IABG. The **Future.**

We build your test benches

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IABG – We build your test benches

We configure and implement test facilities at the highest of technical standard. They offer reliable operation, easy handling, flexible use, cost-effective in operation as well maintenance. The modular and flexible design ensures the possibility to adapt to any specific problem. We are therefore able to ensure cost-efficient and effective applications, which are guaranteed in the future.

Our Services

- Customer support and advice in creating product specifications, designing and implementing test benches
- Products/test benches for springs, roll stabilisers, steering systems, sensors, electric drives and actuators, development test benches and parameter verification
- General contractor for special test benches
- After sales and support

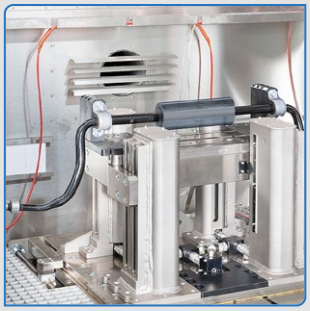
We offer customers the development, planning, manufacture and commissioning of test benches from a single source: turnkey – with and without customer-specific adaptation – or as new development in accordance with customer requirements.

Our portfolio covers the engineering, manufacture and naturally also the servicing and expanding of our test benches. Our test facilities embody our many years of broad experience in dealing with fatigue strength and in the development and fine-tuning of test procedures. Please contact us for customer-specific adaptations or new tailored solutions. We would be glad to advise you personally and find an individual solution for you.

Our seal stands for the quality of our accredited and certified test house.

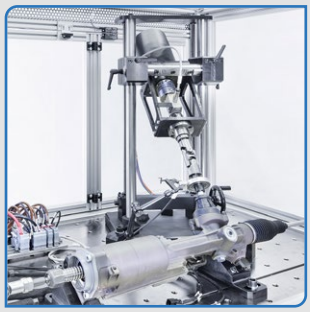
IABG. Test Benches.

SPRINGS

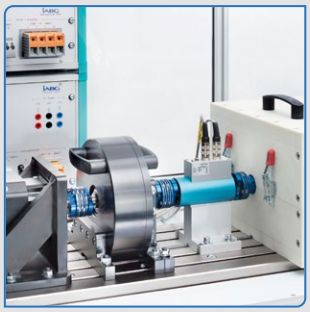


ANTI-ROLL BARS

WE BUILD
YOUR
TEST BENCHES



STEERING SYSTEMS



ELECTRIC DRIVES AND ACTUATORS

SENSORS

DEVELOPMENT TEST BENCHES •
REALISATION OF SPECIAL TEST BENCHES
AS GENERAL CONTRACTOR

PARAMETER
VERIFICATION •
E/E FUNCTION

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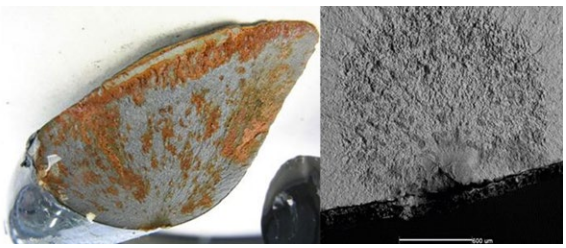
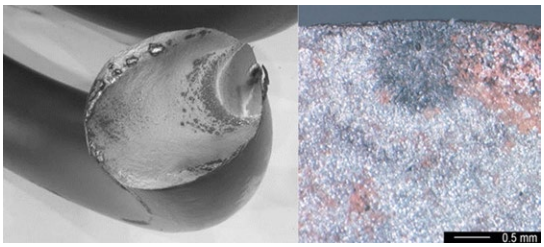
Fatigue strength of axle springs

Relevant influences

- Mechanical loading as a result of
  - Spring compression
  - Axle kinematics
- Corrosive environmental conditions
- Damage to surface and coating caused by
  - Spring seat abrasion
  - Stone impact





Experimental verification

- Pre-damage caused by stone impact
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Optional tests with simulated compression kinematics
- Tests with original spring seats in installation position
- Vibration fatigue tests with fixed or variable amplitudes
- Abrasive wear simulation
- Corrosion simulation with intermittent salt-water spray exposure
- Statistical validation by systematic testing and a sufficient number of test items

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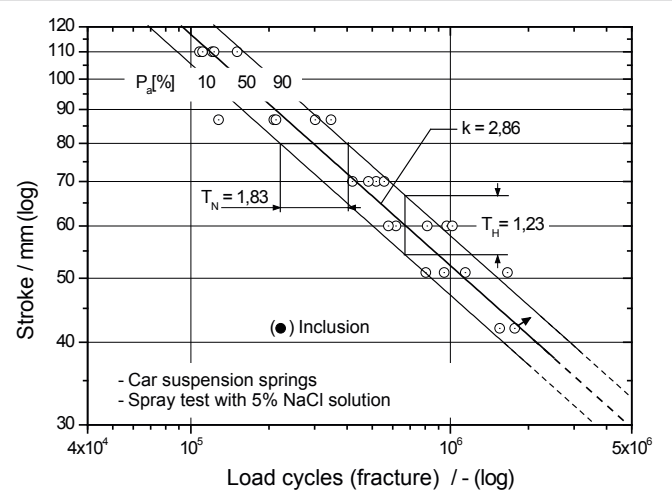

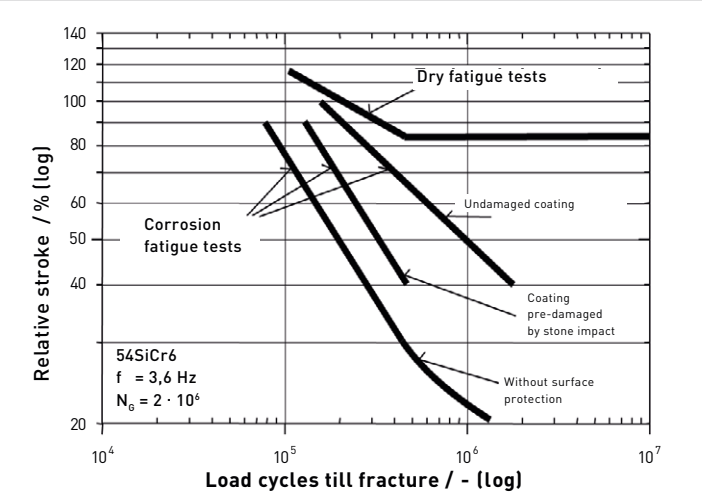

Benefits of IABG spring test benches

- Energy efficiency by utilising the principle of resonance in tests
- Reliability and low maintenance
- Exclusion of exogenic forces and vibrations
- Testing with parallel and circular deflection
- Tests with original spring seats in installation position
- Dry and wet fatigue tests
- Optional application of abrasive media to spring seat
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) for springs and stabilizer bars

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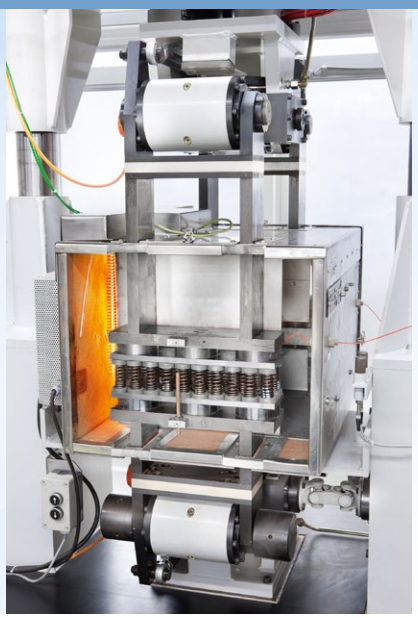


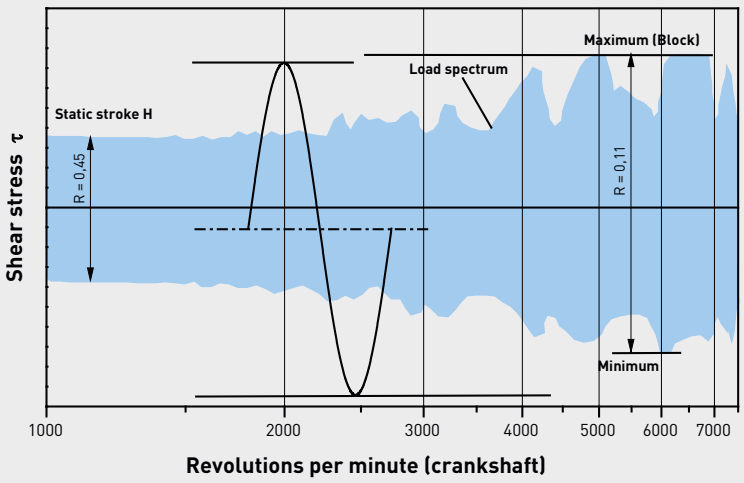
Fatigue strength of valve springs

Relevant influences

- Mechanical loading as a result of compression
- Very high number of load cycles
- Increased temperature
- Dynamic settling

Experimental verification

- Tests with maximum stress almost to block length of the spring
- Vibration fatigue tests with fixed amplitudes
- Simultaneous testing of a high number of valve springs
- Simulation of increased temperature
- Statistical validation by systematic testing and a sufficient number of test items
- Determination of dynamic settling



