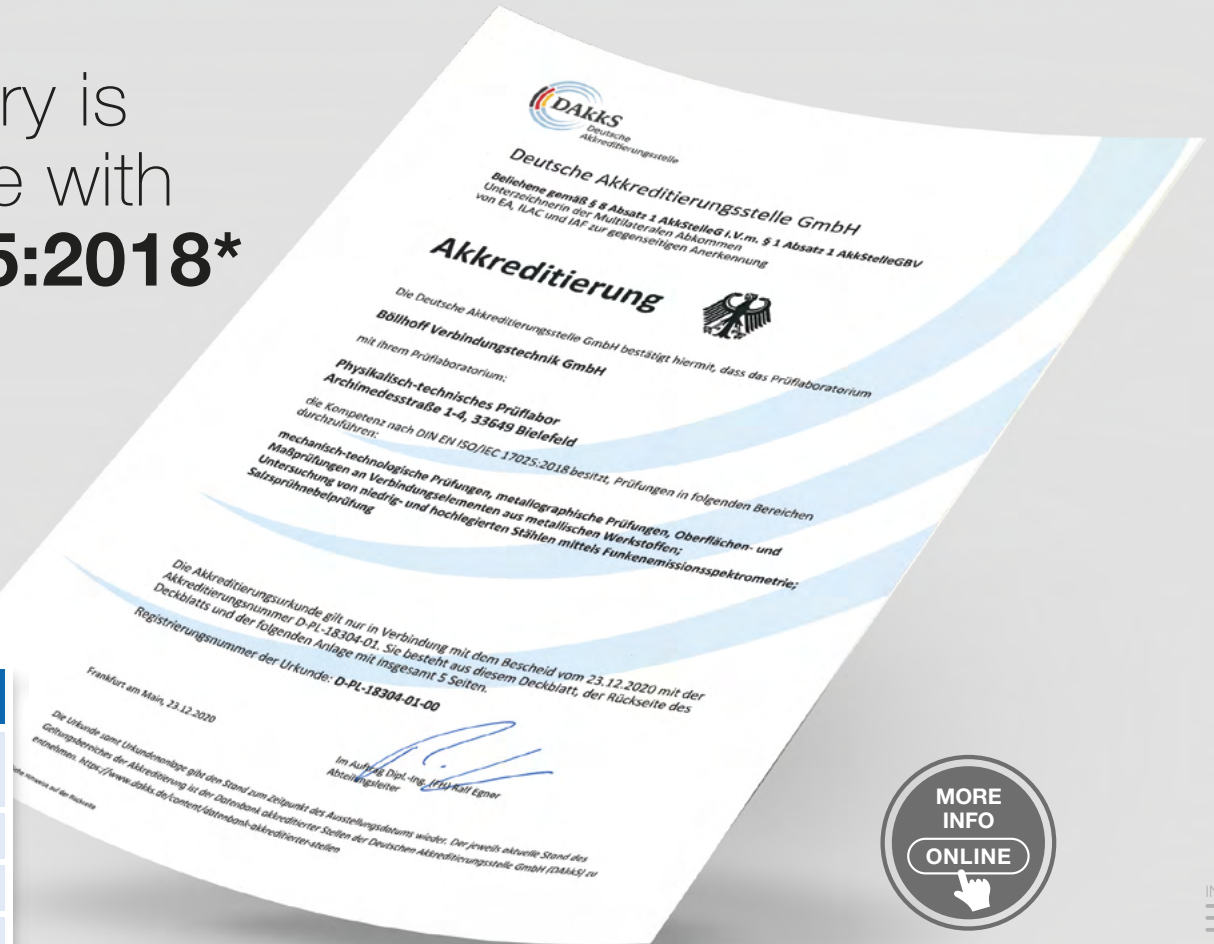
Your advantages

The Böllhoff laboratory is professionally and technically competent. This is regularly verified on-site by the German Accreditation Body (DAKkS).

An effective management system for quality assurance is established.

Independence and impartiality towards third parties is guaranteed.

Test reports from accredited test laboratories are recognised globally.



