

Terminal Blocks

Proven quality and expertise in connectivity

Klippon® Connect terminal blocks in the laboratory



Weidmüller 

Klippon® Connect - From the pioneer of connectivity

Decades of experience in connection technology and several billion connections manufactured and countless hours of development make Weidmüller's Klippon® Connect terminal blocks the safest and most powerful on the market.

Over the years, our experts have constantly worked to develop and improve terminal blocks and connection technologies to meet the needs of our customers and the requirements of modern industry. From conception to manufacturing and testing, our terminal blocks are guided by experienced specialists and are subject to stringent quality controls to ensure they meet the highest global standards.



Dr. Christian Dülme, Head of Business Unit Terminals

Expertise and responsibility

Due to our global presence, we enable seamless cross-site collaboration in R&D and in the lab to drive innovations and solution concepts from idea to market. Numerous pioneering achievements in the field of industrial connectivity, such as the first plastic-based terminal block on the market in 1938, or the world's first preloaded and self-releasing connection technology (SNAP IN) in 2021, were realized in this way. Quality is one of our trademarks, guaranteed by a stringent quality management system and advanced automation in production.

At the same time, we consistently focus on energy efficiency, using independently produced electricity from photovoltaics and geothermal energy.

The Laboratory

- Accredited laboratory
- Worldwide locations
- Over 70 years of experience

Research & Development

- 8 research locations
- Worldwide cooperation between the locations
- Global networks and partnerships

Environmental protection

- Product-related environmental protection
- Careful selection of materials
- Energy efficient sites

Quality

- Quality management system
- High degree of automation in production
- Continuous controls from incoming to outgoing goods

The Weidmüller laboratory

Central interface of product development

Product tests for global use

The Weidmüller laboratory, with its headquarters in Germany and a subsidiary in China, holds international accreditations. For you and your applications, this means safety, outstanding performance and high quality in many areas of use. From the very first hour of a project, the laboratory sees through all the phases of an innovation, paying equal attention to design and quality aspects as well as product management and sales strategies.

Working closely with our partners in the relevant departments, the laboratory is one central interface for project work. The laboratory's results produce technical evaluations, reports, providing technical information and specifications of importance within and outside the company so that products around the globe can function as intended in their target application. As well as this central function, the laboratory takes on work for external clients. This includes traditional testing and advisory services as well as country- an application-specific product approvals and individual test planning, tailored perfectly to your requirements.

Key figures

7 decades of experience since being founded in 1953 in Königswinter

- 70 technicians, engineers and natural scientists conduct research in a total area of 3500 square metres
- 3000 requests, 500 lab reports and 1500 measurement reports a year
- Around 50 technical-physical test and measuring methods
- Hundreds of products, components, materials and systems are tested and assessed from the first prototype to mass production
- Since 2005 in Suzhou, China



Accreditation

The Weidmüller laboratory is DIN EN ISO IEC 17025 accredited. This accreditation confirms the independence of the laboratory and backs up recognition by official bodies, licensing offices and other authorities. As well as this accreditation, the Weidmüller laboratory is a member of the UL-Client Test Data Programme (CTDP) of the Underwriter Laboratories®. Through its involvement in the CTDP programme, the test procedures, quality management and documentation of Weidmüller are regularly audited by UL.



DIN EN ISO IEC 17025

Accreditation in accordance with DIN EN ISO IEC 17025 by an independent institution (DAKKS) confirms that the Weidmüller laboratory possesses internationally recognised expertise and independence to test products and procedures in a manner conforming to standards and to produce test reports. The standard also guarantees the declaration of conformity with standards issued by Weidmüller and the product quality and liability associated with it. Test reports are recognised by authorities, licensing offices and test bodies.

UL CTDP

As part of the Client Data Test Programme (CTDP) of the Underwriter Laboratories® (UL) scientific company, Weidmüller is regularly audited by the independent institution. The audits cover the test equipment, implementation of work, aspects of quality management and documentation. Involvement in the CTDP brings with it major benefits such as speeding up the approval process, good transparency of the test results and a significant reduction in costs.

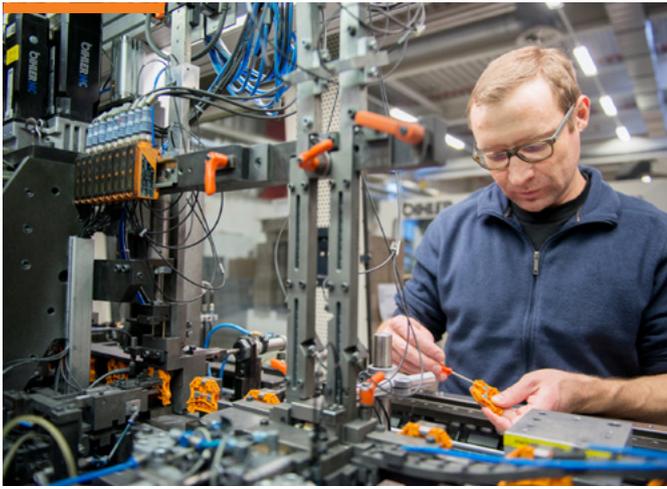


When using the product in your application, you can rest assured that not only is it fully functional - it has been put through technical testing too. You can also expect legal protection from international certification applicable to your application. As part of its work, the Weidmüller laboratory is also active as an international approval body: we provide highly accurate documentation, operating instructions, labelling and certificates in line with the applicable regulations.

Tests and Certificates

The services in our laboratory

The basic requirement of raw materials and products is the fulfilment and compliance with quality and normative requirements. To meet these requirements, quality and laboratory tests are carried out on the raw materials and products during the final development phase and throughout the entire production process.



Qualifying Tests

Our products are not only subject to the normative quality requirements. To ensure the best quality of the products, both the raw materials in production as well as the entire production processes are controlled. Numerous tests in the respective production steps ensure a constant and high quality of our products.

Approval Tests

Different markets and industries demand different requirements on the raw materials and the end products. Within the scope of approval tests, the data collected in the Weidmüller laboratory or in the respective approval centres and will be and documented. If all normative requirements are met, the relevant certificate will be issued for the product.





Customer specific tests

In a complex world, not all practical applications can be covered normatively and practical application cannot be ensured. For example, in some industries or special applications, increased requirements may be placed on the products.

The Weidmüller laboratory therefore also takes on other areas of responsibility and customer-specific tasks such as classic testing and consulting services as well as country- and application-specific product approvals and individual test planning that is precisely tailored to your requirements.

- Special heating tests
- Special forms of wires and their current load in relation to the products
- High voltage applications with special application setups
- Application scenarios for special altitudes
- Increased environmental influences

Certified test procedures

Secured, standard-compliant quality management

The combination of efficiency and safety

Economic viability, safety aspects and potential for improvement form the focal point of the approx. 50 test procedures carried out in the Weidmüller laboratory. The laboratory team enjoys first-class conditions in a lab covering around 3500 square metres: from simple mechanical testing to extensive projects out of doors, from long-term testing to IP69k type of protection testing, the latest and best equipment is used.