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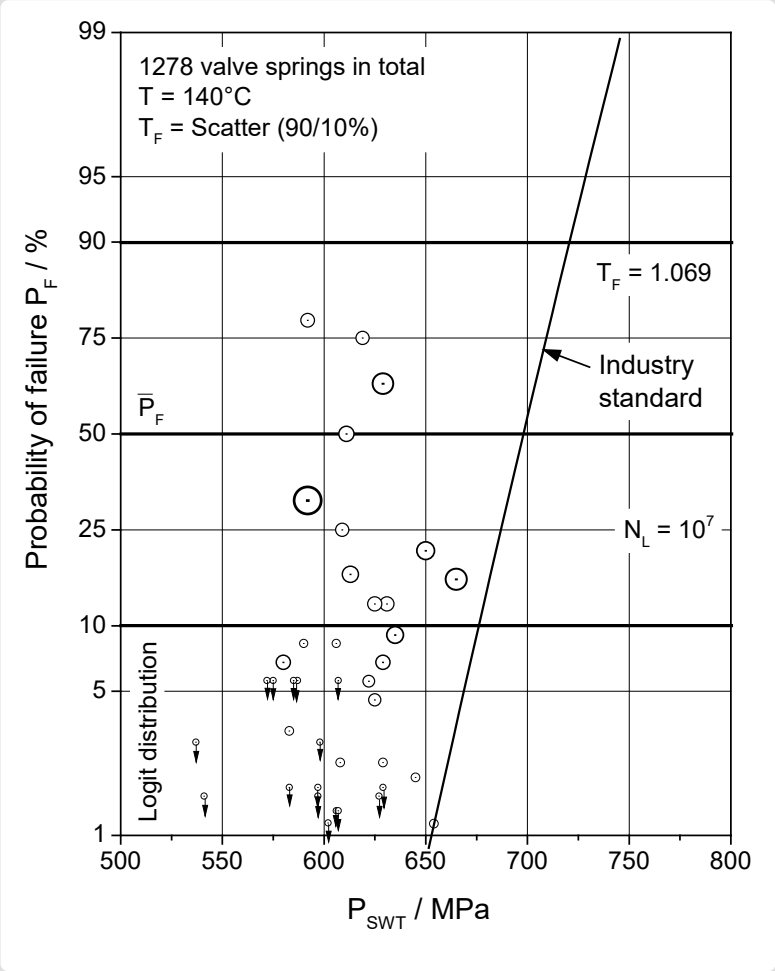
Benefits of IABG valve spring test benches

- Energy efficiency by utilising the principle of resonance in tests
- Reliability and low maintenance
- Exclusion of exogenic forces and vibrations
- Simultaneous testing of a large number of springs
- Fatigue tests at various temperatures
- Software-based testing, documentation and evaluation
- Recognised by all leading car manufacturers



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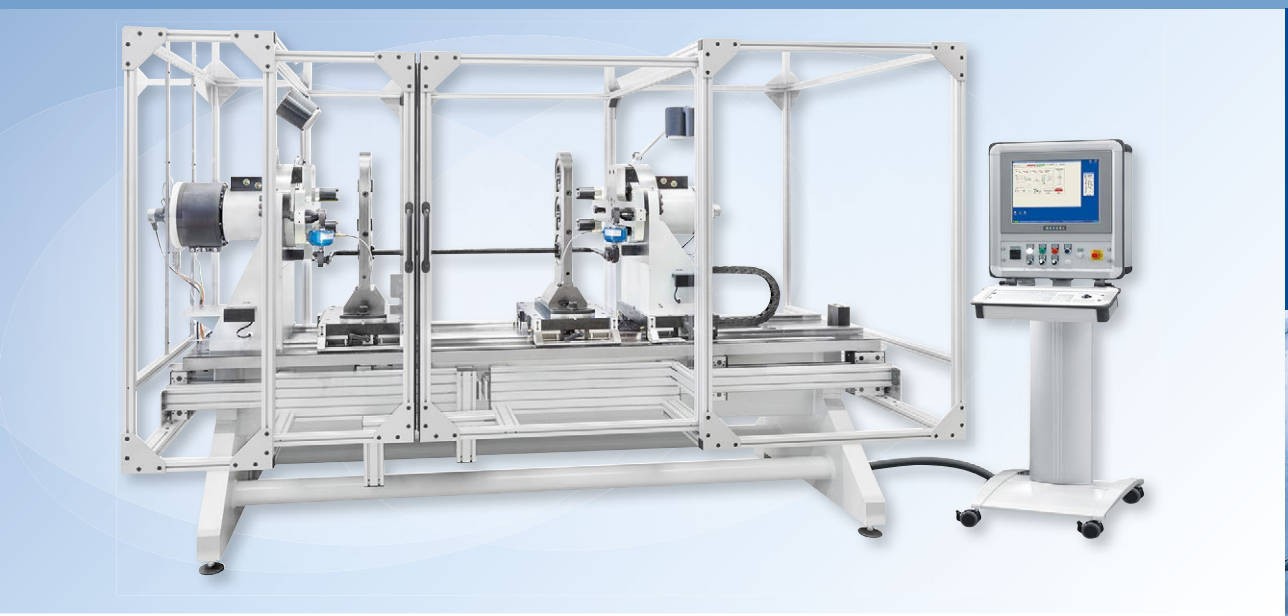


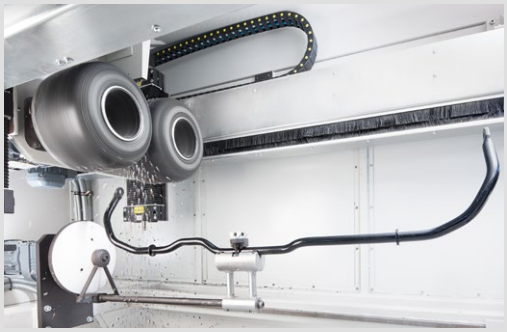
Fatigue strength of stabilizer bars

Relevant influences

- Mechanical loading as a result of
  - Bar torsion
  - Axle kinematics
- Corrosive environmental conditions
- Damage to surface and coating caused by
  - Stone impact

Experimental verification

- Pre-damage caused by stone impact
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Tests with original stabilizer bars in installation position
- Optional tests with simulated compression kinematics on full axle configuration
- Vibration fatigue tests with fixed or variable amplitudes
- Statistical validation by systematic testing and a sufficient number of test items



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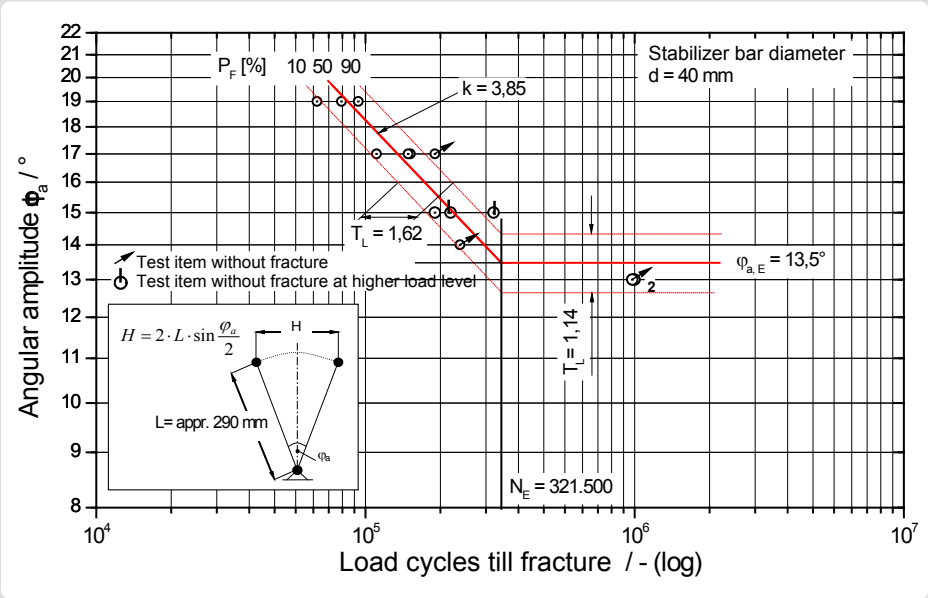

Benefits of IABG stabilizer bar test benches

- Energy efficiency by utilising the principle of resonance in tests
- Reliability and low maintenance
- Exclusion of exogenic forces and vibrations
- Tests with original stabilizer bar bearings and full axle configuration
- Tests for up to 42 mm thick stabilizer bars
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) for springs and stabilizer bars

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Dry Spring Testing Machine (DSTM)

The development and quality monitoring of resilient, highly stressed automotive components such as springs requires testing that represents actual vehicle conditions as accurately as possible. There are some essential test areas when determining the quality of spring steel, for example, fatigue strength and setting behavior under realistic load and environmental conditions.

Based on these requirements, IABG offers a **spring testing machine capable of performing fatigue tests in normal laboratory atmosphere.** Thus allowing the determination of spring fatigue strength while reducing both time and cost.

Advantages of the IABG spring testing machines

- Energy efficiency by utilising the principles of resonance in tests
- Reliability and low maintenance
- Designed to exclude all external forces and vibrations
- Testing with parallel and circular deflection
- Tests with original spring seats in installation position
- Integrated measurement of spring characteristic curves and spring setting
- Optional application of abrasive media to spring seat
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) of springs and stabilizer bars

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Abrasive wear simulation with grit in the lower spring seat

Relevant influences on springs

- Mechanical demands from
  - Spring compression
  - Axle kinematics
- Damage to the surface and coating through
  - Abrasion caused by spring coil contact
  - Stone impact
  - Corrosion

Experimental verification

- Pre-damage caused by stone impact
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Optional tests with simulated compression kinematics on full axle configuration
- Tests with original spring seats in installation position
- Fatigue test with cylic load and with fixed or variable amplitudes
- Abrasive wear simulation
- Statistical validation by systematic testing and a sufficient number of test items

Technical data

- **Test specimens:**
  parallel or circular deflection on springs of all types
- **Max. permissible load per test position:**
  F_{max} = 70 kN
- **Number of possible test specimens per test:**
  2, 4, ... limited by F_{max}
- **Stroke (displacement control):** S = 10 to 250 mm
- **Max. spring length:** L_o = 650 mm
- **Test frequency:**
  $f_o = 0{,}47 \sqrt{(n \cdot R)}$ [Hz] = 2 to 15 Hz
  n = Number of test specimens tested
  R = Spring constant [N/mm]
- **Weight / measurements of machine:**
  3,3 tons, L = 1,600 mm, W = 2,200 mm,
  H = 2.900 mm (additional space required for: operator panel and switching cabinet)

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Corrosion Spring Testing Machine (CSTM)

The development and quality monitoring of resilient, highly stressed automotive components such as springs and stabilizer bars, requires testing that represents actual vehicle conditions as accurately as possible. There are some essential test areas when determining the quality of spring steel, for example, fatigue strength and setting behavior under realistic load and environmental conditions.

