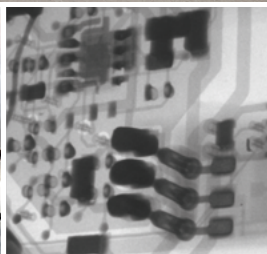


Latest Technologies and Smart Solutions

Test Center for Electronics



LIEBHERR

Testing Services for Electronics



State-of-the-Art Laboratory Equipment

In Lindau, Liebherr operates the Competence Center for Electronics – a test center with state-of-the-art testing and measurement technology that realistically simulates environmental influences. Liebherr offers services at the highest level to customers from the aviation and traffic engineering sector as well as from the automotive and industrial sectors.

Optimize Your Products

Throughout their entire life cycle, electronic products are subject to a wide range of environmental influences, such as extreme temperatures, temperature variations, vibrations or electromagnetic radiation. Analyze and improve the reliability and quality of your electronic assemblies right from the development stage. This not only improves the performance and service life of your devices, but also ensures their functionality throughout their entire life cycle.



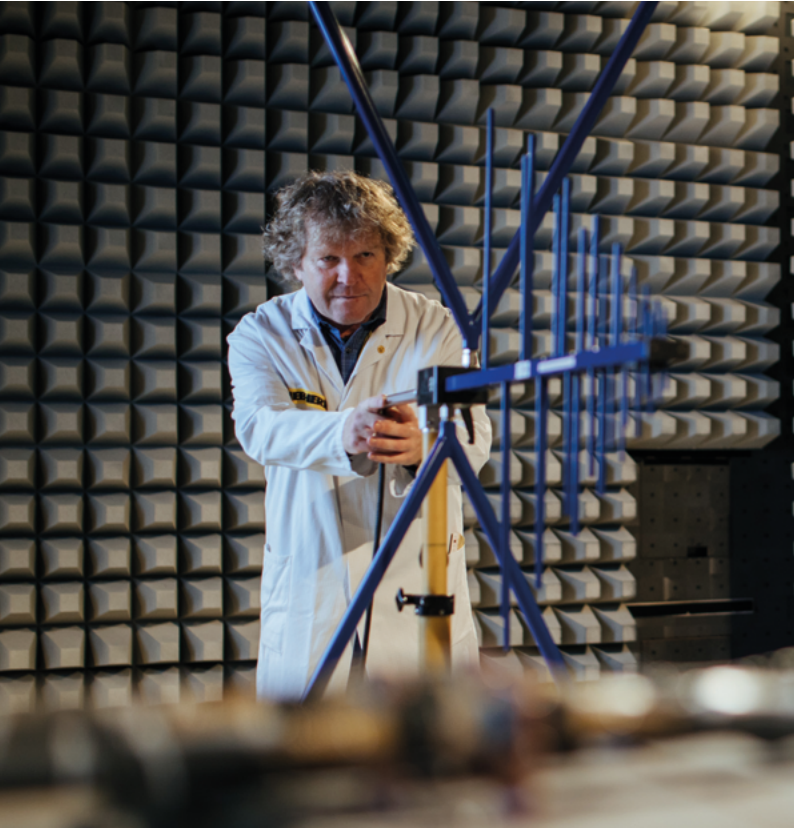
From the Idea to the Product Lifecycle

Individual consulting, development services and product certifications in compliance with international standards: Our test center supports you throughout the whole process. Our skilled team will work with you to develop innovative and cost-effective solutions for your test requirements.

Our Test Services at a Glance

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Electromagnetic Compatibility



Our test center examines electromagnetic compatibility (EMC) for you in accordance with all common standards in the aviation, automotive, railway and commercial industry sectors (RTCA/DO-160, MIL-STD, CISPR 16/25/32, DIN EN 61000 amongst others).

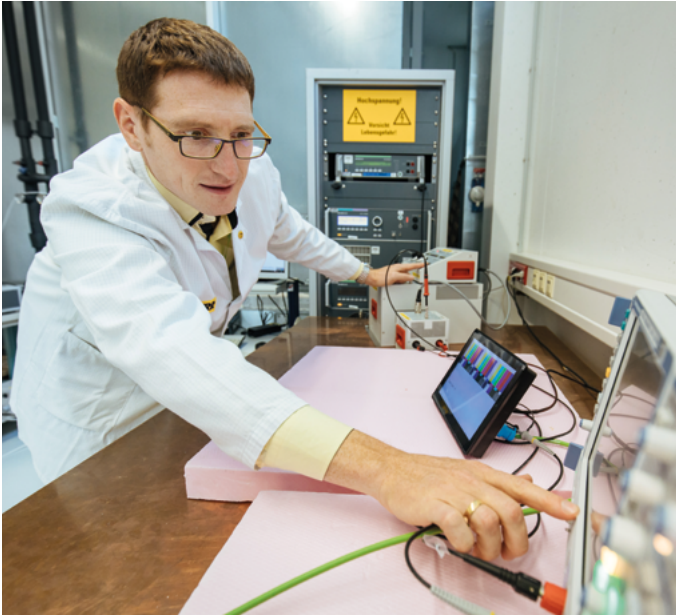
- Radiated Susceptibility:
80 MHz to 18 GHz; up to 200 V/m (from 100 MHz continuously)
- Conducted Susceptibility:
10 kHz to 400 MHz; up to 600 mA
- Radiated Emissions:
9 kHz to 18 GHz
- Conducted Emissions:
10 kHz to 200 MHz



