



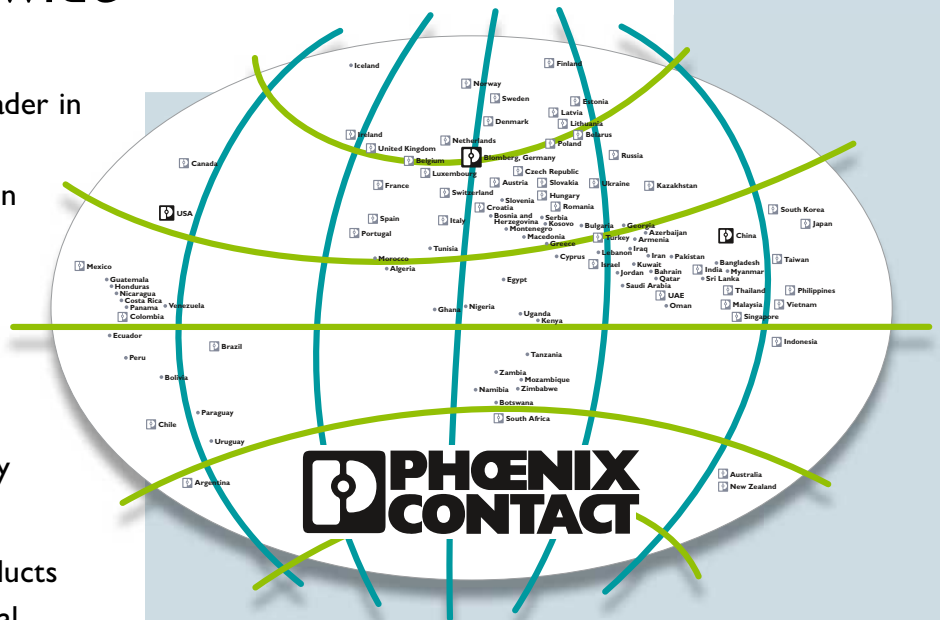
# Tested quality with safety

Connectors and electronics housings

# PHOENIX CONTACT – In dialog with customers and partners worldwide

Phoenix Contact is a global market leader in the field of electrical engineering, electronics and automation. Founded in 1923, the family-owned company now employs around 14,500 people worldwide. A sales network with over 50 sales subsidiaries and more than 30 additional global sales partners guarantees customer proximity directly on site, anywhere in the world.

Our range of services consists of products associated with various electrotechnical applications. This includes numerous connection technologies for device manufacturers and machine building, components for modern control cabinets, and tailor-made solutions for many applications and industries such as the automotive industry, wind energy, solar energy, the process industry or applications in the field of water management, power transmission/distribution, and transportation infrastructure.



## Global player with personal customer contact

Company independence is an integral part of our corporate policy. Phoenix Contact therefore relies on in-house competence and expertise in a range of contexts: the design and development departments constantly come up with innovative product ideas, developing special solutions to meet customer requirements. Numerous patents emphasize the fact that many of Phoenix Contact's products have been developed in-house.

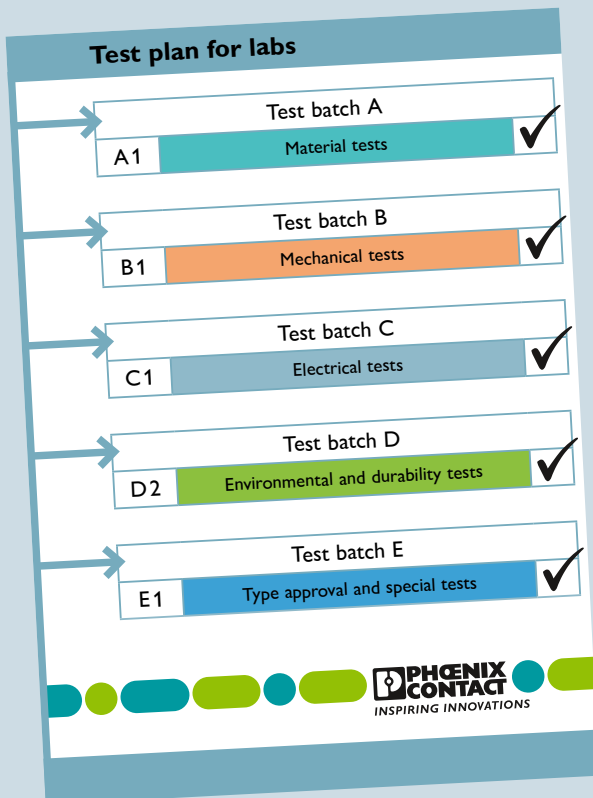


## Tested quality with safety

Reliable connections – that is our everyday motto. The quality of our products is the key. Product quality is generated at each step of production and is not simply an aspect that is checked after products have been finished.

We are also dedicated to a caring and responsible approach toward the use of natural resources to benefit employees, business partners and the environment.

A process-oriented, integrated management system based on international standards ISO 9001 and ISO 14001 ensures that not only legislation and standards, but also customer requirements are taken into account in the development and manufacture of our products.



Standardized test sequences ensure the highest quality and safety

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### Find out more with the web code

You can find web codes in this brochure: a pound sign followed by a four-digit number combination.

**i** Web code: #1234 (example)

This allows you to access information on our website quickly.

#### It couldn't be simpler:

1. Go to the Phoenix Contact website
2. Enter # and the number combination in the search field
3. Get more information and product versions



Or use the direct link:  
[phoenixcontact.net/webcode/#1234](https://phoenixcontact.net/webcode/#1234)



# PCB terminal blocks, connectors and electronics housings

PCB terminal blocks and connectors rank among the key elements in device manufacturing. They must not only be reliable, but, following the trend of miniaturization, also increasingly smaller and more robust. In addition, they must be easy to handle and feature new options for device design. Device connection solutions and electronics housings from Phoenix Contact are among the most innovative on the market and are setting standards in electronics and electrical engineering.