Based on these requirements, IABG offers a **spring testing machine capable of performing fatigue tests in both a salt water corrosion environment and a normal laboratory atmosphere.** Thus allowing the determination of spring fatigue strength while reducing both time and cost.

Advantages of the IABG spring testing machines

- Energy efficiency by utilising the principles of resonance in tests
- Reliability and low maintenance
- Designed to exclude all external forces and vibrations
- Testing with parallel and circular deflection
- Tests with original spring seats in installation position
- Dry and wet fatigue tests
- Integrated measurement of spring characteristic curves and spring setting
- Optional application of abrasive media to spring seat
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) of springs and stabilizer bars

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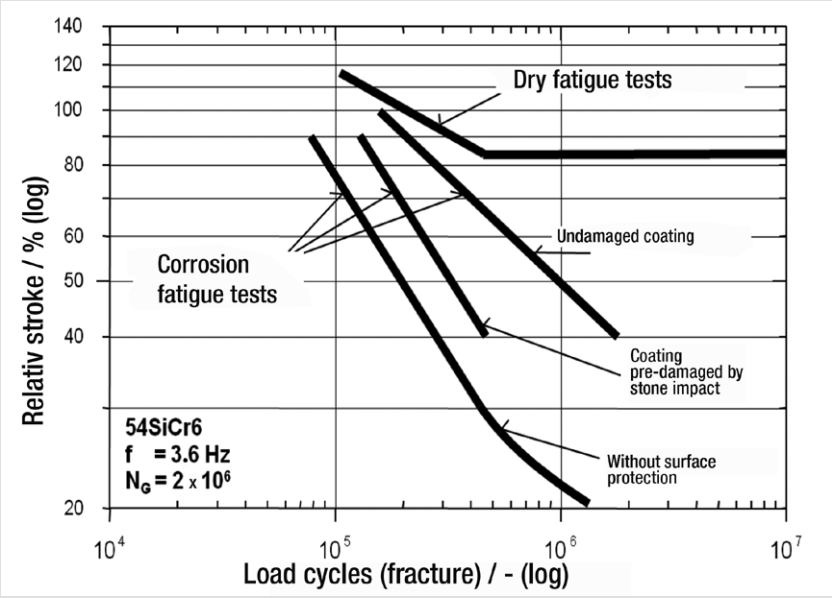

Influence of pre-damage and corrosion on the fatigue lifetime of springs

Relevant influences on Springs

- Mechanical demands from
  - Spring compression
  - Axle kinematics
- Corrosive environment conditions
- Damage to the surface and coating through
  - Abrasion caused by spring coil contact
  - Stone impact

Experimental verification

- Pre-damage caused by stone impact
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Optional tests with simulated compression kinematics on full axle configuration
- Tests with original spring seats in installation position
- Fatigue test with cylic load and with fixed or variable amplitudes
- Abrasive wear simulation
- Corrosion simulation through intermittent salt-water spray exposure
- Statistical validation by systematic testing and a sufficient number of test items

Technical data

- **Test specimens:**
  parallel or circular deflection on springs of all types
- **Max. permissible load per test position:**
  F_{max} = 100 kN
- **Number of possible test specimens per test:**
  2, 4, ... limited by F_{max}
- **Stroke (displacement control):** S = 10 to 300 mm
- **Max. spring length:** L_o = 700 mm
- **Test frequency:**
  $f_o = 0{,}16 \ldots 0{,}28 \sqrt{(n \cdot R)}$ [Hz] = 1,5 to 10 Hz
  n = Number of test specimens tested
  R = Spring rate [N/mm]
- Salt water container (250 l) with programmable spray intervals and heating capability up to 50 °C
- **Weight / measurements of machine:**
  6,5 tons, L = 2,000 mm, W = 2,300 mm, H = 3,200 mm (additional space required for: operator panel, switching cabinet, corrosion unit and water treatment tank).

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Large Spring Testing Machine (LSTM)

The development and quality monitoring of resilient, highly stressed automotive components such as springs requires testing that represents actual vehicle conditions as accurately as possible. There are some essential test areas when determining the quality of spring steel, for example, fatigue strength and settling behavior under realistic load and environmental conditions.

Based on these requirements, IABG offers a spring testing machine capable of performing fatigue tests on large resilient components under normal laboratory atmosphere. Thus allowing the determination of the fatigue strength of such components as coil and leaf springs, while reducing both time and cost.

Advantages of the IABG Large Spring Testing Machine

- Higher energy efficiency in comparison to a hydraulic system due to the utilisation of resonance principals
- The testing of larger springs with higher spring rates, or the simultaneous testing of a large amount of springs with lower spring rates
- High test frequency
- Statistical determination of load and spring length (plotting spring characteristic curves, settling determination)
- Designed to exclude all external forces and vibrations
- Reliability and low maintenance
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) of springs and stabilizer bars

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Test of leaf springs
with the IABG LSTM

Relevant influences on springs

- Mechanical demands from
  - Spring compression
  - Axle kinematics
- Damage to the surface and coating through
  - Abrasion caused by spring coil contact
  - Stone impact
  - Corrosion

Experimental verification

- Pre-damage caused by stone impact
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Tests with original spring seats in installation position
- Fatigue test with cyclic load with fixed or variable amplitudes
- Abrasive wear simulation
- Statistical validation by systematic testing and a sufficient number of test items
- Determination of dynamic settling

Technical data

- **Test specimens:**
  parallel deflected springs of all types, leaf springs
- **Max. permissible load over both test areas:**
  F_{max} = 200 kN
- **Number of springs that can be tested simultaneously:** 2, 4, ... limited by F_{max}
- **Stroke (displacement controlled):**
  S = 10 to 400 mm
- **Max. spring length:** L_o = 1,000 mm
- **Test frequency:**
  $f_o = 0{,}19 \ldots 0{,}28 \sqrt{(n \cdot R)}$ [Hz] = 2 to 20 Hz
  n = Number of test specimens tested
  R = Spring rate [N/mm]
- **Weight / measurement of machine:**
  8,5 tons, L = 2,200 mm, W = 2,200 mm, H = 3,500 mm (additional space required for: operator panel, switching cabinet and hydraulic aggregate)

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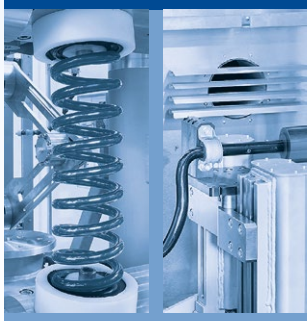

Variable Test Rig for Resilient Components (VTRC)

The development and quality monitoring of high stressed spring components of vehicles like suspension springs and stabilizer bars demand fatigue tests under near-service conditions. The main quality features to be tested are, for instance, fatigue strength and relaxation behaviour under near to reality load and environmental conditions.

Based on these requirements IABG offers an **energy-efficient test rig for the testing of resilient components under saltwater corrosion, with different temperatures or under laboratory conditions** for a time and cost saving determination of fatigue strength.

Benefits of the IABG Test Rig

- Energy efficiency by testing with a new actuator concept
- Implementation of cycling tests
- **Testing in the frequency range under** 2 Hz
- **Testing of single and multi-level realtime signals**
- Testing at different temperatures and/or in corrosive media
- Free configuration of test components in clamping area
- Testing of springs/stabilizer bars with original stabilizer bar bearings and assembly tests in full axle configurations

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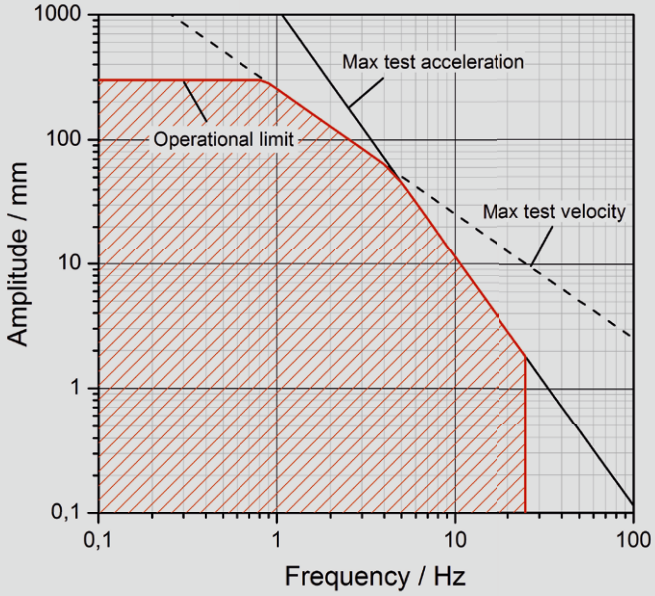

VTRC – Performance chart

Testing an anti-roll bar

Technical data

- **Maximum load allowed** for each test station: F_{max} = 35 kN
- **Maximum number of test stations:** 4
- **Cycle stroke and test frequency:** see performance chart
- **Testing of resilient components** like springs and stabilizer bars
  - Parallel deflection or simulation of axle kinematics
  - Free configuration with complete vehicle axle
- **Optional testing** at different temperatures, levels of humidity and types of corrosion
- **Weight/dimensions of the test rig:**
  - 5,5 t, L = 3,200 mm, W = 2,200 mm, H = 2,850 mm
  - Additional space required for operator panel, switching cabinet, power electronics, and corrosion unit.

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Valve Spring Testing Machine (VSTM)

Despite the very low cost per part of valve springs compared to the total engine component cost, the valve spring is still a safety-critical component. It is vital that valve spring failure be prevented entirely, for if a failure should occur it could result in total engine failure. The high risk involved with valve spring failure to the overall engine means the measures taken to ensure spring quality are of great significance.