Mechanical test methods

- Insertion and withdrawal forces
- Tensile test on wire connections
- Mechanical service life testing
- Rotational test equipment
- Torque

Electrical test methods

- Voltage drop
- Contact resistance
- Insulation resistance
- High voltage: static
- Partial discharge
- High current, pulse current
- Current heating, derating
- Current load change
- Cyclic aging
- Thermography

Surfaces/Materials/ Chemistry Lab

- REM/EDX
- XRF
- Microsection preparation
- X-ray CT
- Hardness
- CTI
- Media resistance
- Flammability
- RoHS

Steam pressure and High pressure tests

- Liquid test (LOCA)
- Underwater simulation

Microscopy

- Stereomicroscopies
- Material microscopes
- Digital 3D-Microscopes

Geometry/Dimension

- Multisensory Coordinate Measuring Technology
- Contour/Roughness
- 3D surface metrology



Environmental and Aging simulation

- Thermal
- Climate/climate change/temperature shock
- Corrosion: Salt
- Corrosion: Kesternich
- Corrosion: toxic gas
- Solar simulation/weathering

EMC/Signal integrity

- Signal integrity
- Radiated
- Conducted
- Burst/Surge/ESD

Tightness

- IP X3-X6
- IP X7-X8
- IP X9k
- UL50 hose down
- Dust test

Soldering Lab

- Wetting
- Reflow soldering
- Wave soldering

EMC-Immunity tests

- Electrostatic discharge (ESD)
- Electrical transients: Burst & Surge
- Conducted radio-frequency voltages
- Radiated radio-frequency fields
- Power magnetic fields
- Voltage dips / short interruptions

Vibration

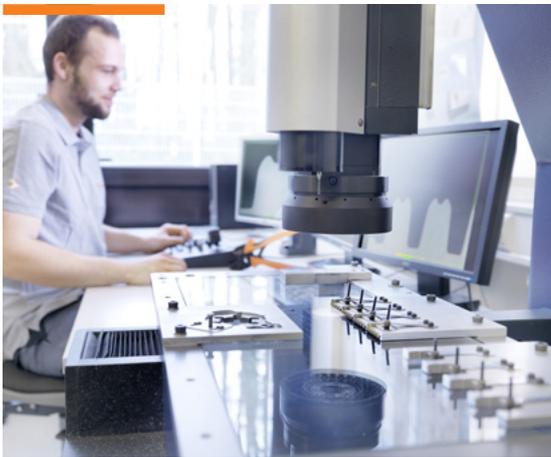
- Vibration equipment
- Vibration measurement technology incl. modal analysis

Research in the field of electrical connectivity

Researching and advancing future technologies

The continuous further development of electrical connectivity and trends such as miniaturization, DC infrastructure, etc., require a scientific examination of the scientific examination of the emerging issues. The technology laboratory is actively involved in shaping this

research and contributes its skills in the areas of surface and materials analysis, contact physics, lifetime and reliability analyses for customers as well as at congresses and in the technical literature.



Tribometer und tribologischer Versuchs-Aufbau zur Untersuchung eines Kontaktes

Contact physics and tribological basic studies

The performance of any electrical contact is largely determined by the underlying contact physics and the behaviour under relative movements:

- Simulation of contacting processes on the tribometer (loading)
- Determination of friction and wear characteristics as well as the electrical behaviour in the area of micro and macro friction
- Characterization of abrasion mechanisms



Implementation of technology projects

New and further developments of products, solutions or processes are professionally accompanied in order to guarantee maximum protection in relation to the requirements and continuous of ongoing innovation. Projects are carried out in cooperation with external partners such as universities and institutes.

- Investigation of new materials, surfaces and functionalization
- Support in the area of new connection and contact developments
- Investigation and implementation of technological process developments



Statistical design of experiments

To understand complex interactions in the field of electrical interconnection technology and associated manufacturing processes and to take them into account, statistical design of experiments is an indispensable tool for technological questions.

- Identification of target and influencing variables
- Creation of test schedules
- Determination of the effect of influencing variables and their interactions
- Optimization and validation of process and product properties



Reliability studies

Both in the context of development processes and on a customer specific basis, service life and reliability tests are carried out for the bearing arrangements and the use of products in the field of electrical connectivity.

- Prediction of the long-term behaviour of electrical contacts
- Development of models for reliability assessment
- Lifetime and time-lapse tests for a wide range of different mechanisms of action



Development-accompanying simulation tests

Simulative modelling of laboratory tests



Laboratory engineer Wiebke Meyer is Weidmüller's expert for Simulative Modelling

At the end of a development phase, the physical laboratory tests of a terminal block follow. If, in the course of these tests, required values are not achieved or even exceeded, a further development loop will have to be performed in order to optimize the product. Consequently, the sometimes time-consuming tests have to be repeated in the laboratory.

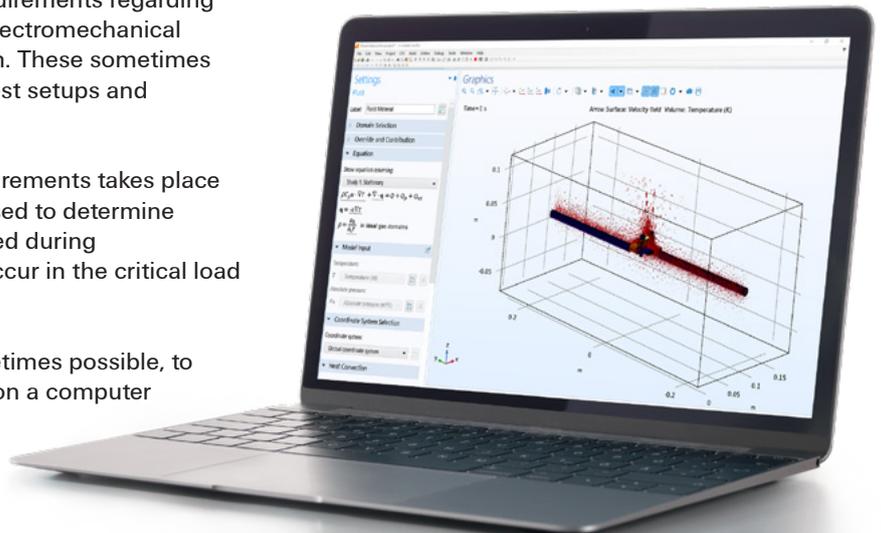
In order to reduce development times and speed up the time to market, the Weidmüller laboratory simulates some of these tests using complex simulation software. These are confirmed and documented at the end of the development phase by the physical and normative required laboratory tests.

Basics for the simulation tests during development

An electric current flow always involves heating of the current-carrying component. In this case, there are normative requirements regarding the permissible temperatures of electronic and electromechanical components and the method for measuring them. These sometimes result in long test durations as well as complex test setups and preparations and additional pre-testing.

In our laboratory, the implementation of the requirements takes place in two basic steps. First of all, thermography is used to determine critical points as well as load cases are determined during thermography, and then the temperatures that occur in the critical load cases in steady-state condition.