## PCB terminal blocks and PCB connectors

Whether you use a screw connection or push-in spring connection, as a PCB terminal block or easy-to-maintain connector for 2 to 24 positions, Phoenix Contact offers the right connection technology to transmit signals, data or power for almost any application.

 Web code: #0513

## Connectors

Versatile M5 to M58 circular connectors, data and photo-voltaic connectors as well as modular rectangular connectors: the comprehensive connector range from Phoenix Contact offers a huge variety of solutions for industrial and semi-industrial applications.

 Web code: #0515

## Electronics housings

A wide range of options for form, color, and function – this is the central idea behind electronics housing types from Phoenix Contact. Whether on a wall or on a DIN rail, from light gray to sky blue, narrow or wide.

 Web code: #0514

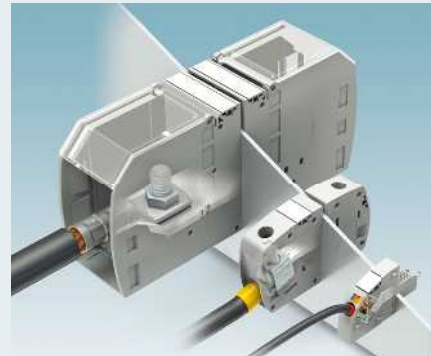




PCB terminal blocks



PCB connectors



High-current feed-through terminal blocks



Circular connectors



Data connectors



Photovoltaic connectors



Modular rectangular connectors



Multifunctional housings



Modular and building installation housings



Basic housings



Section profile and field housings

# Top quality in production

We conduct intensive quality tests before the production release and fully automatic inspections of all important parameters during production to ensure that the high quality requirements for our products are fulfilled.

## Computer simulations

State-of-the-art computer technologies and simulation methods provide us with an insight and understanding right down to the smallest detail.

## Qualification tests

All of our products must pass regular tests and inspections. This is how we guarantee high quality and reliable use.

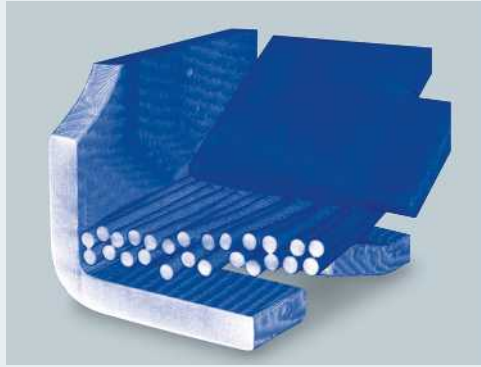
## Process monitoring

Only by carrying out consistent and multi-stage process monitoring can we meet, maintain, and improve high quality requirements.

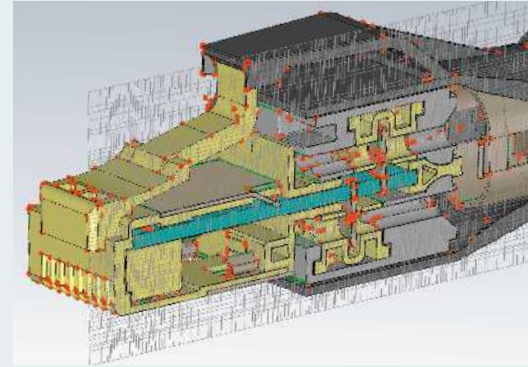




*Simulation and calculation of mechanical strains*



*X-ray of the correct conductor position in a spring-cage terminal block*



*Simulation of the high-frequency behavior of RJ45 connectors*



*Durability test under extreme climatic conditions*



*Mechanical load tests through vibration tests*



*Load tests through conductor tensile tests*



*Quality inspection using optical camera systems*



*Including employees in the continuous quality improvement process*



*Fully automatic screw test in the manufacturing process*

# Quality begins in the development stage

The Phoenix Contact technology lab uses the most modern simulation tools to optimize the development process and quality right from the start. Since the ambient conditions during a computer simulation can be defined in any number of ways, these systems offer the optimal conditions for testing the long-term stability of the products early on in the development phase.

## Advanced quality planning

Advanced quality planning is an established approach to preventing potential errors and continuously improving products and processes. Following ISO 9001, TS 16949, and VDA, product and process features to be developed are harmonized, test concepts worked out, test methods and test classification are taken into consideration, and product specifications defined in the form of necessary production documents. The knowledge gained is continuously applied in the development of new products.

### Advanced quality planning

Development team



Qualification phase in the pre-production shop

### Operating quality assurance

Series production





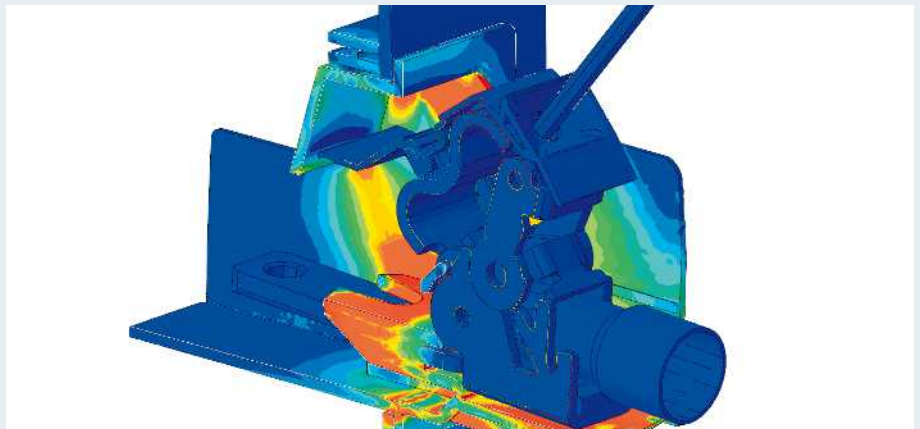
## Failure mode analysis

Product and process-related failure mode and effects analyses are performed in interdisciplinary project teams. The goal is to identify, understand, limit, and eliminate potential weaknesses and risks. The corrective actions defined in this process are documented, monitored, and used as the basis for further activities in advanced quality planning to optimize designs as well as the existing or planned production facilities.