The **IABG Valve Spring Testing Machine** allows the efficient determination of the fatigue strength of valve springs under the influence of temperature, saving both time and money. The testing machine operates using resonance principles, and is able to simultaneously test a large number of valve springs up to their maximum possible stress achieving a statistically reliable result with minimal effort.

Advantages of the IABG Valve Spring Testing Machines

- Energy efficiency by utilising the principles of resonance in tests
- Reliability and low maintenance
- Designed to exclude all external forces and vibrations
- Simultaneous testing of a large number of springs
- Fatigue test at various temperatures
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers

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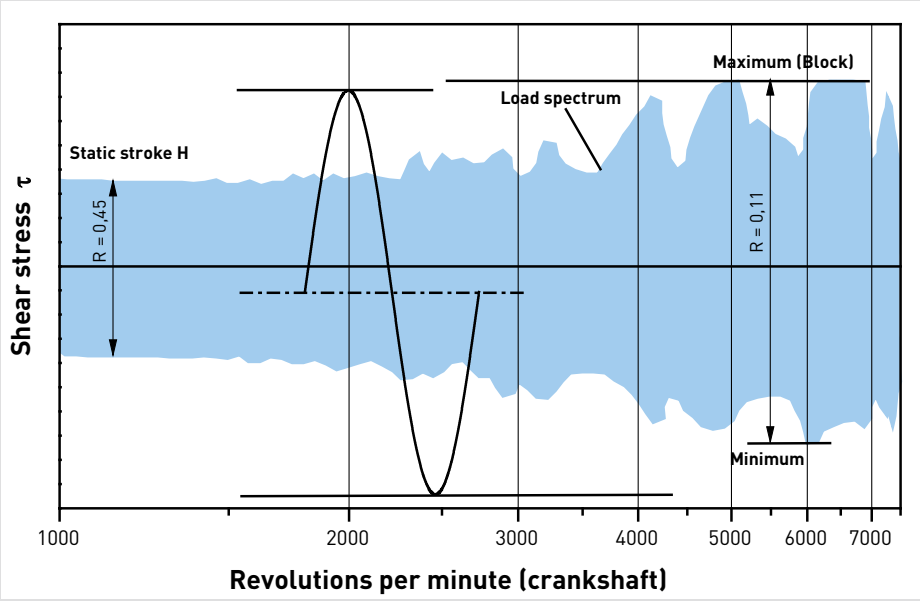

Definition of the test load based on the operational demands

Relevant influences

- Mechanical demand from compression
- Very high amount of load cycles
- Working environment with increased temperatures
- Dynamic settling as a result of many load cycles

Experimental verification

- Fatigue resistance design of valve spring on the basis of safety requirements
- Tests with maximum stress, just before block length of the spring
- Fatigue tests with fixed amplitudes
- Simultaneous testing of a large number of springs
- Simulation of environmental conditions incl. increased temperature
- Statistical validation by systematic testing and a sufficient number of test items
- Determination of dynamic setting

Technical data

- **Maximum permissible load per test position:** F_{max} = 20 kN
- **Maximum permissible mean load over the two test areas:** $F_{m,\,max}$ = 13 kN
- **Maximum possible stroke:** H = 80 mm
- **Maximum possible mounting height:** L = 250 mm
- **Test frequency:**
  $f_o = 0{,}6\ \sqrt{(n \cdot R)}$ [Hz] = 2 to 30 Hz
  n = Number of test specimens tested
  R = Spring rate [N/mm]
- **Temperature control up to:** T_{max} = 200 °C
- Constant or randomly variable amplitudes (block program)

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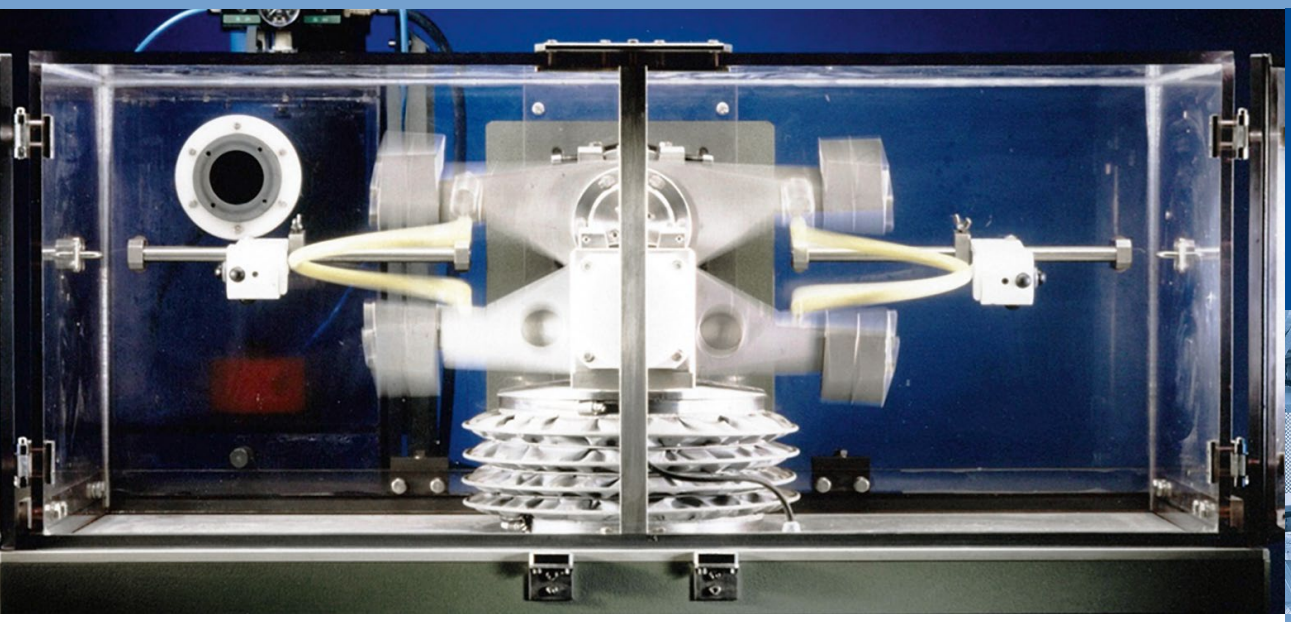

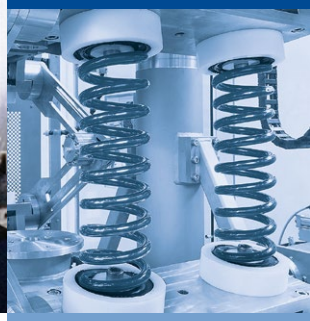

Spring Coil Testing Machine (SCTM)

The development and quality monitoring of resilient, highly stressed automotive components such as springs requires testing that represents actual vehicle conditions as accurately as possible.

The influences relevant to fatigue strength must therefore be known and the effects therefore determined with the testing of adequate specimens.

The **IABG Spring Coil Testing Machine** allows the time- and cost-saving determination of the fatigue strength of individual spring coils under corrosion. In this way, it is possible to perform comparative tests to determine the influence of specific factors on the fatigue strength of the test samples.

Advantages compared to other existing testing machines

- Energy efficient due to the application of resonance principals
- High test frequencies
- Under corrosion lower test frequencies are also possible in the slow drive function
- Short set up and test specimen exchange
- Reliable and low maintenance
- Testing under temperature and corrosion

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Test possibilities

Due to the special geometry of the test specimen, in this test it is possible to load the spring wire approximately 40 % more than in a test with a complete spring. This allows for a greater variation of the mean load and a very time efficient test procedure.

Experimental examples:

- Examination of the surface protection, the influence of pre-corrosion and corrosion during a test under realistic conditions
- Examination of the influence of the test frequency on the fatigue life under corrosion
- Verification of the influence of the material, the heat treatments, the shoot-peening process, the surface layer quality and the surface protection
- Analysis of the influence of the mean load (vehicle load)
- S/N Curves (Wöhler lines)
- Scatter and distribution in the finite-life fatigue strength area and fatigue limit areas
- Analysis of the fatigue life predictions (damage accumulation) under collective load

Technical data

- **Test specimens:** two spring coils taken from cylindrical passenger vehicle springs
- **Mounting and loading in the testing machine:** between load tips
- **Spring wire diameter:** d < 22 mm
- **Spring diameter:** D_m = 40 to 320 mm
- **Test frequency:** Slow drive f = 0,2 to 1,5 Hz
  Fast drive f = 8 to 40 Hz
- **Environmental conditions:** normal laboratory atmosphere or salt water spray
- **Weight / measurement of machine (without switching cabinet):** 1.000 kg, L = 1,200 mm, W = 1,100 mm, H = 1,600 mm
- **Power consumption:** < 1 kW