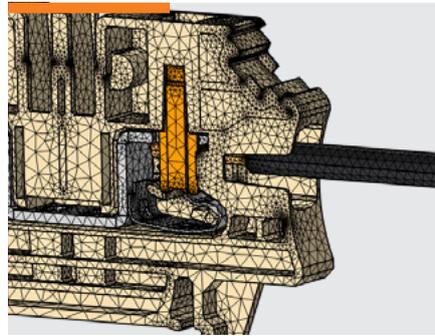
In order to reduce the inspection effort, it is sometimes possible, to simulate the thermography and the heating test on a computer by using a complex simulation software. Based on a CAD model the principle of the simulation is based on the following principles:



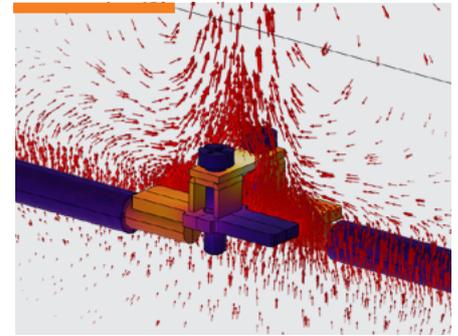
$$Q = m * c * \Delta T$$

$$Q_w = \int_{t_2}^{t_1} P * d_{\Gamma}$$

Simulation of physical processes that can be described using differential equations



Finite Element Method -> Representation of real geometry using simple geometric shapes



Multiphysical couplings -> simultaneous calculation of mutually influencing physical effects resulting from different mechanisms possible

Practical implementation within the software

For a sufficiently accurate simulation, various influencing factors and definitions are required within the software. As a basis, the digital twin is loaded into the software in the form of a CAD model. Here, component-related objects such as variables, functions or „examination probes“ can be defined subsequently.

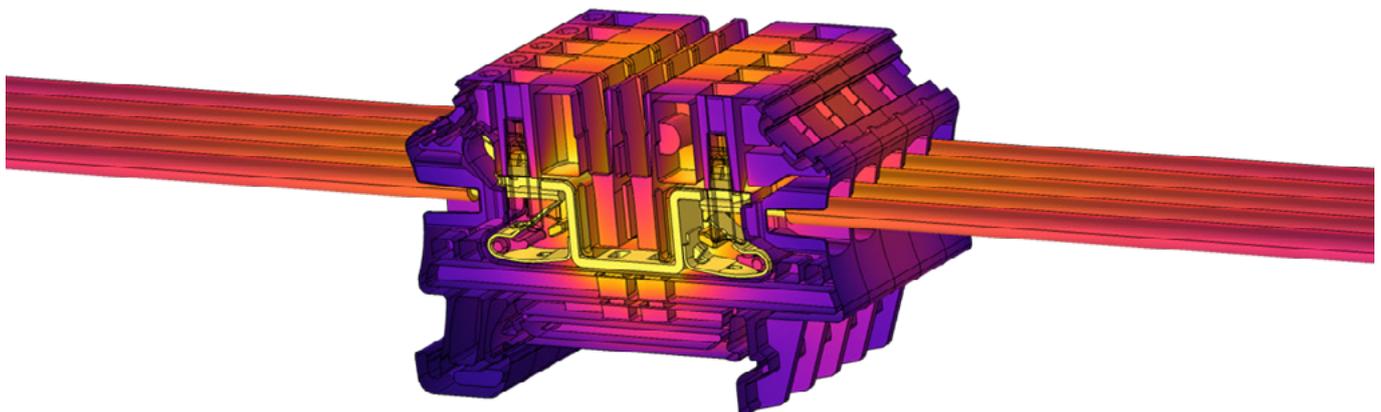
The next step is the assignment of materials and their specific properties. What type of conductor is used, what plastics and what mechanical and electrical properties they have.

Following the definition of the materials, the physical laws are defined and assigned.

Ultimately, a meshing of the geometry takes place, the mesh of data points over the entire model. These data points contain the previously entered properties, physical laws and mathematical functions, which are necessary for the calculation.

Depending on the complexity of the data structure, a simulation calculation can take between a few seconds and several hours and delivers an accuracy of 87% to 99%.

-> Based on the digital twin enriched with the physical and mathematical factors described, it will also be possible to simulate other laboratory tests on the computer.



Test sequence according to IEC 60947-7-x

Type testing of a terminal block

Standardized tests ensure that connections comply with the conditions required by the regulations. IEC 60947-7-x prescribes a series of tests for conductor connections in terminal blocks. One or more terminals of a type are tested for compliance with certain limit values. The tests refer to mechanical, electrical and material properties.

Testing in accordance with IEC 60947-7-x is considered a basic prerequisite for the marketing of a terminal block. It is divided 3 types of rail-mounted terminal blocks as follows:

1. feed-through modular terminal
2. protective earth / ground terminal block
3. fuse terminal block

Mechanical testing

- Rated connection capacity
- Mechanical strength
- Flexion test
- Pull-out test
- Attachment of the terminal block on its support

Electrical testing

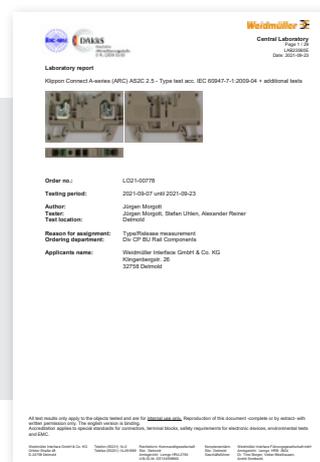
- Clearance and creepage distances
- Impulse withstand voltage test
- Voltage drop test
- Temperature rise test
- Short-time withstand current
- Dielectric test

Material testing

- Aging test
- Needle flame test

Type report of a terminal block

Type testing in accordance with IEC 60947-7-1-2/3 is the basis and basic requirement for every terminal block. All results are documented in the so-called type test report. The type test report is the basis for approvals and certifications.

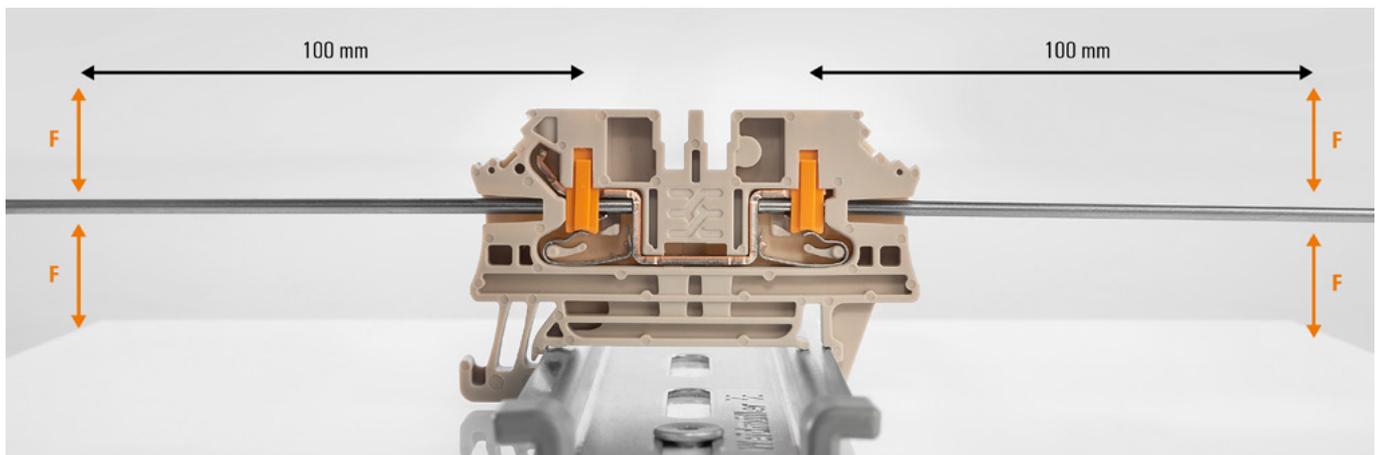


Attachment of the terminal block on its support

The proof of installation of the terminal block on its mounting support ensures that the terminal block is firmly seated on the standardized DIN rail. The required test force is applied to the terminal block via the connection point.