## Computer simulation

The FEM calculation (Finite Element Method) allows engineers and designers to evaluate whether the materials and geometries selected for a product meet the high demands of industrial use. As early as the initial stages of development, products can be optimized. The FEM analysis permits both operation by the user to be simulated and the desired long-term behavior to be verified.



*Simplified FEM model*

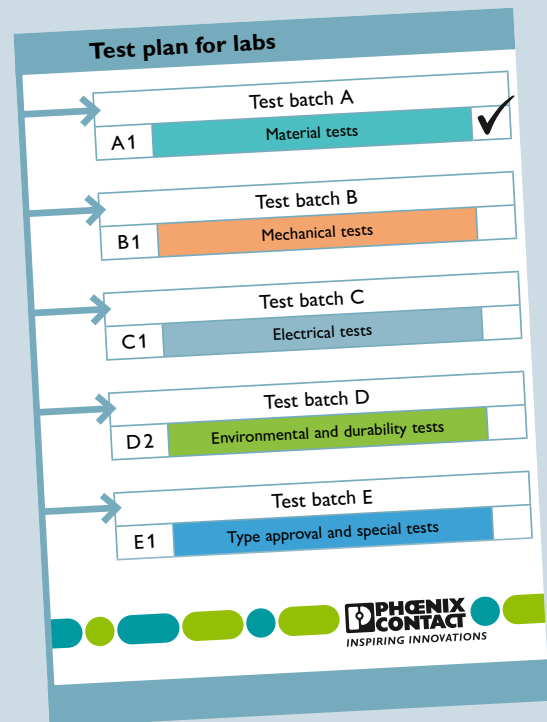
## Product and process approval

The structured product and process approval (PPF behavior) verifies whether the customer requirements agreed on in the specifications are met as well as the corresponding regulations and standards. The approval issued during the procedure covers the evaluation of the processes and products using relevant documents, drawings and samples to ensure that the conditions for serial delivery to the customer are present.



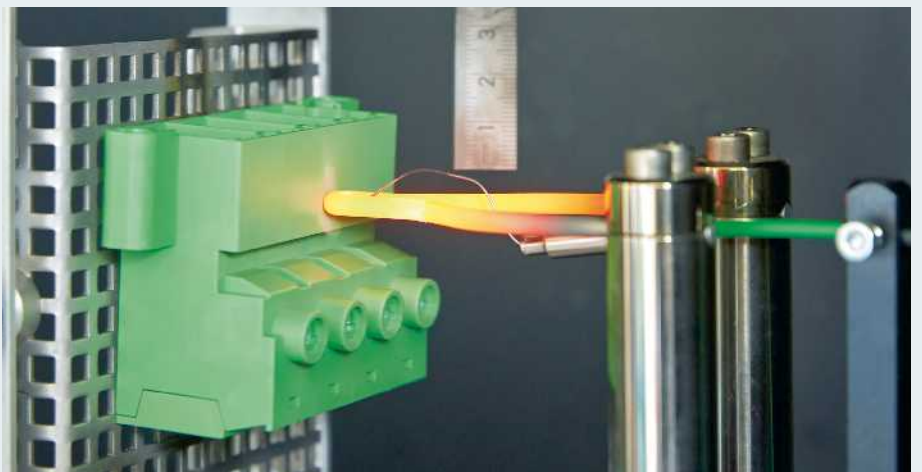
# Material tests

In addition to the computer-assisted simulation, Phoenix Contact subjects the materials it uses to comprehensive testing to assess their suitability and especially their long-term behavior. This ensures that only materials are used that satisfy the highest demands for reliability and dependability.



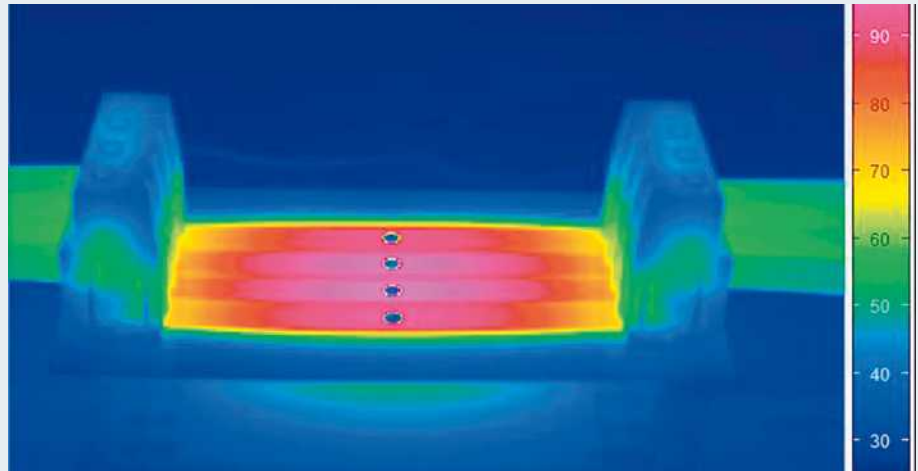
## Glow wire test

The glow wire test simulates thermal stresses that run, for example, through glowing parts or short-term overloaded electrical resistances. During the test, the tip of the glow wire is in contact with the test object for 30 seconds at a contact pressure of 1 N. In cases where the material is melted away by the glow wire, the penetration depth of the glow wire in the material is limited to 7 mm. Flames or a red-hot glow on the test object must extinguish no longer than 30 seconds after removing the glow wire.