* The accreditation applies to the procedures listed in the annex to the accreditation certificate.
Registration number: D-PL-18304-01-00

As soon as it has to be clarified whether a material can hold out against all parameters under given conditions, the physical-technical test laboratory is called on with one or more or all of “**THE BIG 5**” tests:

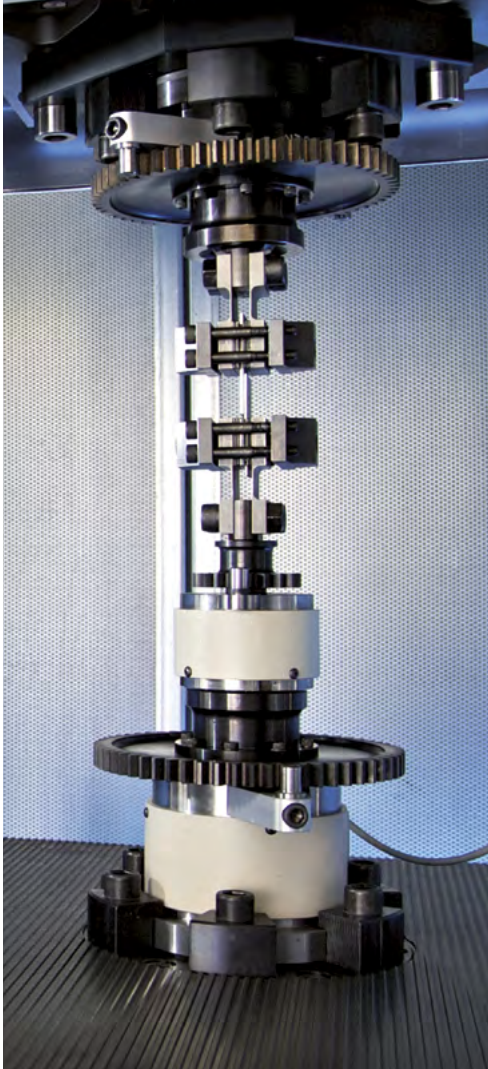
1. Mechanical-technological tests
2. Metallographic tests
3. Surface and dimensional tests
4. Optical spark emission spectrometry
5. Corrosion tests

The Böllhoff laboratory also uses other methods, for example chemical tests or heat treatments. In addition, the laboratory offers supplementary services, such as the sampling of joint connections, the preparation of samples and the construction of jigs and fixtures.

Our quality factors

- Scientific competence based on consequent employee training
- State-of-the-art technology with investments in the latest test equipment
- Security due to accredited and acknowledged procedures
- Innovative for our customers based on networking with universities and public institutions and associations





1. Mechanical-technological tests

Mechanical-technological methods comprise various test methods with which the behaviour and material characteristics of standardised material samples or finished components under mechanical stress are determined. In contrast to physical sizes, technological properties depend on the boundary conditions under which they are tested. For this reason, such methods are often standardised because of the comparability of the test results. The Böllhoff laboratory is equipped to test fasteners in a wide variety of dimensions and materials.

Tensile and compressive tests up to 400 kN

- Tensile tests of full-size screws
- Tensile tests of wires
- Tensile tests of structural elements/ thread inserts/machined test pieces
- Tensile test of wires at higher temperatures
- Tensile tests under wedge loading of full-size screws
- Proof load test of nuts

Hardness test

- Sample preparation for hardness test
- Vickers hardness test (HV 10, HV 30)
- Microhardness test (Vickers HV 0.2, HV 0.3), surface hardness test, case depth measurement

Screwing test

- Torque, rotation angle
- Preload force/single measurements resp. 15 cycle-screwing, overtorque, breaking torque

Endurance tension test

- For the detection of hydrogen embrittlement of fasteners

Determination of coefficients of friction

- Determination of coefficients of friction μ_{total} , μ_{head} and μ_{thread}

Junker test (vibration test)*

- Determination of locking behaviour against loosening of the screw (loss of preload)

Leak test*

- Twist testing (string test)

Cleanliness test*

Fatigue testing*

- Up to 150 kN, ± 75 kN*
- Woehler curve, dynamic strength (fatigue)

Damage analysis*

- Examination of the fracture surface, clarification of the cause of damage according to VDI 3822

* According to national / international standard, not accredited



2. Metallographic tests

Metallographic examinations provide the qualitative and quantitative description of the microstructure of metallic materials with the help of microscopic methods. Metallography consists of preparation, microstructural representation or description and structural assessment. Errors in these steps can lead to incorrect assessment of the microstructure. The employees of the Böllhoff laboratory are specially trained and are familiar with the materials typically used for fasteners and common coating materials.