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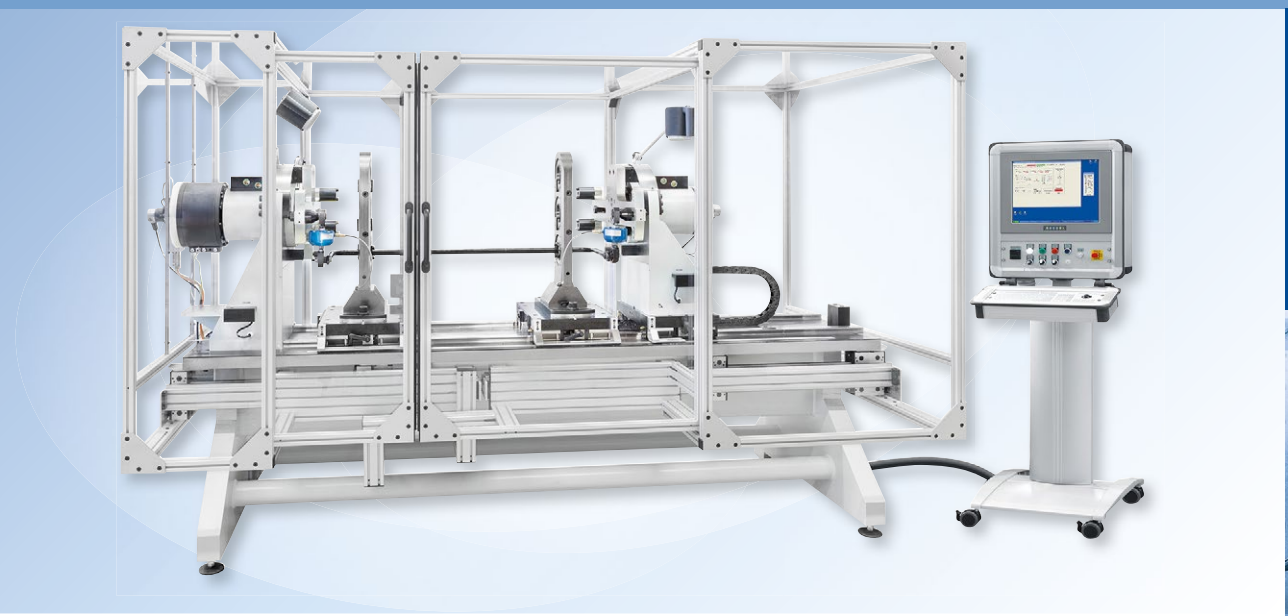

Stabilizer Bar Testing Machine (STAP)

The development and quality monitoring of resilient, highly stressed automotive components such as stabilizer bars, requires testing that represents actual vehicle conditions as accurately as possible. There are some essential test areas when determining the quality of spring steel, for example, fatigue strength under realistic load and environmental conditions.

Based on these requirements, IABG offers a **stabilizer bar testing machine capable of performing fatigue tests under normal laboratory atmosphere.** Thus allowing the determination of stabilizer bar fatigue strength while reducing both time and cost.

Advantages of the IABG stabilizer bar testing machines

- Energy efficiency by utilising the principles of resonance in tests
- Reliability and low maintenance
- Designed to exclude all external forces and vibrations
- Possible test types:
  - Release test with alternative bearings capable of running at higher frequencies
  - Assembly test with original bearings at low frequencies
  - Full axle configuration test for simulation of real kinematics
- Tests for up to 42 mm thick stabilizer bars
- Software-based testing, documentation and evaluation
- Accepted by all leading car manufacturers
- Compliant with German OEM standards (AK-LH 07) of springs and stabilizer bars

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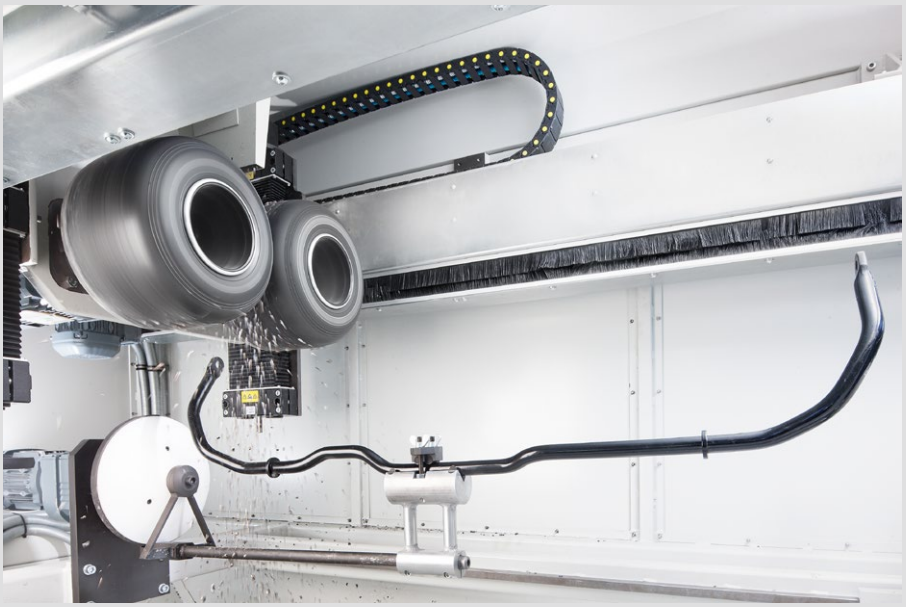

Pre-damage of the stabilizer bar with the IABG Grit Impact Simulator Machine

Relevant influences on stabilizer bars

- Mechanical demands from
  - Tension of the bar
  - Axle kinematics
- Damage to the surface and coating through
  - Stone impact

Experimental verification

- Pre-damage caused by IABG Grit Impact Simulator
- Corrosion in alternating cycle tests developed by the German Association of the Automotive Industry (Verband der Automobilindustrie, VDA)
- Tests with original stabilizer bar bearings in installation position
- Statistical validation by systematic testing and a sufficient number of test items

Technical data

- **Test specimens:** all types of passenger vehicle stabilizer bars, one or two bars can be tested simultaneously.
- **Stabilizer bar diameter:** d = 10 to 42 mm
- **Stabilizer bar length:** L ⩽ 2,000 mm
- **Test frequency:** f = 1,5 to 25 Hz
- **Loading conditions:** constant and randomly variable amplitudes (block program), constantly alternating loads (R = –1)
- **Installation:** flat ground, electric power supply of 1 kW
- **Weight / measurements of the machine:** 3,2 tons, L = 4,700 mm, W = 1,500 mm, H = 2,100 mm

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Grit Impact Simulator Machine (GISM)

With the IABG Grit Impact Simulator Machine it is possible to create stone impact damage to components in a defined and reproducible manner. The type and amount of discharge material and impact velocity is continuously variable, within certain limits. It is guaranteed that every single particle of the selected discharge material – regardless of its shape, size and weight will have the same defined speed.

The two simulators developed by IABG are among other things designed to test suspension springs, stabilizer bars, dampers, axle components, motor vehicle or rail vehicle fronts, car body parts, fuel tanks, transmission housings, oil pans, windscreens and axles. They are also suitable for the simulation of hail fall on wind power rotor blade tips or solar panels.

Advantages of the IABG Grit Impact Simulator Machine

- The velocity of the individual particles in the discharge material is independent of weight, size and shape
- Therefore the test is consistent and accurately reproducible
- The method is equivalent to the standards DIN 20567 and SAE J400
- High Variation of the area to be targeted
- Test specimens can be rotated throughout the procedure producing a regular damage pattern
- Large selection of discharge material (gravel, chippings, stone shards, sand or balls of various materials)
- Simple operation without the need for extensive training
- Reliable and low maintenance

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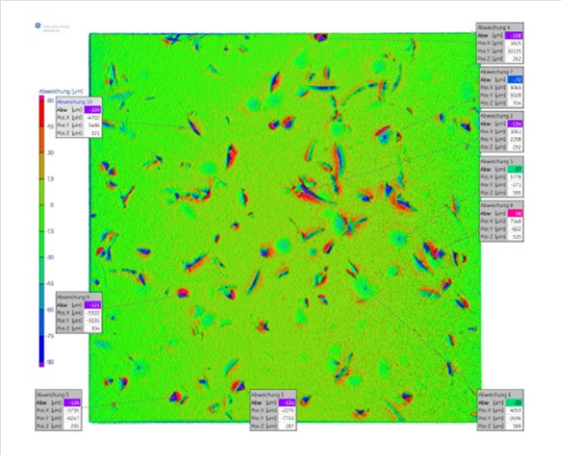
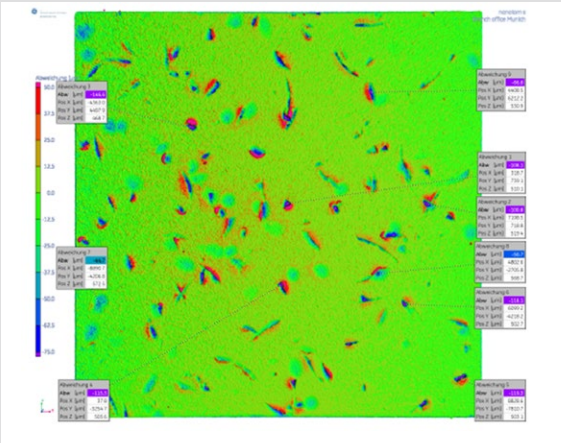
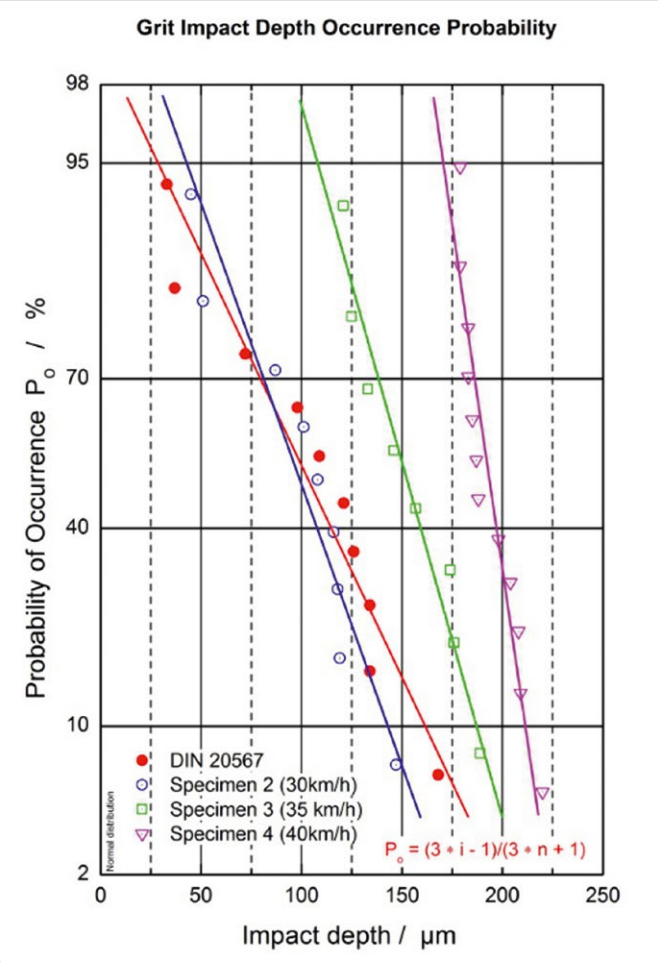


Damage pattern following DIN 20567



Damage pattern with IABG Grit Impact Simulator Machine



Statistical distribution of the impact marks

Verification of the reproducibility of standards DIN 20567 and SAE J400

To confirm the reproducibility in accordance with the required norms, comparative tests were carried out using the different procedures and documented. With the help of imaging techniques, the damage patterns were analysed, measured and compared using statistical evaluation. With this the correlation between the two methods can be demonstrated.