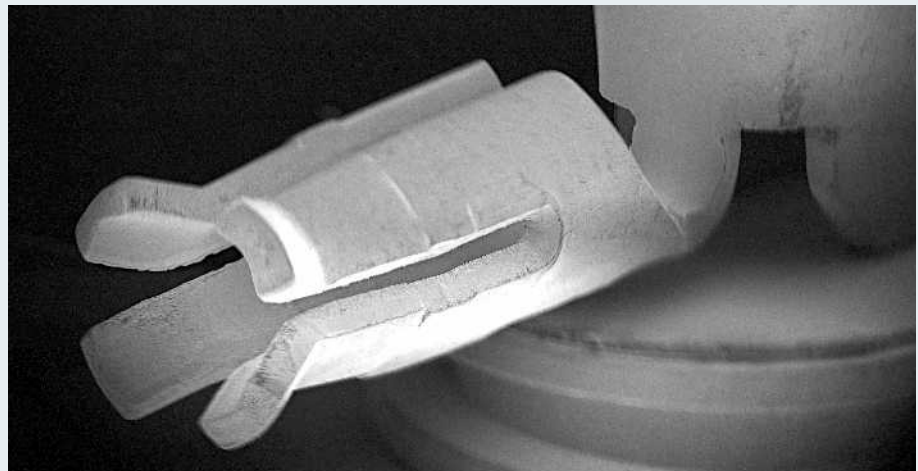
## Thermographic imaging

The electrical and thermal behavior of a material or product can be shown and quantitatively assessed using thermographic imaging. With correspondingly detailed images taken of the component in the application, heat management can be finely tuned. This way, optimizations are easy to identify from the corresponding heat sources and hot spots.



## Scanning electron microscopy

Scanning electron microscopy permits high resolution material and topography analyses, including the element determination and chemical composition of a sample to be analyzed. These results support the development process, especially when it comes to miniaturized components, and ensure material properties as part of the quality assurance process.



## Computer tomography

Computer tomography facilitates a rapid and precise analysis, directly in view of increasingly complex modules. A non-destructive, three-dimensional functional analysis of components, for example in the closed housing, can serve as a quick solution to specific technological questions. A non-destructive incision through all elements of the component or device can be made, for example, that can be used to show the installation conditions of all individual components at each preferred area.

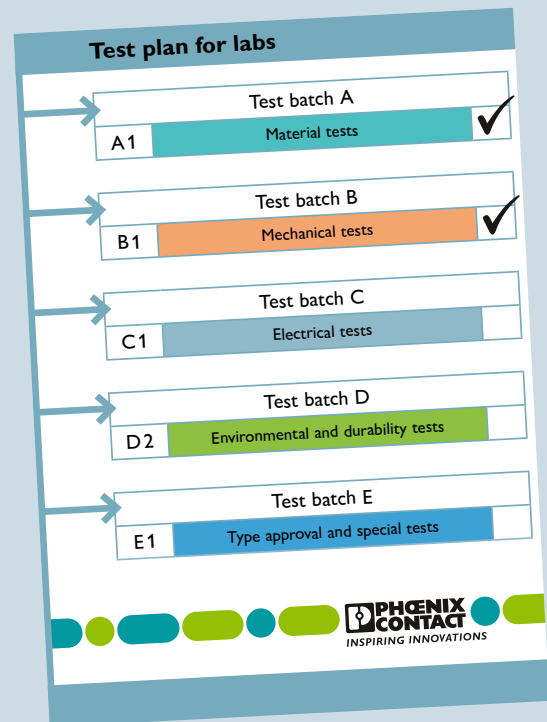




# Mechanical tests

## Overview of mechanical tests:

- Flexion and bending test
- Wire connection capacity
- Conductor pull-out test
- Lock-in position of electrical contacts
- Insertion/withdrawal force
- Drop test
- Bending test
- Number of plugging cycles
- Multiple wiring
- Contact protection
- Uniqueness and coding
- Impact test
- Microsections



## Flexion test or rotation test

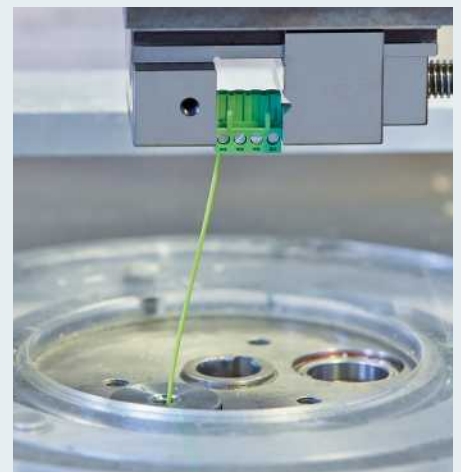
### IEC 60999-1

Correctly wired terminals must offer a high degree of mechanical safety. This includes reliable clamping of the conductor. Therefore, tests are performed using solid and stranded connecting cables with the smallest cross section, with the rated cross section, and with the maximum cross section.

A vertically fixed connector is connected to a conductor. At the end of the conductor, a test weight corresponding to the cross section is attached.

The conductor is fed through a central 37.5 mm aperture in a rotating disc and turned on its own axis 135 times. Afterwards, the contact must pass a conductor pull-out test according to the IEC 60998-2-1 standard.

Terminal points from Phoenix Contact are designed to ensure that the conductor makes contact in the clamping area gently. This prevents damage to the conductor and contact point which still have the same properties even after multiple wiring.



## Conductor pull-out test

### IEC 60998-2-1

Tensile forces can affect the terminal point when being handled or during wiring or operation. To test the tensile load capacity, the terminal point must withstand a given tensile force based on the cross section for 60 seconds. This test is performed after the flexion test and thus represents a stricter requirement. The tensile force

exerts stress on the conductor at the terminal point. The conductor must be held without causing damage. The test results for connectors from Phoenix Contact exceed the required minimum values by 150%.