Metallography

- Microscopic examination (digital, reflected light – and stereo microscope),
- Ground section (microstructural observations, degree of purity, status of carburisation)
- Development of microstructure (micro etching)
- Presentation of deformation lines in the ground section of fasteners (macro etching)



3. Surface and dimensional tests on fasteners made of metallic material

Surface and dimensional tests on fasteners provide information about the condition of the bare, uncoated surface of a fastener, e.g. the total lack of surface defects and matters concerning surface roughness. They include the examination of the geometric dimensions, such as flank and core diameters of screws, in the bare and coated state and also the determination of the thickness of the coating, which is usually applied for corrosion protection reasons. Along with only a few others, the Böllhoff laboratory is accredited for testing for surface defects (cracks, curtaining).

Surface discontinuity inspection
Determination of the surface condition
(surface defects, geometric tests)

Coating thickness measurement according
to X-ray fluorescence method

Measuring of surface profiles and roughness*

Precision length measuring (inside and outside)
of structural elements and measuring equipment

Paint penetration test*

* According to national / international standard, not accredited

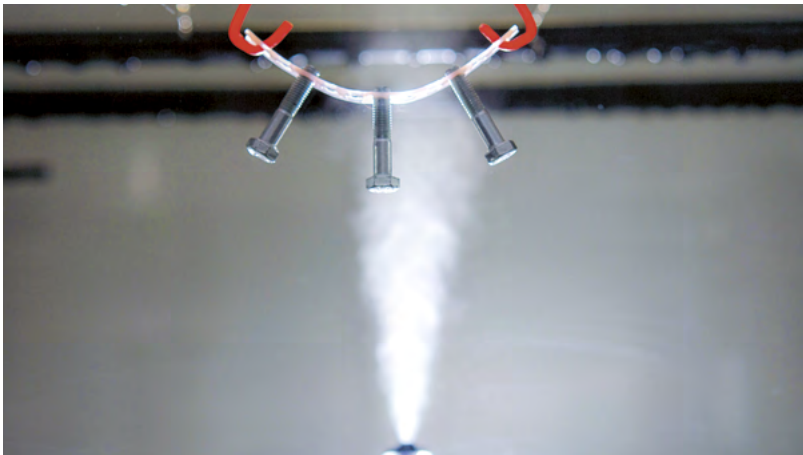


4. Examination of low and high-alloyed steels using optical spark emission spectrometry

Optical spark emission spectrometry is used to quite precisely determine the chemical composition of a metallic material. The test result goes beyond a pure material confusion test. Exact knowledge of the content of alloying and trace elements is important, since even the smallest fluctuations can have a considerable influence on the properties of the component. The Böllhoff laboratory is specialised in testing small dimensions.

Identification of chemical elements in metals

Programmable material identification
(also special qualities)



5. Corrosion tests

Salt spray testing is a recognised technological method for testing the corrosion resistance of fastener coatings with the aim of monitoring the quality of the coating process and coated components. The Böllhoff laboratory can also offer this test in combination with the alternating climate test.

To characterise the bimetal susceptibility of joinings to corrosion (contact corrosion), the Böllhoff laboratory uses a short-term testing method with the help of potential measurements.

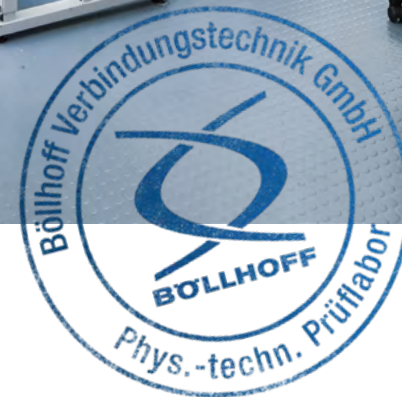
Corrosion test of metallic materials
and protective coatings

Salt spray testing

Alternating climate test

Potential measurements

“THE BIG 5” test methods are in particular applied for damage analysis. The Böllhoff laboratory is specialised in the determination of damages of metallic components and has gained much experience in the detection of the causes of damages in fasteners. This is why we have been appointed to the VDI expert circle for damage analysis. Together with colleagues from the application technology, we additionally support our customers after the detection of the damage cause in developing suitable preventive measures.