Technical Description of Our Semi-Anechoic Chambers

- Dimensions: 6 m x 8 m (less 50 cm absorber thickness)
- Calibrated according to CISPR 25
- Floor load: 500 kg/m² to 1,000 kg/m² depending on the chamber
- 1 m turntable and 3 m antenna mast for fully automatic emission measurements according to CISPR 16 (for preliminary investigations or during the development phase)
- Optical signal transmission links
- Feed through up to 5 x 400 V_{DC}/250 V_{AC}, 100 A
- Rapid development tests with FFT measurements and all bandwidths
- Video monitoring and recording of the test sample

Electrical Tests

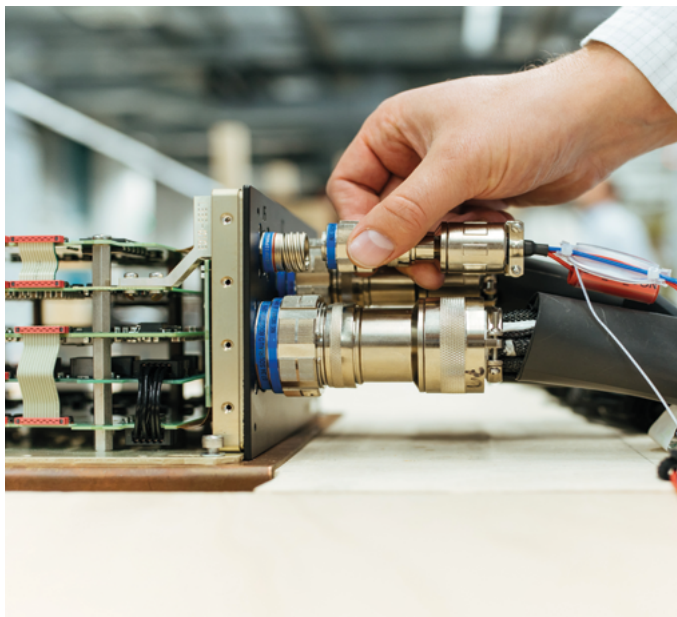


Lightning Induced Transient Susceptibility

- Waveforms: 1, 2, 3, 4, 5A, 5B, 6 according to RTCA/DO-160, ABD0100.1.2, B6-16050
- Pin Injection up to Level 5
- Cable Bundle up to Level 4
- Single/Multiple Stroke, Multiple Burst

Electrostatic Discharge (ESD)

- Contact and air discharge: 0.2 kV to 30 kV
- Various discharge networks: incl. RTCA/DO-160, ABD0100.1.2, IEC 61000-4-2, ISO 10605



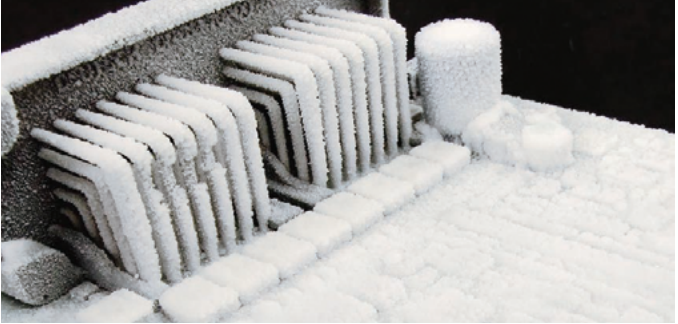
Voltage Transients (Spike, Surge, Burst)

- Compliant with standard pulses in accordance with ISO 7637, ISO 16750 and the standards of all major car and utility vehicle manufacturers (test samples up to 100 A)
- Burst/EFT and surge according to international standards: up to 4.4 kV
- Voltage spikes according to RTCA/DO-160 and ABD0100.1.8: up to 2 kV

Further Electrical Tests

- Tests in accordance with commercial standards for network perturbations (3 phases/ 125 A), harmonic tests and flicker tests (DIN EN 61000-4-xx)
- Power Interrupts, Induced Signal, Audio Frequency amongst others in accordance with RTCA / DO-160, ABD0100.1.8 and AMD-24/MIL-STD
- Tests with power electronics up to 90 kW
- Power tests in accordance with international standards and the standards of all major manufacturers of hybrid and fuel cell vehicles up to 750 Vdc
- Partial discharge tests

Environmental Tests



Climate Tests

- Temperature and humidity chamber
- Temperature range: -70 °C to +180 °C
- Humidity range: 10 % to 98 % relative humidity
- Volume: 1,180 l