For the test, terminal blocks are mounted on a DIN rail. Depending on the cross-section, a standardized steel rod with a defined diameter is fixed in the clamping points. Cross-section-dependent forces act on the terminal block over a lever distance of 100 mm.

The test is considered to be passed if the terminal blocks do not detach from the DIN rail or show any other damage.

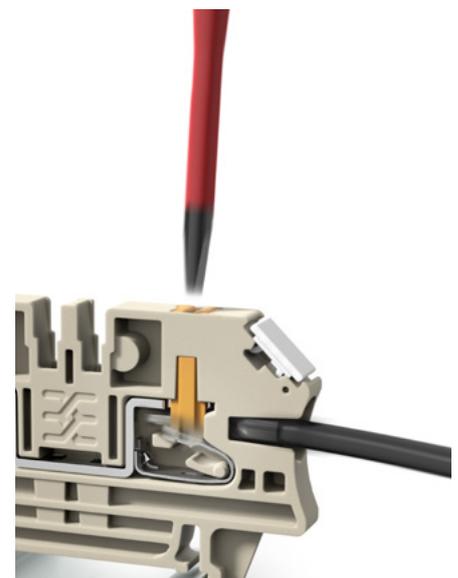


Mechanical strength of the connection points

Proof of the mechanical strength of the connection points ensures the mechanical and electrical contact reliability of the connection point. Thereby, the mechanical stability is assessed via multiple wiring of the connection point and, in addition, the electrical contact reliability is assessed via a measurement of the voltage drop.

For the test, 5 terminal blocks are lined up on a DIN rail conforming to the standard. The wires with the rated cross-section of the terminal block are connected and disconnected five times. A new conductor is used after each disconnection and the voltage drop is measured before and after connection.

The test is considered to be passed if the measured voltage drop across the terminal block, before and after the test, does not exceed the required limits.





Testing for damage to and accidental loosening of conductors of a terminal block (flexion test)

Testing for damage to and accidental loosening of conductors of a terminal block proves both the high mechanical safety and the reliable connection of the wire. The test is divided into two successive parts - the flexion test and a following pull out test.

For the flexion test, one end of the wire is connected in the connection point of the terminal block. A standardized test weight is attached to the other end of the wire so that it can swing freely. The test then provides for a rotation of 135 turns with a defined radius without any interruption.

The test is considered to be passed if, during and also after the subsequent wire pull-out test, the wire neither slips out of the connection point nor breaks in the vicinity of the connection point.





Testing for damage to and accidental loosening of conductors of a terminal block (Pull-out test)



Testing for damage to and accidental loosening of conductors of a terminal block proves both the high mechanical safety and the reliable connection of the wire. The test is divided into two successive parts - the flexion test and a following pull out test.

For the pull-out test, one end of the wire is attached to the terminal block and the other end is attached to the pull out testing machine. Depending on the cross-section of the wire, the standard requires a defined pulling force over 60 seconds.

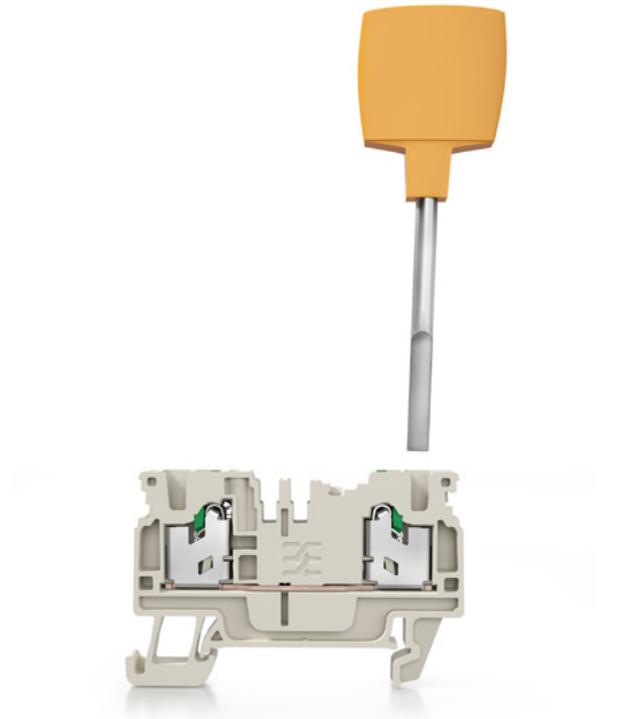
The test is considered to be passed if, during the flexion test and the subsequent pull-out test of the wire, the wire neither moves out of the connection point nor breaks in the area of the connection point.

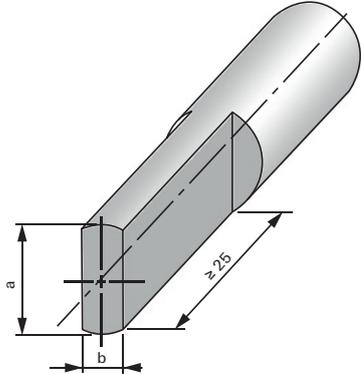
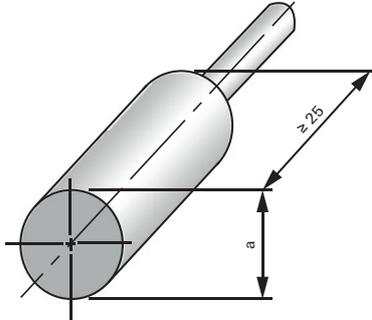
Rated connection capacity

The proof of connection capability ensures that the documented wire cross-sections can be connected. Here, only the insertability of the wire in the connection point is checked. The tested wire cross-sections are ultimately documented in metric (mm²) and Anglo-American values (AWG).

For the test, the insertability of the rated cross-section and the two next smaller wire cross-sections are checked. As an alternative to the respective wires, proof can also be provided by means of a standardized gauge.

The test is considered to be passed if the wire or the gauge can be inserted unhindered in the connection point.



Wire cross-section		Gauge				
		Form A	Form B			
						
Rigid conductor (single or stranded) mm ²	Designation	Diameter a mm	Width b mm	Designation	Diameter a mm	Permissible deviations for a and b mm
1,5	A 1	2,4	1,5	B 1	1,9	
2,5	A 2	2,8	2,0	B 2	2,4	0 - 0,05
4	A 3	2,8	2,4	B 3	2,7	
6	A 4	3,6	3,1	B 4	3,5	
10	A 5	4,3	4,0	B 5	4,4	0 - 0,06
16	A 6	5,4	5,1	B 6	5,3	
25	A 7	7,1	6,3	B 7	6,9	
35	A 8	8,3	7,8	B 8	8,2	0 - 0,07
50	A 9	10,2	9,2	B 9	10,0	
70	A 10	12,3	11,0	B 10	12,0	
95	A 11	14,2	13,1	B 11	14,0	
120	A 12	16,2	15,1	B 12	16,0	0 - 0,08
150	A 13	18,2	17,0	B 13	18,0	

Clearance and creepage distances

The verification of clearances and creepage distances demonstrates compliance with the normative specifications with regard to the rated voltage and the insulating material which is used. The lengths to be maintained are determined as part of the insulation coordination.

For the test, terminal blocks are lined up on a standard-compliant DIN rail. Proof of clearances and creepage distances must be provided between two adjacent terminal blocks and one terminal block and the mounting support. The minimum requirements of the respective distances are defined in IEC 60947-1.