Tensile and compression testing machine 5 kN (0.5 t)

Computer-aided simultaneous recording of the measured values and evaluation of the tests with the software "TestXpert"

Examples:

- Testing of screws up to M3 class 8.8
→ DIN EN ISO 898-1
- Proof load test with nuts up to M3 class 8
→ DIN EN 20898-2
→ DIN EN ISO 898-6
- Tensile test of round and profile wire 0.35 to 1.12 mm diameter
- AMTEC® thread inserts for plastics
→ Determination of pull-out values in plastics

Tensile and compression testing machine 100 kN (10 t)

Tensile test according to DIN EN 10002-1 and DIN EN ISO 6892-1

Computer-aided simultaneous recording of the measured values and evaluation of the tests with the software "TestXpert"

- Microstrain measurement
- Hot tensile test up to 900 °C

Examples:

- Testing of screws up to M12 class 8.8
→ DIN EN ISO 898-1
- Special tests, e.g. on screws with a short shaft
- Proof load test of nuts up to M12 class 10
→ DIN EN 20898-2
→ DIN EN ISO 898-6
- Nut expansion test
→ DIN EN ISO 6157-2 chapter 4.3
→ DIN EN ISO 10484
- HELICOIL® wire (round and profiled)
- Flat samples, samples from punching and riveting technology (tension shear test, peel strength test and cross tension test)

Tensile and compression testing machine 400 kN (40 t)

Tensile test according to DIN EN 10002-1 and DIN EN ISO 6892-1

Examples:

- Tests of screws up to M24 with tensile test and tensile test under wedge loading according to DIN EN ISO 898-1
- Proof load test of nuts up to M24 according to DIN EN 20898-2 and DIN EN ISO 898-6
- Tensile test of wire samples
- Tension shear test, peel strength test and cross tension test of riveted sheet metals
- Pull-out and push-out tests for thread reinforcement

Universal hardness testing device for hardness tests according to Vickers HV 0.1 – HV 30

- Computer-aided testing process
→ Automatic loading, maintaining of force, reduction of load, indentation measurement, calculation of hardness, creation of protocol. Data can be exported
- Hardness curves
→ Automatically verifiable with programmable X-Y-table
- Feasible tests
→ Core hardness, surface hardness, case depth
DIN EN ISO 2639, edge hardness





Screw connection test benches 200 Nm / 1,000 Nm

For the determination of torque-rotation angle developments, clamp forces and coefficients of friction (thread and head values)*, e.g. according to DIN EN ISO 16047 and customer standards.

- Measurement range
 - 0 to 1,000 Nm (M4 – M22) 20 to 200 U/min
- Sensors
 - Torque: to 5 Nm, 20 Nm, 50 Nm, 200 Nm, 1,000 Nm
 - Load: 100 kN/150 Nm, 300 kN/350 Nm
- Application
 - Test of tightening torque, overtorque and breakaway torque
 - Practice-oriented tests of large components, revolving mechanism allows good accessibility of the screw joints
 - Programmable test sequence, computer-aided data collection, graphic representation, evaluation and data export possible



Vibration test device according to the Junker test principle*

For the dynamic testing of the locking behaviour of screw connections according to DIN 15151.

Determination of the clamp force loss in the course of time due to the impact of transverse motion.

- Testing range
 - M6 – M16
 - The vibration test bench operates at room temperature, with a defined clamping length and a uniform frequency. Only the amplitude is varied or determined from the preliminary tests with non-locking elements and then applied to the locking elements.

Different torque wrenches and torque sensors

For the determination of torque-rotation angle developments, clamp forces and coefficients of friction (thread and head values), e.g. determination of the coefficient of friction according to DIN EN ISO 16047 and customer standards.