## Cold Impact Test

### UL 746C, 57/UL 1703, 30

Cable-connected connectors and housings can be subject to impacts. These can occur due to tools that have been dropped, for example, or objects that become airborne in a storm. The corresponding stresses are simulated by letting a test weight fall on the test object with a defined impact energy. In the process, the air clearances and creepage distances to the live elements on the test object can be shortened due

to deformations or fractures. This is checked after the test is performed using a test probe or by testing the high-voltage and insulation properties. Due to the less favorable mechanical properties at low temperatures, the test is performed after storing the test objects at -35 °C.



## Protection against contact (touch-proof)

### IEC 60529

Electrical devices, systems or installations must also provide a high level of safety to service technicians during service or maintenance. Therefore, connecting material must be built with a protection against electrical shock so that during

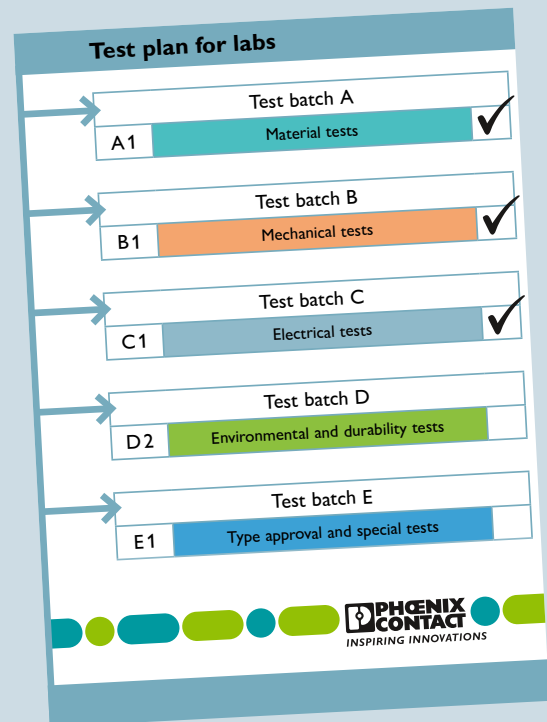
professional installation, live parts are not accessible. Protection against contact is checked using one test probe or test ball that is placed on each opening of the connecting material with a defined force.



# Electrical tests

## Overview of electrical tests:

- Cyclical overload test (heat-cycling test in acc. with UL 1059)
- Cyclical aging test
- Thermal safety
- Insulation resistance
- Derating curve
- Contact resistance
- High-voltage test
- Surge voltage test
- Air clearances and creepage distances
- Resistance measurement



## Wet insulation resistance test

### UL 1703, 27

Connectors permanently in use outdoors must be able to withstand wind and weather for up to 25 years. The insulation materials used must reliably protect the user in the long term from dangerous body currents. The wet insulation resistance test offers a quantitative measure for the insulation performance of the test object. By performing the test in a conductive aqueous solution at rest, changes in the air clearances and creepage distances can be identified, e.g. through hairline cracks.





## Current carrying capacity

### IEC 60512-5-2

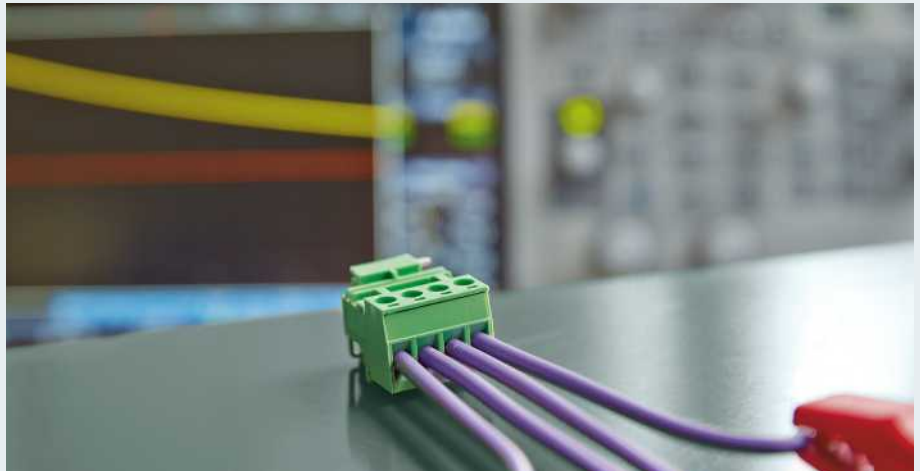
The current carrying capacity of a connector is limited by the thermal properties of the materials used for the contacts and connections as well as by the insulating parts of the housing. It is dependent on the self-heating and the ambient temperatures at which the component is operated. The current carrying capacity derating curve reflects the ratio of the permissible current at the available temperature.



## Impulse withstand voltage test

### IEC 60664-1

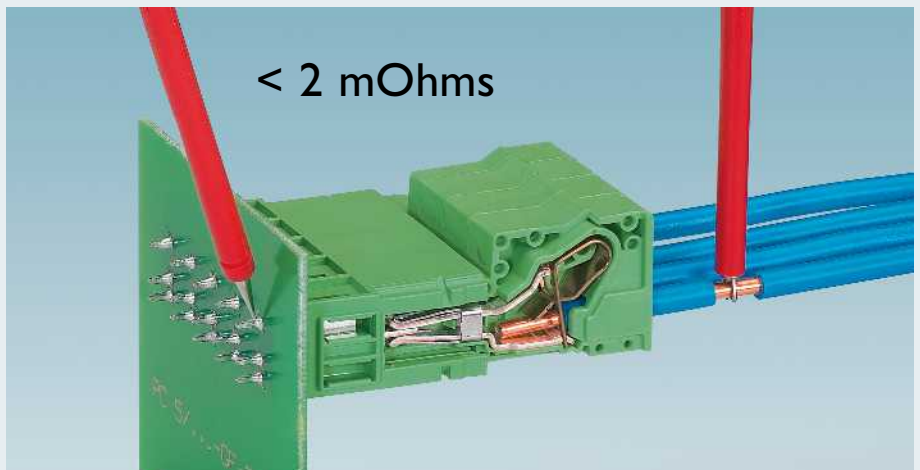
The impulse withstand voltage test provides the evidence of sufficiently large air clearances and creepage distances between two neighboring potentials. The test voltage figure is based on the rated surge voltage of the component. With three voltage surges (1.2/50  $\mu$ s) for each polarity, there must be no sparkovers. This test confirms that the components are safe to use in operation. The oscilloscope shows the time curve for a surge voltage pulse.