The verification is considered to be passed if the required minimum distances are complied with normatively.

Clearance distances

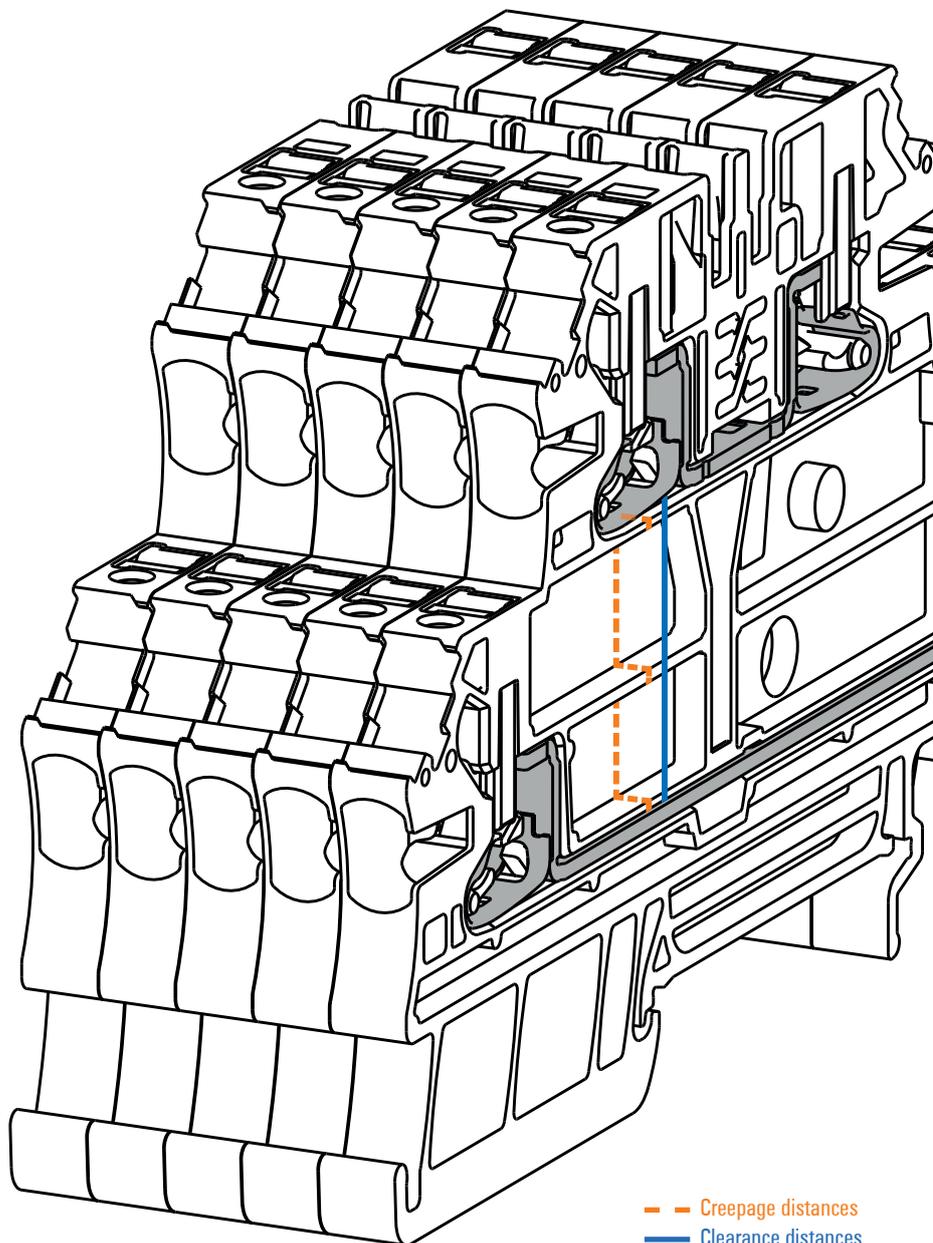
The clearance is the shortest distance in air between two electrically conductive components. A dimensioning of the clearance is obtained taking into account the following factors:

- Expected overvoltage (rated impulse withstand voltage)
- Applied overvoltage protection precaution
- Environmental conditions

Creepage distances

The creepage distance is the shortest distance along the existing insulating body between two electrically conductive components. A dimensioning of the creepage is obtained taking into account the following factors:

- Intended rated voltage
- Insulating materials used (group of insulating materials)
- Environmental conditions (degree of pollution)





Voltage drop test

The voltage drop test is used to verify the contact quality of the connections. Low contact resistances at the contact points are necessary for the lowest possible and stable voltage drop. Compliance with the maximum permitted voltage drop is verified during the following tests:

- Mechanical strength of clamping units
- Temperature rise test
- Short-time withstand current
- Aging test for screwless terminal blocks

For the test, 5 terminal blocks are mounted on a DIN rail and the connection points of the terminal blocks are wired with the rated cross-section. The measuring current is 10% of the rated wire current. The voltage drop is measured over the total distance between the feed-through terminal block or protective earth terminal block and DIN rail.

The verification is considered to be passed if the voltage drop across the feed-through terminal block, before and after the respective test, does not exceed 3.2 mV or 1.5 times the initial measured value. For the PE (ground) terminal block, the voltage drop across the DIN rail must be no higher than 6.4 mV or 1.5 times the initial measured value.

Temperature rise test

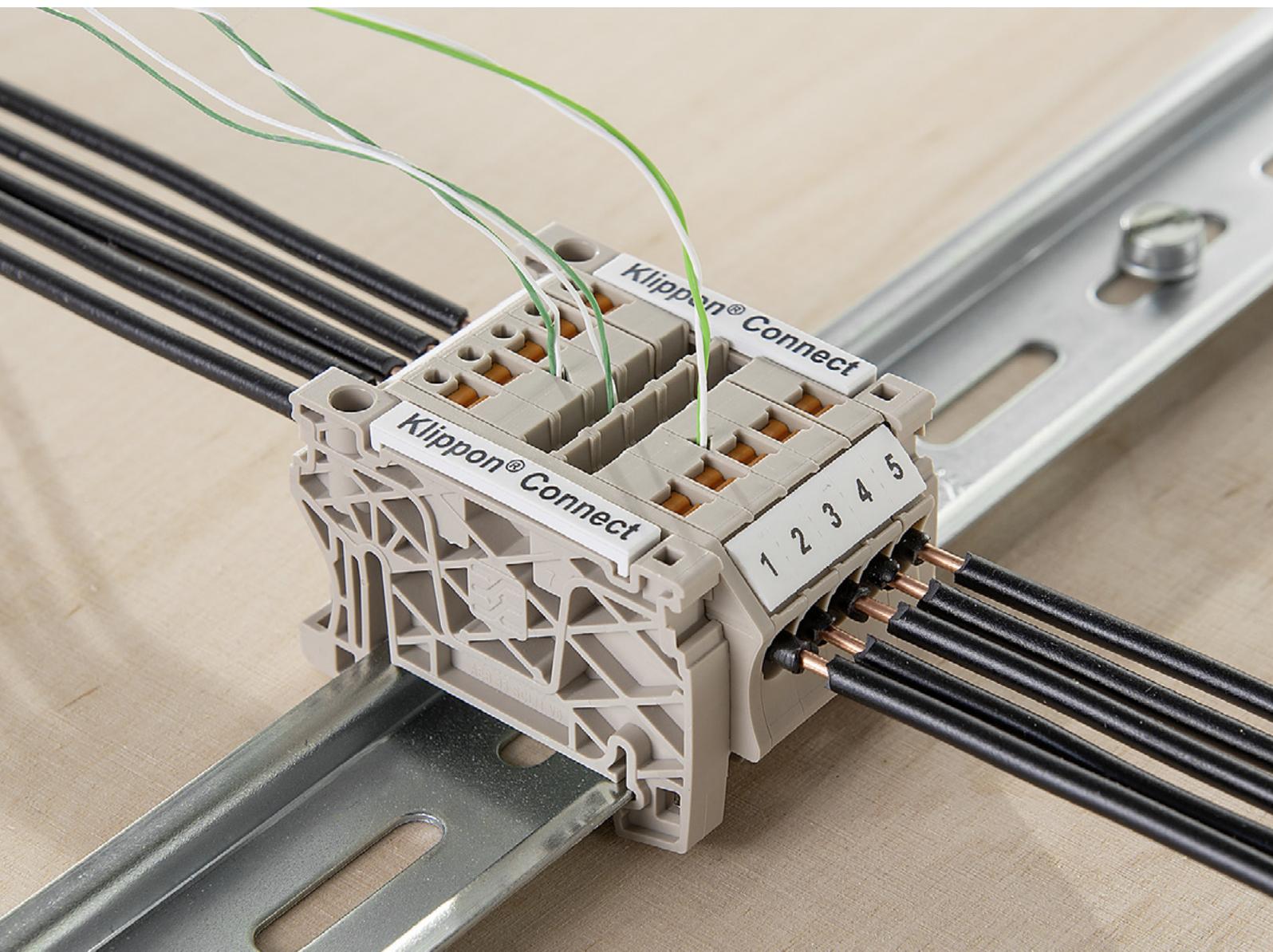
The maximum permissible self-heating of the terminal block under defined conditions is verified with the temperature rise test. Low contact resistances at the contact points are necessary for the lowest possible temperature rise.