- Torque wrench:
 - Measurement range 750 to 2,000 Nm
- Torque wrench:
 - Measurement range 3 to 60 Nm, 10 to 200 Nm, 20 to 400 Nm
- Torque sensors:
 - Measurement range 0 to 25 Nm, 0 to 50 Nm

Temperature resistant ring force sensor with measuring amplifier system for the measurement of preload forces*

With different KMR sensors (ring force sensors) it is possible to determine the development of the preload force of a threaded assembly over time in the laboratory test, e.g. under the influence of temperature or, together with a torque sensor, to determine the torque-preload force development in mobile applications.

- Measurement range of the KMR sensors
 - Up to M6, M8, M10, M20 – heat-resistant up to 120 °C

* According to national / international standard, not accredited



Fatigue testing machine for endurance tests*

For the determination of dynamic strength properties such as duration and fatigue resistance (Woehler curve = stress number curve) of screws, riveted sheets and components under alternating and dynamic axial tensile force or compression force according to DIN 969.

- Working principle
→ High frequency resonance test
- Maximum static test load
→ 150 kN
- Maximum dynamic test load
→ +/- 75 kN
- Frequency
→ 45 – 260 Hz
- Dimension of the sample
→ Round sample and screws approx. M4 – M16, flat samples of up to 10 mm thickness
- Complete components can be tested with individual clamping brackets



Twist test according to the hugging method (string test)*

For the determination of spin structures of surfaces* which can affect the sealing function of a component.

Spin is a thread-like structure on rotationally symmetrical parts which is caused by the grinding of the product and which causes an axial conveyance of fluids and results in leakage.

- Test result
→ Quantitative determination of spin or freedom of spin, spin direction right/left

* According to national / international standard, not accredited

Digital microscope Type: Zeiss Smartzoom5

- Lenses
 - 34 times to 2,021 times magnification
- Device configuration
 - Two lenses with PC connection and evaluation software
- Application
 - Surface defects test of screws DIN EN ISO 26157 parts 1 and 3
 - Surface defects test of nuts DIN EN ISO 6157-2 chapter 4.2
 - Investigations for damage analysis
 - Roughness depth measurement
 - Microstructure analysis
 - Documentation

Reflected light microscope Type: Zeiss, Axio Imager A1m

- Lenses
 - 5 times to 100 times (magnification up to 1000 times)
- Device configuration
 - CCD-colour camera with data-link to the computer and evaluation software, connection to DHS database
- Application
 - Determination of the carburisation status of screws
 - Investigations for damage analysis
 - Length measurement
 - Microstructure analysis
 - Documentation

Stereo microscope with zoom lens

- Lenses
 - 0.75 times to 6 times (magnification up to 60 times)
- Device configuration
 - CCD-colour camera with data-link to the computer and evaluation software, connection to DHS database
- Application
 - Overview pictures
 - Assessment of the fracture surface
 - Direct measurement of length
 - Fracture analysis/Damage analysis
 - Documentation





Coating thickness measurement using the X-ray fluorescence method according to DIN EN ISO 3497

E.g. coating thickness measurement according to DIN EN ISO 4042 and customer standard

- Applications
 - Zn/Fe
 - Zn/Ni
 - Ni/Cu/Fe
 - Cr/Ni/Cu/Fe
 - Zinc flake
 - Zn/Ni-Dacromet/Fe
 - Ni/Cu/Fe-Geomet/Fe
 - Cr/Ni/Cu/Fe-Delta Tone/Fe-Delta Protect/Fe



Mahr contour graph and roughness measuring device*

- Device configuration
 - Test device with DAkkS certified calibration standard and connected evaluation software
- Application
 - Roughness measurement Ra and Rz
 - Contour graph for measuring surface profiles
 - Creation of test results and documentations
 - Determination of diameter, flank diameter, thread pitch, angle measurement and distance measurement
 - Movement range of the measuring probe approx. 200 mm



Precision length measuring machine type "PRECIMAR PLM 600 E"

Length measuring machine for measuring (inside or outside) on components and measuring equipment for quality inspection and calibration of measuring equipment

- External dimensions
 - 0 – 600 mm
- Internal dimensions
 - 0.5 – 445 mm
- Measuring table
 - Universal measuring table with 5 axes
- Measuring force
 - Adjustable from 1 up to 13.9 N
- Measuring carriage
 - Electrically adjustable; automatic probing with selected measuring force
- Application
 - Calibration of limit thread plug gauge or thread rings, length measuring on samples for proof load test



* According to national / international standard, not accredited

Testing device for paint penetration test

For non-destructive testing of small irregularities, such as cracks, pores and overlaps. With the help of the paint penetration test*, defects which are open to the surface of the constructional element can be made visible for instance according to DIN EN 571-1.