Technical data

- **Maximum impact speed:** 140 km/h (39 m/s) / 300 km/h (83 m/s)
- **Angle adjustment:** horizontal/vertical
- **Height adjustment:** up to 700 mm
- **Maximum grain size of discharge material:** 15 mm / 40 mm
- **Weight (without switching cabinet):** ca. 800 kg
- **Measurements (without switching cabinet):** L = 2,300 mm, W = 1,300 mm, H = 2,000 mm

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Rotating Bending Testing Machine (RBTM)

When using high-strength materials it is very important to consider not only the fatigue strength but also the presence of surface defects when determining the fatigue life of components.

The **IABG Rotating Bending Testing Machine** allows the time and cost saving determination of the fatigue strength of high-strength materials, such as those used in the manufacture of springs and stabilizer bars.

Purpose of the rotating bending test

- Comparison of fatigue strength before the raw material is processed to become the final product.
- Material optimisation (e.g. type of material, heat treatments, shot peening parameters, scatter reduction, etc.)
- Discovery of cracks, inclusions or similar discontinuities in the material to determine the materials quality
- Assessment of the surface quality

Advantages compared to other existing testing machines

- Clamping of test bar is not necessary due to the utilisation of special purpose bearings
- High test frequency
- Tests a large and therefore representative material volume
- Short assembly and test specimen exchange time
- Reliable and low maintenance

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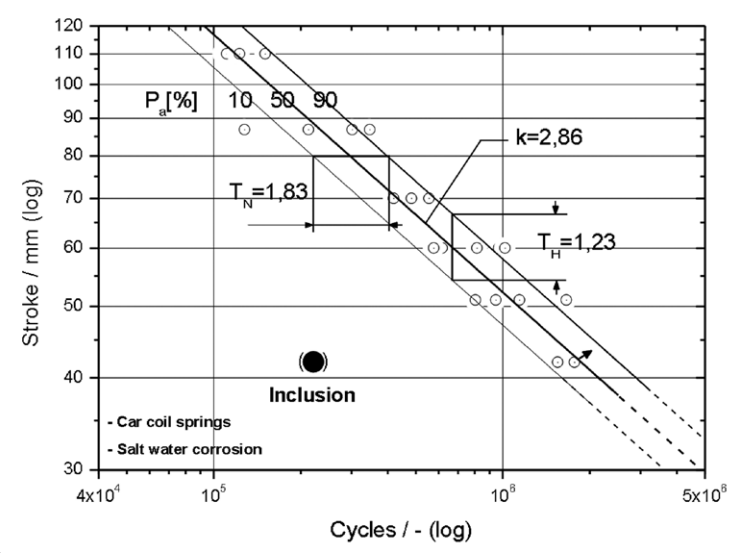
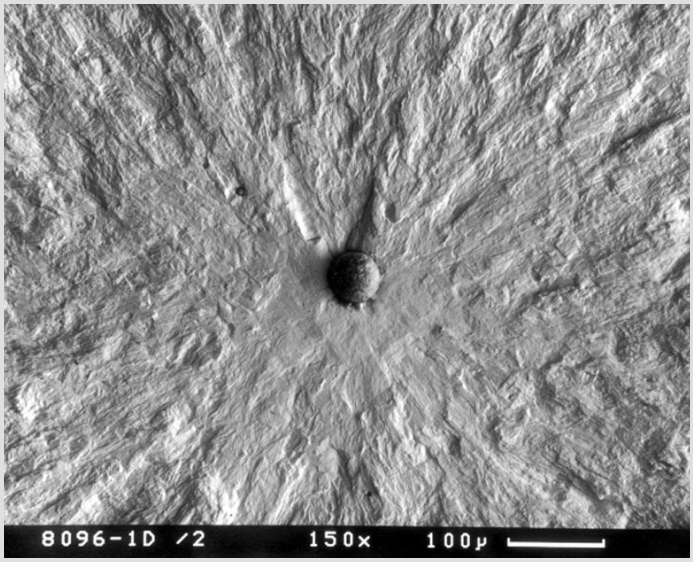


Influence of an inclusion on durability



Example of a non-metallic inclusion in an SEM micrograph

Typical results

- Fatigue strength in the finite-life fatigue strength area
- Fatigue life
- Scatter along an S/N curve (Wöhler line)
- Distribution of material defects in material volume

Typical users

- Manufacturers of high strength steels
- Wire manufacturers for the spring and stabilizer bar industry
- Manufacturers of springs and stabilizer bars
- Generally all manufacturers producing steel of high purity

Technical data

- **Test specimens:** processed and unprocessed cylindrical bars or pipes (also for stepped shafts)
- **Diameter of bar / pipe:** d = 10 to 30 mm
- **Length of bar / pipe:** L = 60 d + 140 mm (or special sample shapes)
- **Test frequency:** f = 5 to 50 Hz (variable)
- **Power consumption:** < 1 kW
- **Properties:** no outward vibration, very quiet
- **Weight / measurements of machine:** ca. 1,000 kg, L = 2,600 mm, W = 1,000 mm, H = 1,500 mm
- **Load conditions:** load transfered over convex, non-wearing plastic bushings
- Load (stress) and strain measurements
- **Max. bending moment:** M_{max} = 3,6 kNm

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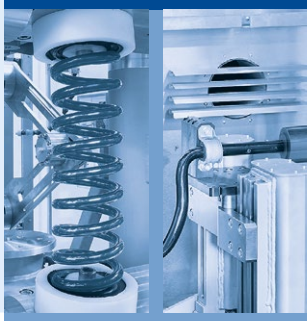

Rotational bending tests on thin wires and samples

Rotating Bending Test Machine (RBTM) • 100 Nm

Service description

- Testing machine for rotating bending testing on thin wires and samples
- Determination of the fatigue strength depending on the material properties
- Material optimisation (e.g. purity, type of material, heat-treatment, shot peening parameters)

Fields of application

- Quality assurance
- Determination of the fatigue strength of high-strength materials for the production of springs or other highly designed components

Added value for our customers

- Efficient optimisation by comparing the fatigue strength of the raw material even before processing into the end product

Reference customers / projects

- Spring maker
- Spring wire manufacturer
- Steel producer

Technical data

- **Shouldered samples (Ø):** max. 12 mm
- **Spring wire (Ø):** 3 to 6 mm
- **Test frequency:** 5 Hz to 50 Hz (variable)
- **Power consumption:** max. 1 kW
- **Weight:** approx. 500 kg
- **Circumferential bending, load maintenance:** quick-action chuck or domed, wear-free plastic rings
- **Bending moment:** max. 100 Nm

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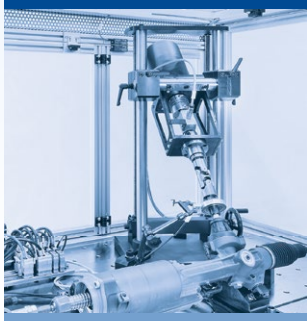

HIL test bench for rear-axle steering systems

Fields of application

- Function development, optimisation and validation of rear-axle steering systems
- Analysis of performance and control in a HIL-environment
- Simulation and validation of rear-axle steering behaviour in failure scenarios
- Automated HIL road and approval tests

Test bench architecture and modules

- Mechatronic integration of rear-axle steering systems, e.g. via
  - Flexibly adjustable and close-to-application mechanical fixtures for different types of rear-axle steering systems
  - Integration of control devices, sensors and fieldbus systems (CAN, FlexRay)
  - Integration of test item and vehicle models
- Linear actuator to apply variable forces and positions
  - Counter force: ± 12 ... ± 25 kN
  - Stroke: ± 150 ... 300 mm
  - Adjustment speed: 500 ... 750 mm/s
- Powerful simulation of vehicle electrical systems incl. energy refeed
- Cut-off relay adaptor for highly automated simulations of electrical failures
- Measurement system to record
  - Control and power signal currents of the specimen actuator and ECU
  - Forces and positions
- Models and interface with real-time hardware (e.g. MATLAB/Simulink, dSpace)
- Compact dimensions and design for use in HIL labs

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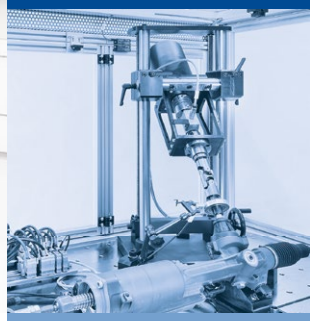

HIL test bench with climatic chamber for rear-axle steering systems

Fields of application

- Function development, optimisation and validation for rear-axle steering systems
- Analysis of performance parameters and control quality within the HIL network and under certain climatic conditions
- Simulation and validation of rear-axle steering behaviour in failure scenarios
- Automated HIL road and approval tests as well as endurance tests