For the test, 5 terminal blocks are lined up on a standard compliant DIN rail. They are wired in series with harmonized PVC insulated wires of the rated cross-section. The terminal

blocks are loaded with a defined test current until a constant temperature is reached.

The verification is considered to be passed if the terminal blocks do not heat up by more than 45 K during the test and if the measured voltage drop across the terminal block, before and after the test, does not exceed the required limit values.

Rated cross-section mm ²	0,2	0,5	0,75	1	1,5	2,5	4	6	10	16	25	35	50	70	95	100
Testing current A	4	6	9	13,5	17,5	24	32	41	57	76	101	125	150	192	232	269

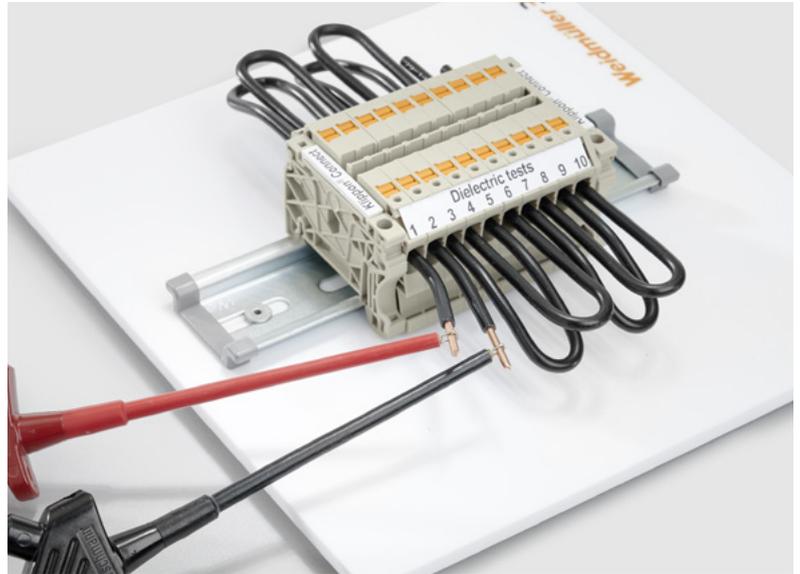


Dielectric test

The insulation test is used to verify the dielectric strength of the insulating material used. The normative test voltage is derived from the rated voltage of the terminal block.

For the test, 5 terminal blocks are lined up on a DIN rail conforming to the standard. The connections of the terminal blocks are wired and the defined test voltage is applied for at least 60 seconds between the adjacent terminal blocks and the DIN rail.

The verification is considered to be passed if there is neither a flashover nor a breakdown between two adjacent terminal blocks or to the standardized DIN rail.