- Operator
 - Qualified and certified according to DIN EN ISO 9712
- Sensitivity
 - Evidence by using calibration block no. K2 according to DIN EN ISO 3452-3
- Testing and evaluation
 - For instance according to DIN EN 571-1, DIN EN ISO 1371-1 or customer requirement

Optical spark emission spectrometry – examination of low and high-alloyed steel

Detection of chemical elements in metals.

- Diagnostic programs
 - Steel low-alloyed (Cr < 5% and Ni < 5%)
 - Steel high-alloyed (Cr > 5% and Ni > 5%)
 - Free cutting steel* (e.g. 11SMnPb30)
 - Al-base*
 - Ni-base*
 - Cu-base brass*
 - Cu-base bronze*
- Programmable material detection
 - e.g. steel according to
 - DIN EN ISO 898-1
 - DIN EN ISO 898-2
 - VDA 231 (strength class: 8.8, 10.9, 12.9)
 - Special qualities



* According to national / international standard, not accredited



Salt spray testing chamber for corrosion tests of metallic materials and protection coatings according to DIN EN ISO 9227 and DIN EN 60068-2-11

- Test method
 - The surface condition is evaluated each working day. A distinction is made according to the following criteria:
 - Zinc corrosion (white rust)
 - Base metal corrosion (red rust)
- Functional description
 - The corrosion resistance of the samples is tested by means of a continuously sprayed aqueous sodium chloride solution with a concentration of 45 – 55g/litre as a corrosive substance. The spraying takes place by means of compressed air.

Temperature and climatic chambers for corrosion tests in an alternating climate test*

- Temperature range: -70 °C to +180 °C, test chamber volume: 64/200 litres
- Climate test
 - Temperature range: +10 °C bis +95 °C
 - Humidity range: 10 to 98% relative humidity
- Application
 - In connection with the measuring amplifier system with respective temperature-resistant ring force sensors, the measuring of clamp force loss under the influence of temperature is possible.
 - Alternating climate test (corrosion test)
 - Test according to TL 244 PV 1200, PV 1210, PV 2005 and PV 1209 with test solution according to DIN EN ISO 9227 NSS



* According to national / international standard, not accredited

Residual dirt / cleanliness test*

Examination of cleanliness of fasteners and components.

■ Test procedure

→ The component or fastener to be tested is cleaned in a residual dirt extraction unit with the requested cleaning procedure (immersion, spraying, ultrasonic cleaning). The used cleaning solution is filtered with a membrane filter. The filter is dried, weighed and the particle size distribution is automatically measured. The type of particles is determined with the optical microscope.

■ Cleaning solution

→ e.g. cold degreaser
DE-SOLV-IT 1000

■ Membrane filter

→ Size 5 µm

■ Application

→ Determination of the dirt mass
→ Determination of the particle type, size and distribution
→ Assessment of the results according to Böllhoff company standard BN 0901.003 or customer specification



Cleanliness test of component surfaces by means of fluorescence measurement*

The test is fast, contactless, mobile and non-destructive. It is a comparing measurement, i.e. a reference surface with known degree of cleanliness is necessary.

Test for absence of oil and grease on surfaces*

Determination of surface tension for the evaluation of surface quality, e.g. for the assessment of cleaning processes resp. for the monitoring of the pre-treatment of coatings by means of test ink.



* According to national / international standard, not accredited

Besides **“THE BIG 5”** test methods, the Böllhoff laboratory offers further additional services.