Test bench architecture and modules

- Mechatronic integration of rear-axle steering systems, e.g. via
  - Flexibly adjustable and close-to-application mechanical fixtures for different types of rear-axle steering systems
  - Integration of control devices, sensors and fieldbus systems (CAN, FlexRay)
  - Integration of test item and vehicle models
- Hydraulic actuator to test different forces and positions
  - Counter force: ± 12 ... ± 25 kN
  - Stroke: ± 150 ... 300 mm
  - Adjustment speed: 500 ... 1,000 mm/s
- Powerful simulation of vehicle electrical systems incl. energy recovery
- Cut-off relay adaptor for highly automated simulations of electrical failures
- Metrology to record
  - Control and power signal currents of the specimen actuator and ECU
  - Forces, positions, angles, torques and temperatures
- Models and interface with real-time hardware (e.g. MATLAB/Simulink, dSpace)
- Robust design for functional tests and deployment in a testing environment

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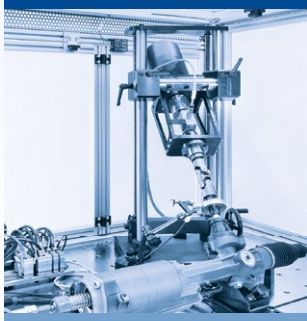

HIL test bench for EPS steering systems

Fields of application

- Function development, optimisation and validation for EPS steering systems
- Analysis of performance parameters and control quality within the HIL network
- Simulation and validation of EPS steering behaviour in failure scenarios
- Automated HIL road and approval tests

Test bench architecture and modules

- Mechatronic integration of EPS steering systems, e.g. via
  - Flexibly adjustable and close-to-application mechanical fixtures for different types of EPS steering systems
  - Integration of control devices, sensors and fieldbus systems (CAN, FlexRay)
  - Integration of test item and vehicle models
- Linear actuator to test variable forces and positions
  - Counter force: ± 12 ... ± 25 kN
  - Stroke: ± 150 ... 300 mm
    Adjustment speed: 500 ... 750 mm/s
  - Force and position control
- Highly dynamic and accurate servo drives for steering purposes
  - Torques: ± 35 ... ± 160 Nm
  - Steering rate: ± 2,100 °/s
  - Angle and torque control
- Powerful simulation of vehicle electrical systems incl. energy refeed
- Cut-off relay adaptor for highly automated simulations of electrical failures
- Metrology to record
  - Control and power signal currents of the specimen actuator and ECU
  - Forces, positions, angles, torques and temperatures
- Models and interface with real-time hardware (e.g. MATLAB/Simulink, dSpace)
- Compact dimensions and design for use in HIL labs

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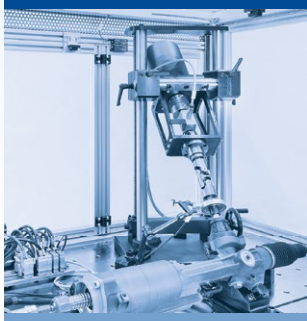

Endurance test bench for EPS steering systems

Fields of application

- Endurance tests for electro-mechanical steering systems (ESP steering systems)
  - Fatigue strength validation
  - Validation of all functions and performance data within the expected service life
- Real-time fatigue load simulations and standardised tests with synthetic nominal data profiles
- Determination of steering parameters (e.g. support characteristic, sliding force, ...)

Test bench architecture and modules

- Hydraulic rotary actuator to test different forces and positions
  - Force: Lever-dependent. Torques: >± 5.7 kN
  - Stroke: Lever-dependent. Rotation angle: ± 55°. Angular velocity: 2.5 rad/s
  - Force and position control
- Highly dynamic and accurate servo drives for steering purposes
  - Torques: ± 35 ... ± 160 Nm
  - Steering rate: ± 2,100°/s
  - Angle and torque control
- High-performance power supply unit to simulate vehicle electrical systems incl. energy recovery
- Metrology to record
  - Electric signals (currents, voltages) as well as the actuator performance of a test item
  - Forces, positions, angles, torques and temperatures
- Compact dimensions, also available as a small series for production quality control
- Integration in a central hydraulic supply system possible, or alternatively deployable with a separate hydraulic supply

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HIL test benches for chassis control systems

Fields of application

- System and component development, optimisation and validation
- Analysis of performance parameters and control quality within the HIL network
- Endurance and HIL road tests
- Simulation and validation of system behaviour in failure scenarios

Test bench architecture and modules

- Mechatronic integration of test items, e.g.
  - Active and passive chassis components (e.g. active anti-roll bars, shock absorbers, wheel modules)
  - Steering systems for front and rear axles and, if applicable, dynamic steering
  - Relevant ancillary components
  - Control devices, sensors and fieldbus systems (CAN, FlexRay)
  - Vehicle models
- Suitable drive transmission technology to test different forces and torques
  - Electrical servo drives, linear cylinders and actuators
  - Hydraulic actuators
- Powerful simulation of vehicle electrical systems incl. energy recovery
- Cut-off relay adaptor for highly automated simulations of electrical failures
- Metrology to record
  - Control and power signals (Currents, voltages) of the specimen actuators and ECU's
  - Forces, torques, positions, angles, accelerations and temperatures
- Models and interface with real-time hardware (e.g. MATLAB/Simulink, dSpace)

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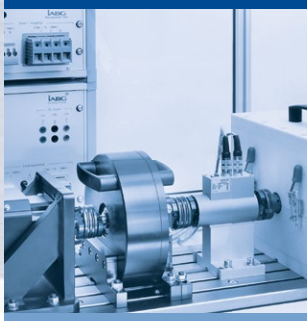

Endurance test bench for vehicle alternators

Fields of application

- Validation of the functionality and fatigue strength of four alternators subjected to certain loads and temperatures
- Definition of application-specific test cycles with predetermined load, torque and temperature collectives
- Direct comparative tests for multiple test items (operated in parallel) and recording of measured values for analyses

Test bench architecture and modules

- Mechatronic integration of different types of alternators
  - Parallel operation of up to four different types of alternators
  - Close-to-application mechanical fixtures for different types of alternators
  - Interfaces: Analogue/digital or bus systems (e.g. LIN interface)
- Belt drive
  - Close-to-application transmission and torques
  - Adjustable, monitored belt tensions
  - Dynamically configurable drive to simulate a vehicle's combustion engine
- Load simulation
  - Dynamically configurable electronic loads of up to 7 kW (resistance or power mode)
  - Energy recovery to reduce operating costs
- Temperature simulation
  - Temperature range: -40 ... +140 °C
  - Support for the parallel operation of two alternators at room temperature and variable temperature conditions
  - Temperature chamber incl. lift and guide rails for easy mounting
- Metrology to record
  - Current, voltage and torque outputs of the test items
  - Temperatures of the chamber and the test items
- Automation
  - Definition of application-specific test cycles with predetermined load, torque and temperature collectives
  - Error control with individual limits for test items, belt drive, load simulation and the climatic chamber

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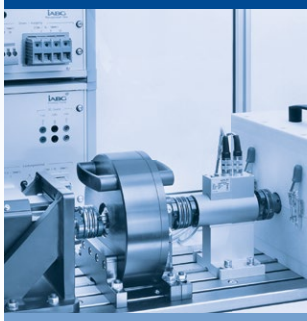

Development test bench for electric actuators

Fields of application

- Function development, optimisation and validation for electric drive systems
- Analysis of drive functions in the HiL network (ECU and BLDC motors, for example, possibly with transmission)
- Identification properties and dynamics, also under specific climatic conditions

Test bench architecture and modules

- Load machine and modular load drive configurations for flexible operation
  - with highly dynamic load machine (e.g. ±12 000 U/min, ±20 Nm with high power density)
  - with/without flywheel mass, with freely rotating or clamped test item
- Electricity supply for test item
  - Vehicle electrical system simulations (12/24/48V) for power as well as logic and energy recovery with dynamic bidirectional power supply units (up to ±450 A)
  - Optional battery switch to connect a battery simulator
  - Optional integrated supercaps to simulate storage in vehicle power supply systems
- Temperature or climatic simulation
  - Temperature (–40 ... +150 °C) and humidity control (10...85 % RH)
  - Standard or customer-specific chambers, units and interfaces
- Metrology
  - Torque and speed measuring technology with applicable measuring ranges and resolutions
  - Measurement of current, voltage, temperature and acceleration
  - Optional integration of electrical power meters

Automation and functions

- Manual and highly automated analysis of characteristics, efficiency or long-term stability
- Determination of harmonics, torques and step responses
- Automatic identification of transmission functions and test item parameters
- Database-oriented test sequencer for developing specific test programmes
- Flexible model integration and extension options for FIU functions
- Automatic report generation of test results with DIAdem

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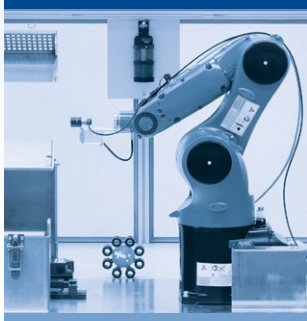

Speed Sensor Test Benches

Fields of application

- Development, optimisation and validation of speed sensors
- Analysis of sensors, evaluation electronics and rotors in the HiL network
- Identification properties under emulated installation criteria, positions and speeds

Test bench architecture and modules

- Rotor drive and seat
  - Application in accordance with requirements of the acceleration dynamics, speed range and synchronisation characteristics
  - Rotor seat with high concentricity and flexible quick-action clamping mechanism
- Positioning robot
  - Positioning and air-gap control via 3-axis portal (±25µm accuracy) or 6-axis robot (±50µm accuracy)
  - Multiple-sensor recording when using a robot
- Electricity supply for test item
  - Stabilised power supply via logic power supplies (5/12/24/48V)
  - Optional dynamic vehicle electrical system simulation (12/24/48V) or battery switch for battery simulator
- Metrology
  - High-resolution speed and angle measuring technology with applicable reference signals
  - Air gap measurement up to a resolution of ±5µm
  - Highly dynamic current, voltage and digital signal acquisition of sensor signals and field bus data from evaluation electronics or control devices
  - Optional integration of oscilloscopes, field meters or customer-specific measuring systems
- Optional extensions for temperature and climatic simulation