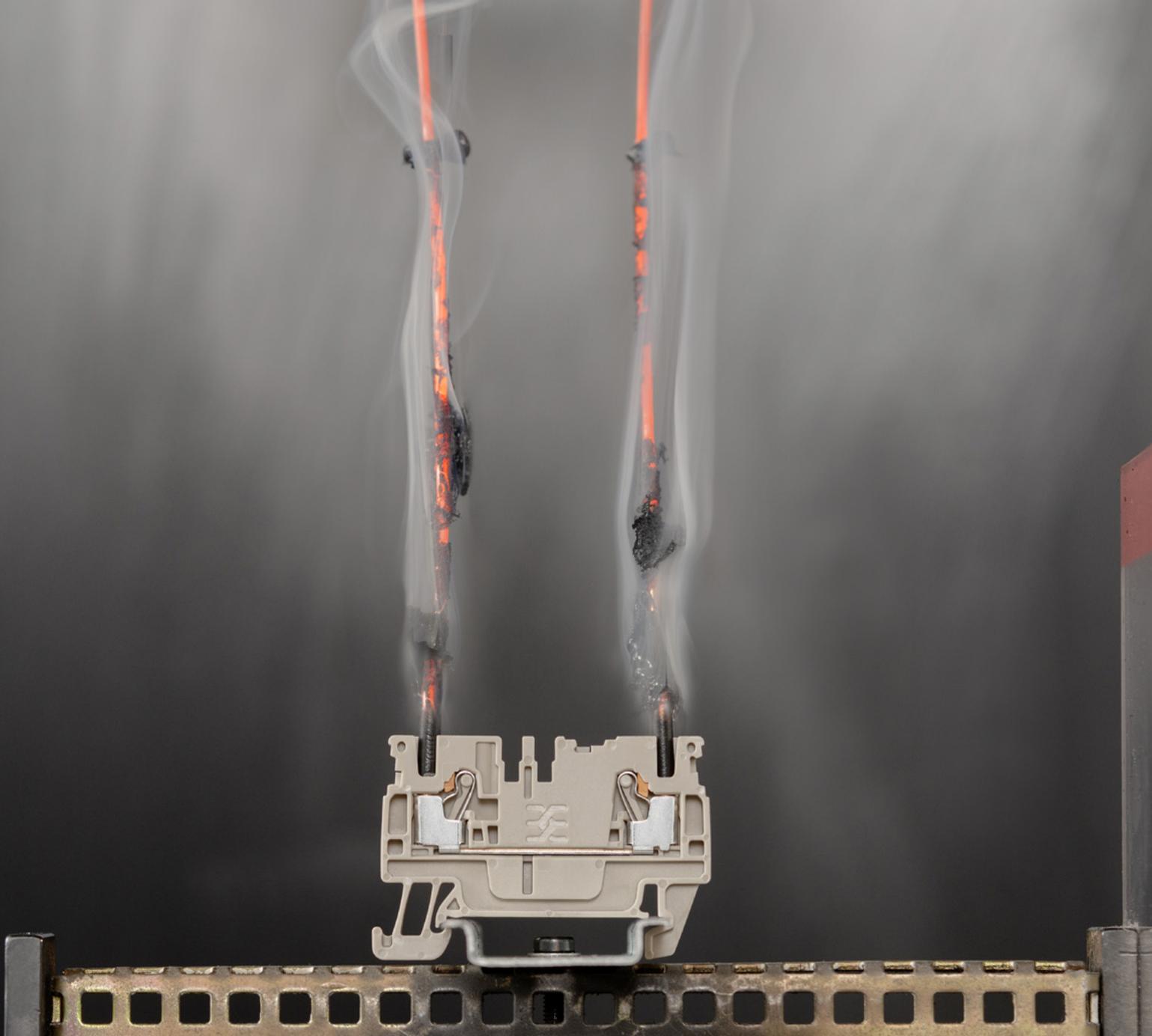
Impulse withstand voltage test

The verification of impulse withstand voltage test is used to verify sufficient clearances between two adjacent potentials. The rated voltages derived from the rated voltages of the power supply for the corresponding grid type in conjunction with the overvoltage category are the deciding factors for the dimensioning of the clearances.

For the test, 10 terminal blocks are lined up on a DIN rail conforming to the standard and the connections of the terminal blocks are wired. The voltage is first applied between adjacent terminal blocks and then between the terminal blocks and the DIN rail. The impulse withstand voltage test is performed with a pulse form of 1.2/50 μ s with at least 1s break between the pulses. 10 pulses each are applied with alternating polarity.

The verification is considered to be passed if there is neither a flashover nor a breakdown between two adjacent terminal blocks or to the standardized DIN rail.



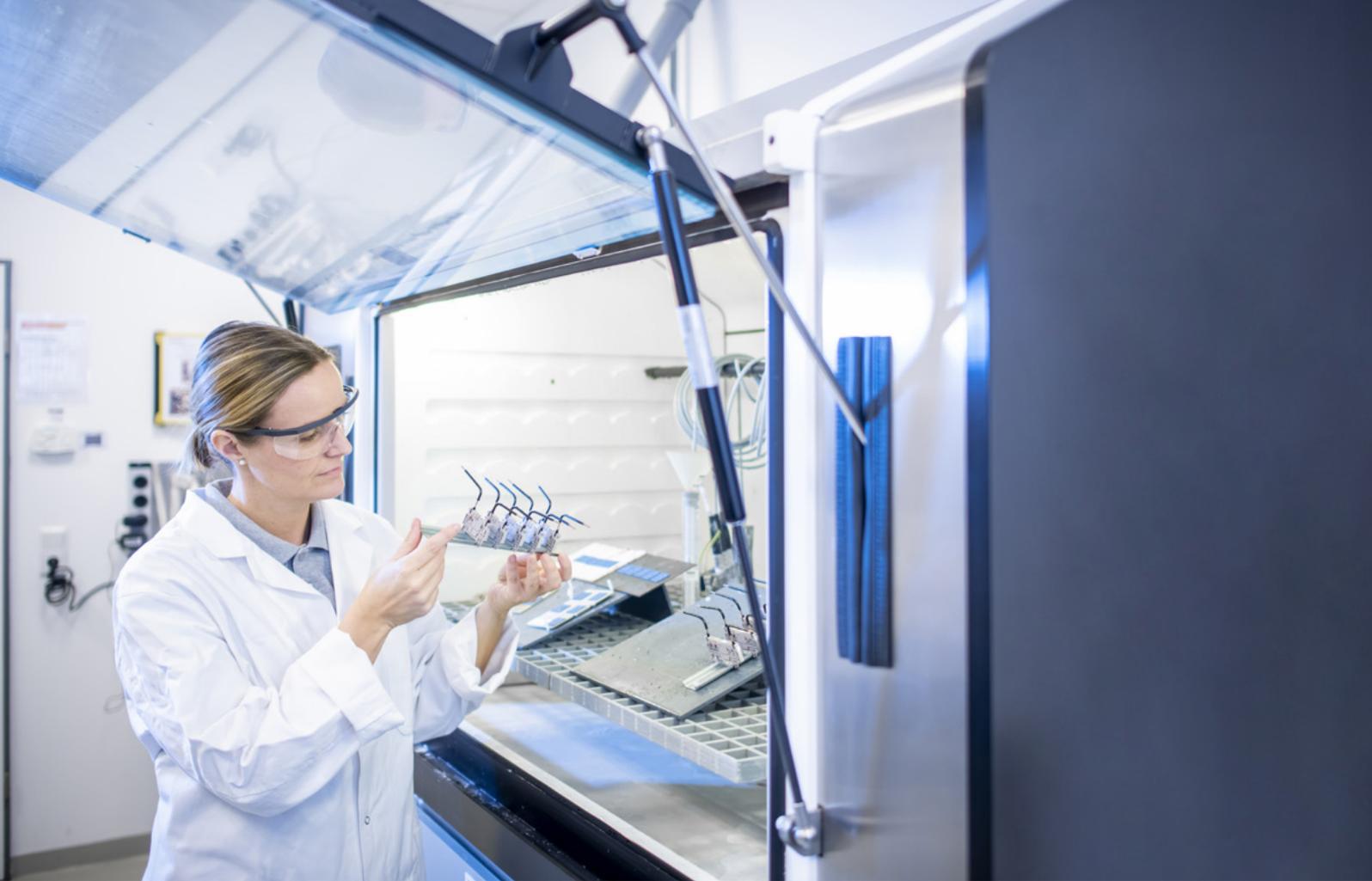


Short-time withstand current

The verification of the short-time withstand current ensures that the terminal blocks can withstand the short-circuit currents occurring in practice without damage in the event of a fault until the protective device intervenes and switches off the current.

For the test, terminal blocks are mounted on a DIN rail and the connection points of the terminal blocks are wired with the rated cross-section. Protective earth terminal blocks are subjected to this test procedure over 3 runs, feed-through terminal blocks over one run. The terminal block is loaded with a test current of 120 A/mm^2 for 1 second. The voltage drop over the total distance of the feed-through terminal block or protective earth terminal block and DIN rail is measured before and after the test.

The verification is considered to be passed if there is no damage to the terminal block and further use is guaranteed and the measured voltage drop complies with the specified values.