## Volume resistance measurement

### IEC 60998-2-1

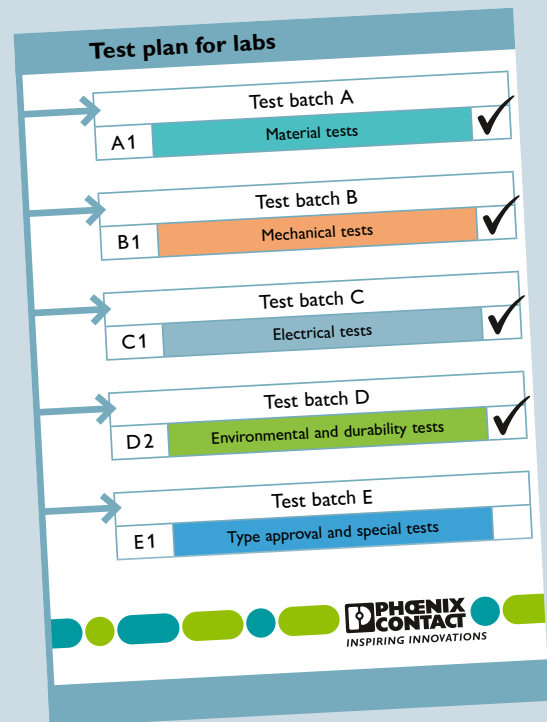
A gas-tight connection ensures a continuously reliable electrical contact. Determining the electrical transfer resistance, typically before and after a test sequence, assesses the high quality of a connection.



# Environmental and durability tests

## Overview of environmental and durability tests:

- Degree of protection tests (IP classification)
- Vibration tests: Sine waves, resonance search, mechanical shock, broadband noise
- Corrosion tests: Salt-spray test, Kesternich test (SO<sub>2</sub>), condensation climate, flowing gas mix
- Climate tests: Heat, cold, humidity, temperature shock



## Degree of protection test

### DIN 40050-9/60529

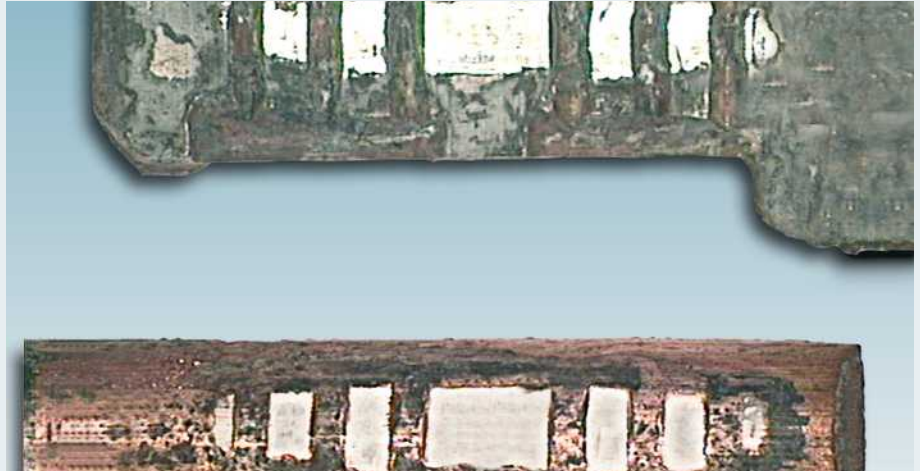
The IP classes describe the protection of a housing from contact with dangerous parts as well as the penetration of foreign bodies or water. Phoenix Contact has the necessary equipment for reproducibly testing the test objects for contact, water and dust protection according to currently valid standards.



## Corrosion test

### IEC 6988

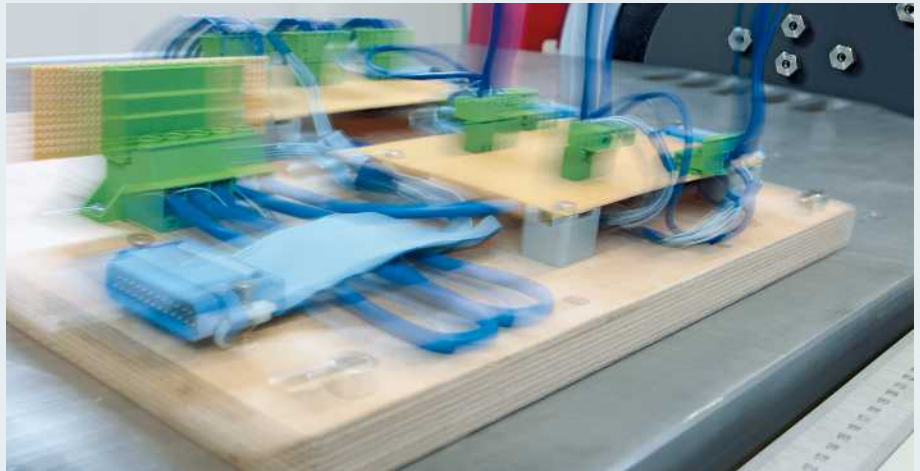
High-quality, gas-tight connections demonstrate a corrosion-free and constant low-ohm contact area even when exposed to the affects of aggressive media. During the Kesternich test, the test object is exposed to a sulphur-oxidic atmosphere at an ambient temperature of +40 °C. After a subsequent drying period, a visual inspection is performed and the transition resistance is measured to assess the influence of the corrosive environment on the contact point.