Automation and functions

- Single-item or series testing of sensor signals and functions
- Analysis of rotor properties (stroke, pitch, tooth shapes)
- Customer-specific online analysis of sensor functions and test sequencers for customer-specific test programs
- Automatic report generation of test results with DIAdem

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HiL and Parameter Test Benches

Fields of application

- Highly automated parameter tests or environmental tests of mechatronic systems
- Development, optimisation and validation of electrically operated systems (e.g. for Automotive LV124)
- Analysis of functions, performance parameters and control quality.
- Simulation and validation of behaviour in failure scenarios

Test bench architecture and modules

- Test-item and customer-specific application of hardware and functions
- Automation
  - Control and regulation of test sequences for environmental and parameter tests via field bus interfaces
  - Integrated control of climatic chambers and vibration test systems
  - Monitoring of test procedure and progress
  - Data analysis with automatic report generation
  - Implementation based on MATLAB/Simulink with National Instruments or dSpace
- Power supplies for test items
  - High-performance simulation of 6 vehicle electrical systems 0..60V or 115V incl. energy recovery where applicable
  - Automatic clamping circuits of power supplies for up to six test items
  - Implementation of integrated laboratory power supply units or connectable external battery simulators
- Measuring technology and field bus interface
  - Sensors for highly dynamic and precise acquisition of currents (0,2..200 A) and voltages (0..150V) of power supplies, sensors and actuators
  - Field bus interfaces CAN/LIN/FlexRay and RS/ARINC
  - Continuous measurement data acquisition and online analysis
- Signal specification or HiL simulation
  - Automatic real-time specifications for emulating temperature sensors, resistances, and voltage, frequency or load signals
  - Optional: FIU functionality for automatic for testing for electrical faults on actuators, sensors and field buses
  - Integration of test item models (MATLAB/Simulink) and real-time simulation in the automation system

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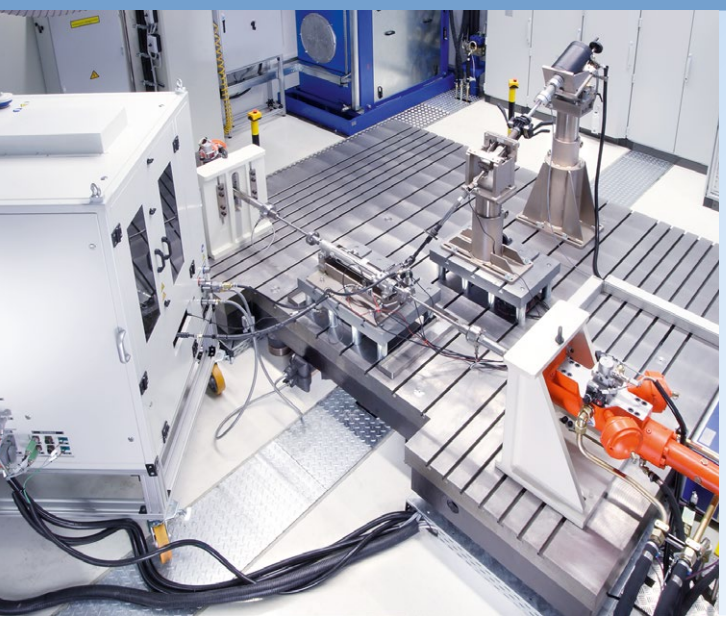

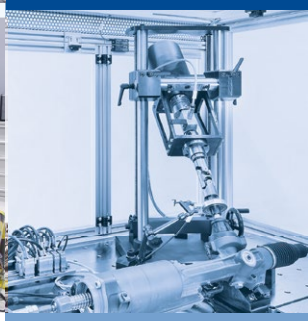

Test Rig for Steering Systems

Fields of application

- Function development, optimisation and validation of steering systems
- Analysis of performance parameters and control quality within the HIL network and under certain climatic conditions
- Simulation and validation of steering behaviour in failure scenarios
- Automated HIL road and approval tests as well as endurance tests

Test bench architecture and modules

- Mechatronic integration of steering systems, e.g. via
  - Flexibly adjustable and close-to-application mechanical fixtures for different types of rear-axle steering systems
  - Integration of control devices, sensors and fieldbus systems (CAN, FlexRay)
  - Integration of test item and vehicle models
- Hydraulic actuator to test different forces and positions
  - Counter force: ±25 kN
  - Stroke: ±150 ... 300 mm
  - Adjustment speed: 500 ... 1000 mm/s
- Powerful simulation of vehicle electrical systems incl. energy recovery
- Cut-off relay adaptor for highly automated simulations of electrical failures
- Metrology to record
  - Control and power signal currents of the specimen actuator and ECU
  - Forces, positions, angles, torques and temperatures
- Models and interface with real-time hardware (e.g. MATLAB/Simulink, dSpace)
- Robust design for functional tests and deployment in a testing environment

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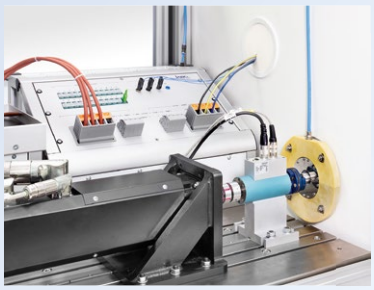

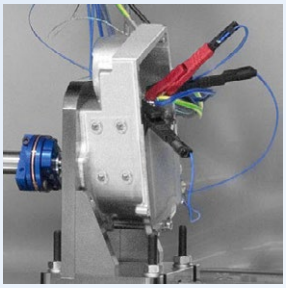

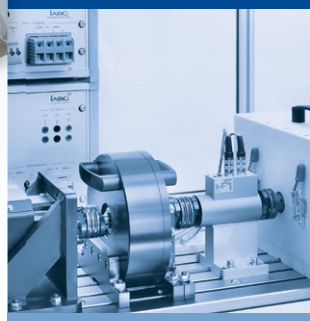

Test bench for electric BLDC-motors and drive systems

Mission and intended purpose of the test rig

- Engineering, optimization and validation of functions, performance and endurance of electric drive systems
- Analysis of drive-functions in system setup configurations (e.g. ECU and BLDC-Motors, if required including actuation gear or belt drive)
- Identification of performance values and dynamic characteristics, as option including enviromental climate control

Test rig setup and modules

- Load drive and modulare power-train-configuration for flexible setups
  - high dynamic loading drive (e.g. up to ± 15.000 rpm, ± 20 Nm with optimized intertia)
  - w/o intertia mass, w/o gearbox, free rotating or blocked specimen
- Electric supply for the specimen
  - Vehicle power circuit emulation (12/24/48V) for power and logic supply as well as energy feed-back using high dynamic bi-directional supply units
  - Option: Battery switch for connection with battery simulators
  - Option: Integrated superCAPs for emulation of vehicle electric supply systems
- Temperature- or climate control
  - Temperature (-40 ... +150°C) and humidity-control (10 .. 85 % RH)
  - Standard or customer specific design of chamber, climate control units and interfaces
- Measurement technology
  - Torque and speed sensors with applicable range and resolution
  - Current, voltage, temperature and acceleration sensors (as option)
  - Option: Integration of additional electric power measurement devices

Automation system based on National Instruments VeriStand

- Manual or automated analysis of characteric curves, efficiencies, harmonics, cogging curves, step response and transfer functions or long-term stability
- Test sequencer with data base or NI Test Stand functionality for generic generation of specific test programs
- Model-integration capability, high scalability for functional extensions (e.g. fault-insertion)
- Automated report-generation with NI DIAdem

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Test Benches for Active Roll Control Systems

Fields of application

- Engineering, optimization and validation of functions of electromechanic roll control systems
- Analysis of static and dynamic characteristics
- Parameter identification as a function of temperature
- Simulation and validation of system behaviour in failure scenarios

Test bench architecture and modules

- Highly dynamic mechanical loading devices
  - hydraulic or electrical servo-drives
  - i.e.: +/- 20 kN; +/- 125 mm; +/- 4 m/s; 300 m/s²
  - High lateral forces (+/- 5 kN)
- Electric supply for the specimen
  - Capable vehicle power circuit emulation
  - Recuperation by means of bi-directional power supplies
  - Option: Battery switch for connection with battery simulators
- Temperature control (i.e.: - 40 ... + 140 °C)
- Measurement technology for
  - Cuurents and voltages
  - Forces, displacements and angles (for the entire temperature range between - 40 ... + 140 °C)

Automation

- Force and stroke control for various load cases such as:
  - Identification of static and dynamic stiffness
  - Identification of command responses
  - Identification of disturbance rejection
- Model-integration capability, high scalability for functional extensions (e.g. fault-insertion)
- Automated report-generation with NI DIAdem

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IABG testing method for rotor blades of wind power stations

IABG developed a new and improved concept for dynamic fatigue tests on rotor blades that offers significant advantages over traditional testing methods. In general, the proof of fatigue strength for rotor blades is obtained in dynamic fatigue tests endured over several millions of stress cycles, i.e., by vibration tests in line with the resonance principle.

The test frequency is hereby limited by the initial natural bending frequency of the item under test. For current blades, this lies clearly below one Hertz, which leads to long testing times and thus, in the end, to high costs. The blade deflection curve appearing in resonance tests often varies from the real-operation deflection curve due to aerodynamic loads. Here, exceedingly high or low stress levels can appear locally that negatively impact testing quality.

The patented test method of IABG can significantly reduce or avoid these deficiencies.

The new method allows for increasing the natural bending frequency, improved simulation of the deflection curve, setting a medium load during the text cycle, as well as for doubling the testing frequency.

IABG test concept	Impact
Elastic pinning through hinged supports and spring elements	→ Quick adaptation of the test device
Increasing system rigidity	→ Increasing test frequency
Positive influence on the deflection curve	→ Improved test quality, compensation of interfering masses
Adjustable static initial load	→ Testing under near-reality medium load
Impact & swivel tests	→ One test stand, two test types

Advantages

- Shorter test times
- Improved quality of proof
- Increasing strength reserves
- Multiple test types in one stand
- Combination of simulation and testing

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