Thermal Shock Tests

- Two-chamber system with 120 l capacity
- Hot chamber: +50 °C to +220 °C
- Cold chamber: -80 °C to +70 °C



Corrosion Tests

- Volume: 1,170 l with cover, 700 l without cover
- Salt spray test: +5 °C above ambient temperature up to +50 °C
- Condensation: 1.5 ml ± 0.5 ml/80 cm²/h
- Water condensation test: +5 °C above ambient temperature up to +45 °C
- Standard atmospheres
- In accordance with: RTCA/DO-160, DIN EN ISO 9227, DIN EN 50155, DIN EN 60068-2-11, DIN EN 60068-2-52, DIN EN ISO 6270-2



HALT Tests

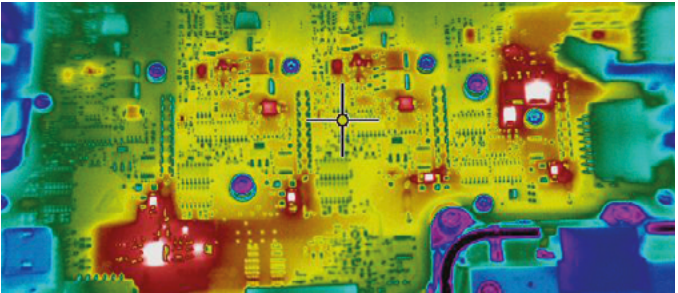
Stress conditions acting on the test sample outside the specified values cause mechanical or electrical failures. Their analysis reveals design weaknesses and thus contributes to product improvement.

Temperature:

- Temperature range: -100 °C to +200 °C
- Temperature changes: max. 70 °C/minute

Vibration:

- Acceleration: max. 70 gRMS
- Frequency range: 5 Hz to 10 kHz
- 6 degrees of freedom



Infrared Thermal Analysis

- Automatic hot/cold spot and Delta T differential temperature measurement
- Temperature measurement points: 307,200 pixels (640 x 480)
- Thermal sensitivity: < 0.035 °C
- Image in image: the scalable and movable infrared image area superimposes the real image
- Temperature ranges: -40 °C to +2,000 °C

Vibration and Shock Testing



The constantly increasing demands on the mechanical reliability of electronic devices necessitate extensive vibration and shock tests. The Liebherr test laboratory has two electrodynamic vibration test systems at your disposal, which you can use both for development purposes and for certifications.

Test Portfolio

- Random/sine/shock
- Sine dwell
- Combined tests (sine-on-random, multi-sine)
- Superimposed temperature cycling



Technical Characteristics of the Vibration Facilities

- Frequency range: 10 Hz to 3 kHz
- Force vector: up to 55 kN
- Displacement: up to 76 mm (peak-to-peak)
- Superimposed temperature cycling: -50 °C to +100 °C

Example Standards

- RTCA/DO-160
- MIL-STD 810
- DIN EN 60068-2-6, DIN EN 60068-2-64, DIN EN 60068-2-27
- ABD0100.1.2
- D6-81926

Material Analyses and Examinations



Whether you wish to analyze materials or understand complex relations, our analysis laboratory is at your complete disposal for your test assignments. The laboratory is equipped with the latest technology. It offers the following possibilities for development-related examinations, special analyses and serial-production monitoring:

- X-ray examinations
- X-ray fluorescence spectroscopy
- Microsection preparation
- Optical examinations



The process of micrograph generation is split into the individual steps of cutting, embedding, grinding and polishing. The sample is prepared using the cold embedding process.

If the reason for the defect is not determined in this way, 3D X-ray computed tomography can be used in the Liebherr laboratory for further analysis. The ultra-high-resolution sectional images and slices can be created on almost all mechanical and electronic objects and used for defect analysis.

Material Analyses and Examinations



X-ray Examinations

- Resolution: 250 nm
- Tube power: up to 160 kV/3 W
- Camera can be swiveled through 70° and rotated through 360°
- Automatic recording of the ball grid array (BGA Void): BGA solder ball recognition
- Possibility of 3D computed tomography

X-ray Fluorescence Spectroscopy

- Analysis of thin and very thin coatings, e.g. gold and palladium coatings of $\leq 0.1 \mu\text{m}$
- Measurement of functional coatings in the electronics and semiconductor industry
- Determination of lead content in solder
- Determination of complex multiple coating systems with silicon PIN detector
- Detector resolution: $< 190 \text{ eV}$



Microsection Preparation

- Automated sample preparation for sample diameters of 30 mm and 40 mm
- Automated dosing of the suspension
- Use of diamond polishing suspensions of 9 μm to 1 μm and active oxide suspensions of up to 0.25 μm grain size
- Section diameter: 250 mm
- Diverse etching methods for sample processing
- Sample contrasting

Optical Examinations

- High-power reflecting/stereo microscopes with 1000-times magnification
- For use in bright field (BF), dark field (DF) with polarization filter (POL) or differential interference contrast (DIC)
- Fluorescence possible

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