## Vibration test

### IEC 60068-2-6

This test demonstrates the vibration resistance of an electrical connection. Harmonic, sinusoidal vibrations are applied to the test object to simulate rotating, pulsating or oscillating forces. Along all three axes, frequencies in the 10 to 2,000 Hz range, for example, are successively applied at a rate of one octave per minute. The test object may in no way sustain damage that might impair further use.



## Temperature shock test

### IEC 60512-11-4, test 11d

In industrial applications, process-related temperature changes may occur. To simulate such conditions, electrical connections are subjected to extreme temperature changes in the climatic chamber. In a two-chamber procedure, the test objects are moved between their lower and upper limit temperature within just a few seconds and usually remain there for 45 minutes. This must not result in damage that might impair further use.

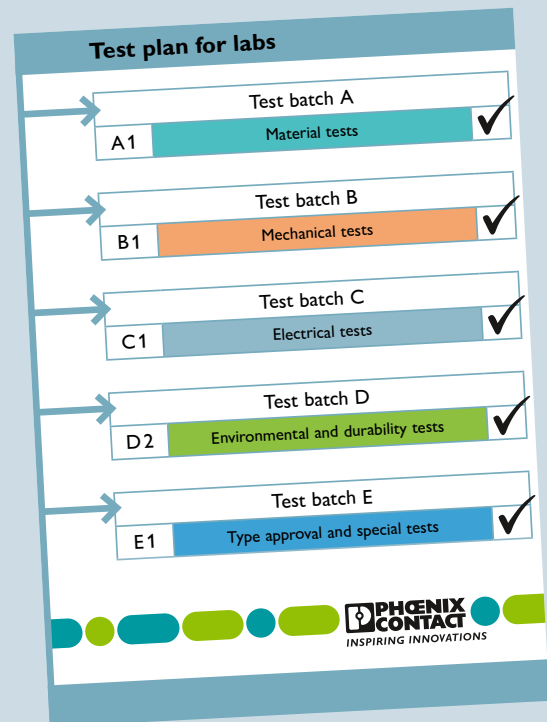




# Type approval and special tests

## Overview of type approval and special tests:

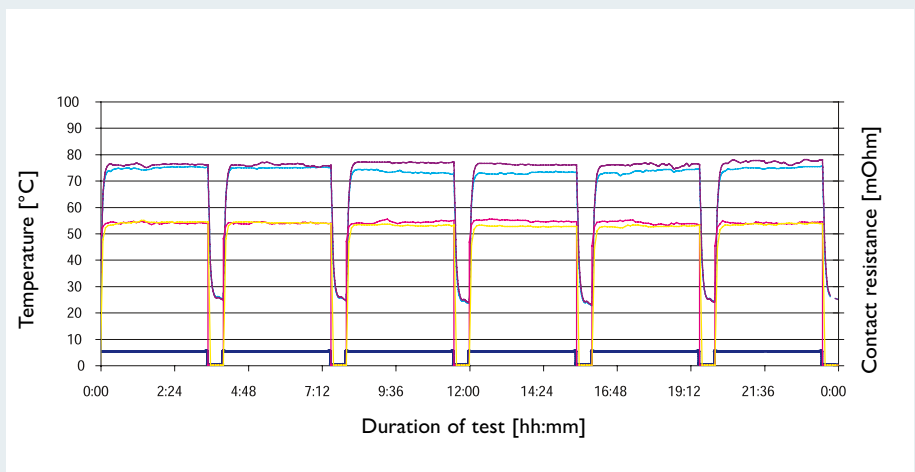
- Relaxation
- Solderability test
- Bending value
- Stress-corrosion cracking
- Freedom from whiskers
- Inflammability classification
- Glow wire test
- RoHS conformity
- Branch and country-specific approvals
- Corrosion tests:  
Salt-spray test, Kesternich test (SO<sub>2</sub>),  
condensation climate, flowing gas mix
- Climate tests:  
Heat, cold, humidity, temperature shock



## Heat cycling test

### UL 1059

By means of a cyclical overload test, the service life of an electrical connection is also verified under extreme electrical loads. As a requirement in this process, 1.5 times the rated current is intermittently charged at a time interval of 210 minutes current flow rate and 30 minutes cool-down over 14 days.



## Explosion protection

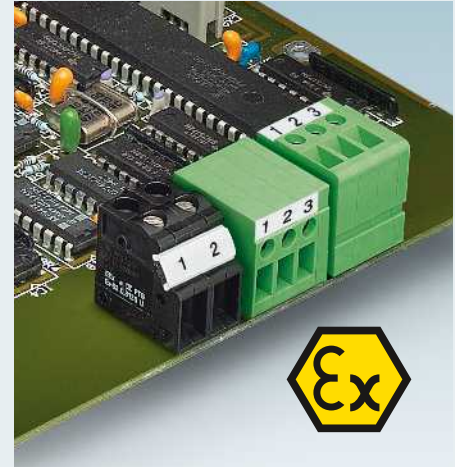
### IEC 60079

For process engineering, Phoenix Contact also offers PCB terminal blocks for use in potentially explosive areas. The protection principle of increased safety “e” (IEC/EN 60079-7) is generally based on stricter building and construction measures.