Jig and prototype construction

In-house development of jigs, samples and prototypes

Preparation of samples

Sampling of joint connections

Selection of joining parameters

Preparation of joined prototypes

Chemical methods

Check for no Cr(VI) content*

Heat treatment

For more details,
see the next page »»

* According to national / international standard, not accredited

Chemical methods*

- Applications:
 - Check of surface coatings for no Cr(VI) content
 - Hardening, annealing, tempering (Heating furnace up to 1,000 °C), baking

Sampling of joint connections*

- Method
 - Selection of rivet geometries and setting parameters for specified applications
 - Consideration of customer-specific constraints
 - Creation of tensile shear, peel strength and cross tension samples as well as prototypes
- Application
 - Test of mechanical properties of joinings*
 - Cross tension test
 - Peel strength test
 - Tensile shear test

Jig and prototype construction

- Machining equipment
 - CNC lathe
 - Conventional lathe
 - Milling machine
- Extended equipment
 - Pillar drill
 - Band saw
 - Belt sander
 - Wet-sanding-disc
 - Cut-off machine
 - Hole punching machine for RIVKLE® products
 - Hardening furnace
- Capabilities
 - Creation of prototypes
 - Creation of samples, pilot samples
 - Creation of jigs, clamping devices
 - Creation of cut samples

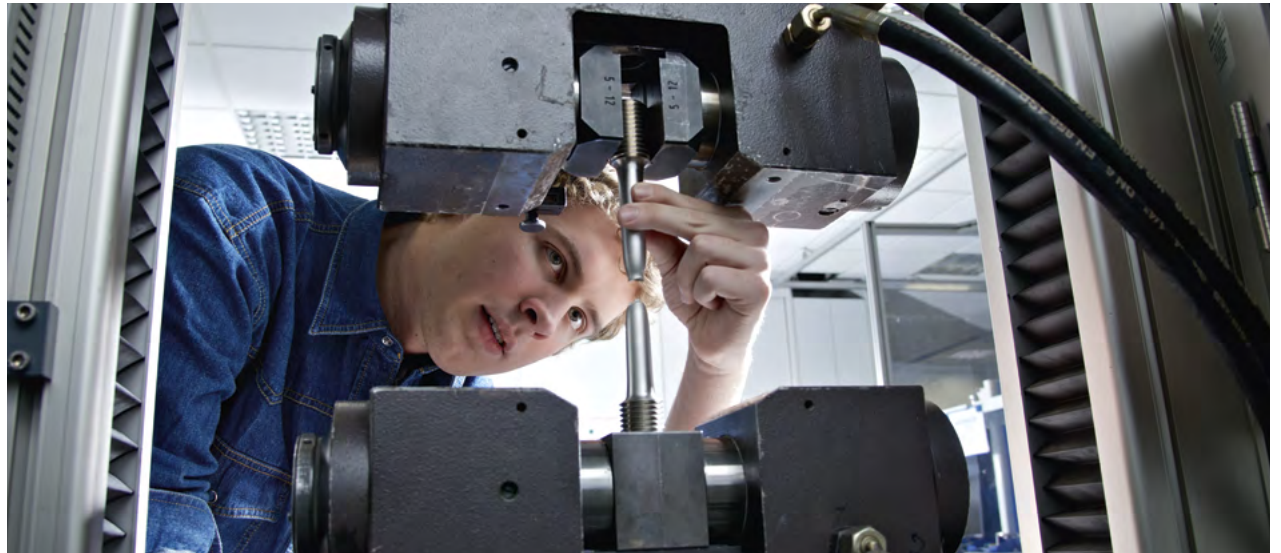


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Our know-how for your success

It is a good decision to choose the Böllhoff test laboratory as your partner. This way you profit from our long-standing experience all around testing and technical design of connections.

As a consequence, we place great emphasis on passing on our knowledge from generation to generation. We train material testers and laboratory technicians ourselves and offer internships for high school graduates and university students.



Whenever you want to create successful connections, we are at your side

Whether it is about fasteners or the best matching assembly or logistics solution, if you need application-related consulting or would like us to conduct quality inspections in our laboratory – we support you all along your value chain with our wide portfolio of products and services. We call this comprehensive approach our 360° joining technology.

Our claim:

To strengthen your competitive position with sustainable connections.





Passion for successful joining.



Böllhoff Group

Innovative partner for joining technology with assembly and logistics solutions.

Find your local partner at www.boellhoff.com or contact us at info@boellhoff.com.

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