The most important items for connecting points are:

- Air clearances and creepage distances

- Protection against loosening on its own and impermissible damage to the conductor
- The clamping pressure must not be transferred via insulating parts
- Terminal points for connecting stranded conductors must be equipped with an elastic intermediate element

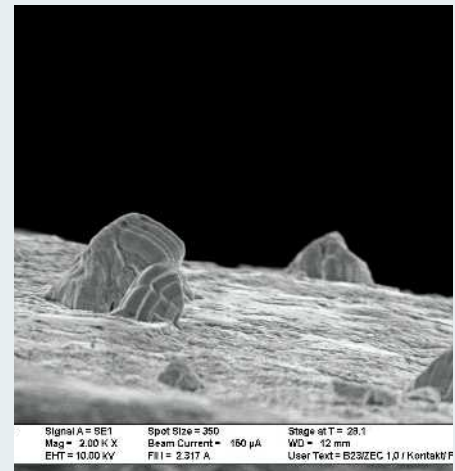


## Whisker test

### DIN IEC 60068-2-82 or JEDEC JESD201

Needle-like mono-crystals are referred to as whiskers. Under poor conditions, these can grow out of a tin-plated surface and, in some circumstances, cause malfunctions in electronic circuits. For many years, Phoenix Contact has used its own high in-house standards regarding the application of

intermediate layers, electrolyte parameters, etc. on all its tin-plated surfaces so that the formation of whiskers has not been shown to occur as described in the standards. This fact is confirmed on a continuous basis through detailed testing.



## Solderability test

### IEC 68-2-54

A wetting test is used to assess and qualify the soldering properties of surfaces and systems. This test ensures a constantly high quality of the soldering metals. PCB terminal blocks and PCB connectors from

Phoenix Contact are also usually readily able to be soldered even under normal storage of three years. It goes without saying that they are also qualified for lead-free soldering processes.



# Excellent processes from development to delivery

Innovative products and highly automated production processes require the highest level of systematically developed product and process quality. Corresponding processes ensure this quality from development to series production.

## Zero error strategy

Lean, error and disturbance-free production processes without rejects and re-finishing work are the goals we are consistently striving for. To achieve these goals, we are integrating advanced quality planning early on in product and process development. In series production, operational quality assurance monitors processes and organizations, while Supplier Quality Engineering actively integrates the suppliers. We thereby ensure flawless products that meet market requirements and specifications.





## Advanced quality planning

Systematically and using modern methods, we implement our customers' product requirements in the process and quality requirements right from the beginning of a development project. After risk analysis, we design and qualify a corresponding test concept based on the production control plan. Processes and products are qualified following the conventional industrial standards and procedures.



## Operational quality assurance

We monitor, scrutinize and continuously optimize our production processes. In the process, it is important to us to apply the experience and knowledge of our employees so that the entire company is motivated to continuously improve. Quality circle, 8D methodology, process audits and the use of statistic methods for assessing processes and solving problems also keep quality, costs and delivery dates continuously in line with one another.



## Supplier Quality Engineering

Integrating suppliers and vendors early on in the process ensures our product and process quality as well as capacity to deliver. The duties of Supplier Quality Engineering include qualification programs as well as complaint processing and production part acceptances in cooperation with our suppliers. Integrated into a tight network consisting of Purchasing, Production and Process Development, SQE contributes globally to our high quality standard.



# Professional service

In addition to a large number of new products, we also provide great flexibility in customer-specific adaptations. From color variations to printing and special packaging, we can provide you with almost anything – even brand new product developments.

## **Flexibility in different versions**

Whether you need individual colors, modern special printing, a specific number of contacts or complete cable assemblies, our Service Centers will be happy to support you in quickly meeting your needs.

## **Innovation expertise**

Benefit from our extensive development and manufacturing expertise for your individual solution – from the initial idea to series production.

## **Professional service and support**

During the design-in process, we'll offer advice and support from the initial inquiry right up to the finished product, wherever you are in the world.







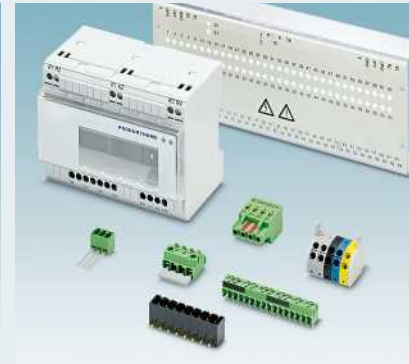
Wide range of color versions



Customer-specific cable assemblies



Individual printing



Special punching, coding, and pin lengths



Connection block for temperature sensors



Hybrid connector for charging stations



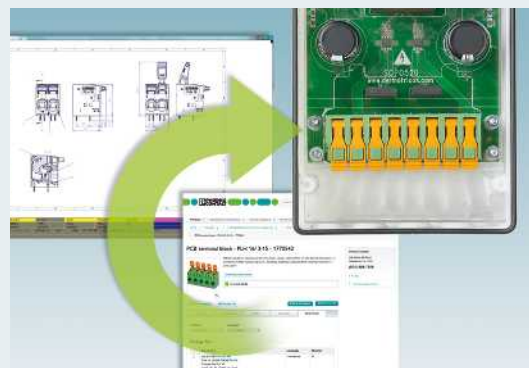
Connection system for LED street lighting



Controller housing with front connection technology



Fast product selection using web tools



Convenient 3D data download



International training on products and technologies





Always up-to-date, always available to you. Here you'll find everything on our products, solutions and service:

[phoenixcontact.com](http://phoenixcontact.com)

## Product range

- Cables and wires
- Connectors
- Controllers
- Electronics housings
- Electronic switchgear and motor control
- Fieldbus components and systems
- Functional safety
- HMIs and industrial PCs
- I/O systems
- Industrial communication technology
- Industrial Ethernet
- Installation and mounting material
- Lighting and signaling
- Marking and labeling
- Measurement and control technology
- Monitoring
- PCB terminal blocks and PCB connectors
- Power supply units and UPS
- Protective devices
- Relay modules
- Sensor/actuator cabling
- Software
- Surge protection and interference filters
- System cabling for controllers
- Terminal blocks
- Tools
- Wireless data communication

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INSPIRING INNOVATIONS