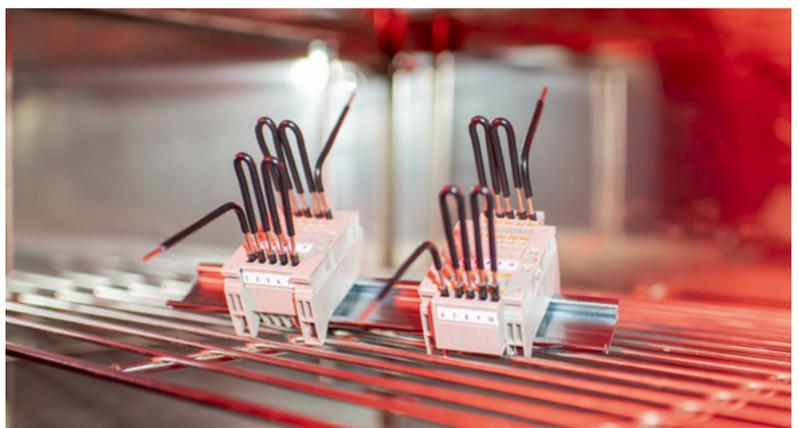


Aging test

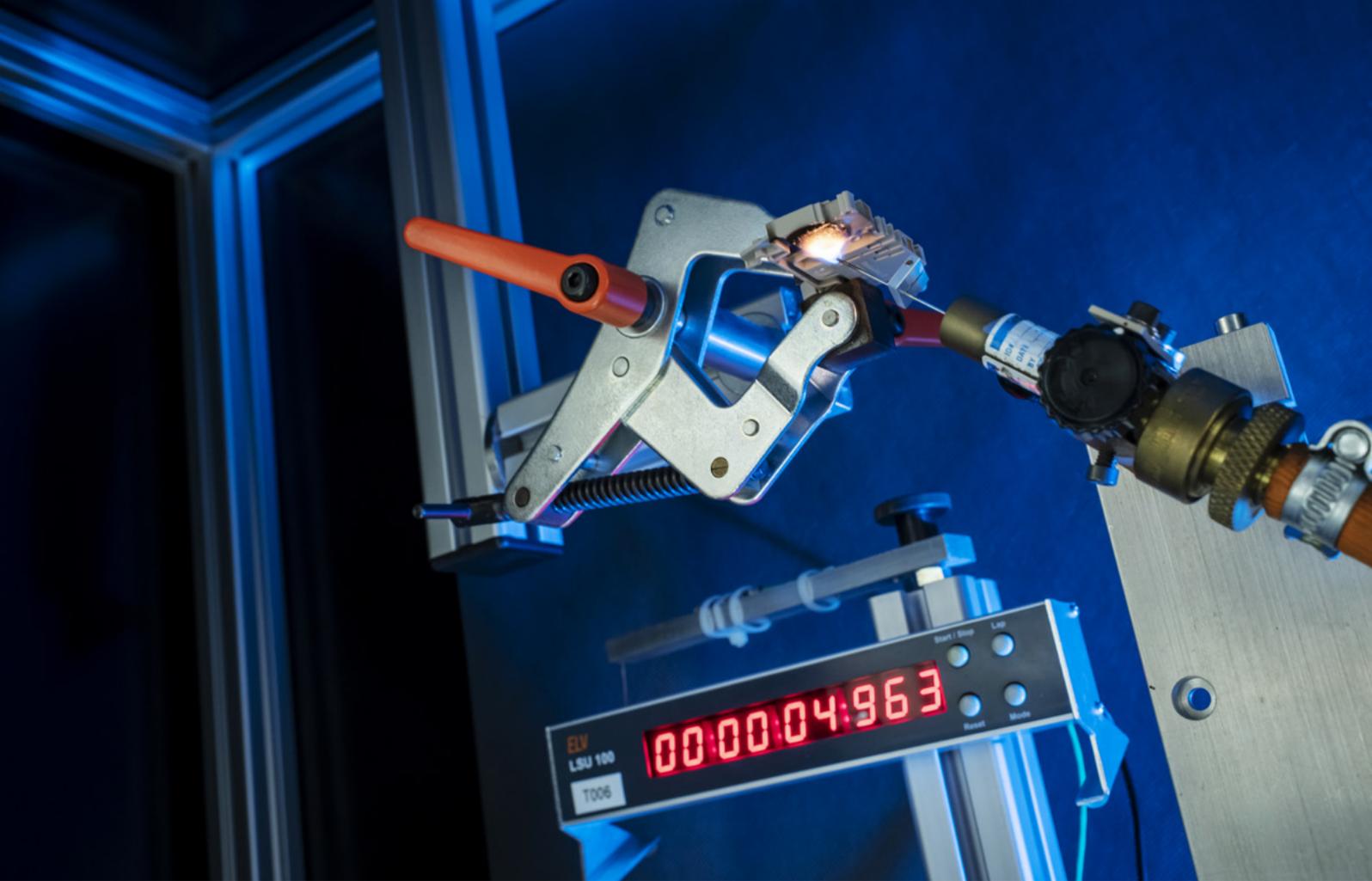
The aging test verifies the contact quality under simulated aging. Thus, the quality of the connections can also be ensured for a long life cycle of the terminal block.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired in series with the rated cross-section. The temperature range within the climatic cabinet alternates between 20 °C and 85 °C. The rated current flows between the heating phase and the 10-minute holding phase.

This is followed by the cooling phase. The scope of the aging test includes 192 cycles, with the following after every 24th cycle, the voltage drop is measured over the total distance of the terminal block or protective earth terminal block and DIN rail.



The test is considered to be passed if the measured voltage drop for terminal blocks according to the 24. cycle maximum 4.8 mV or 1.5 times the voltage measured after the 24th cycle does not exceed the specified value. In the case of protective earth terminal blocks, the proof is deemed to have been passed if the measured voltage drop to the DIN rail is higher than the 24th cycle does not exceed 9.6 mV or 1.5 times the voltage drop measured after the 24th cycle in each case.

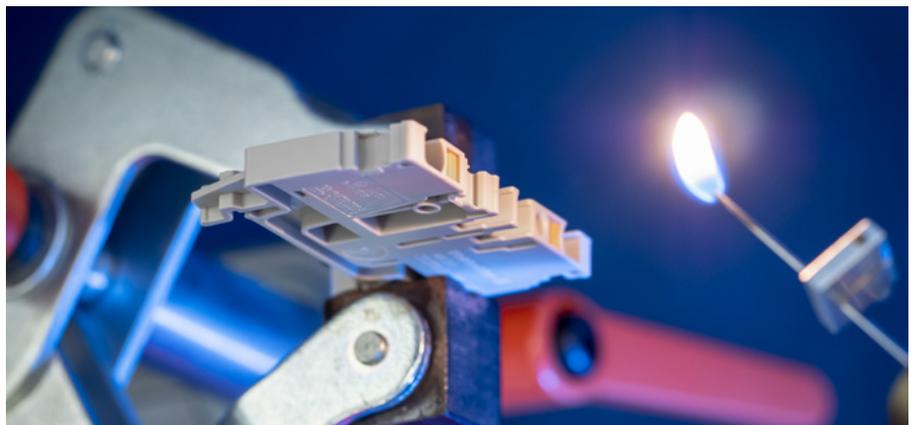


Needle flame test

The needle flame test demonstrates safe fire behaviour in the event of direct contact with an inflammation source. The requirement for the fire behaviour of a terminal block is a self-extinguishing plastic, which, in the event of a fire, neither promotes nor contributes to its acceleration.

For the test, an open flame, at an angle of 45°, is applied to an edge or surface of the terminal block. A tissue paper pad is positioned under the experimental setup, which must not inflame during and after the experiment due to dropping parts.

The exposure time of the flame is 10 s, but 5 s for wall thicknesses below 1 mm or areas < 100 mm². After the flame has been removed, the afterburning time is determined, provided inflammation has occurred.



The test is considered to be passed if the burning time is < 30 seconds and falling burning or glowing particles do not inflame the tissue paper backing.

IEC 60947-7-x as a basis for further markets and industries

The existence of different standards and industry requirements for components results from the variety of applications, environments and industries in which these components are used. These standards not only ensure the safety of people and property, but also take into account the technological advances and cultural differences in different countries.

The basis here is also a large part of IEC 60947-7-x, which is supplemented or extended by additional industry- or country-specific tests. This ensures that switchgear cabinet components work efficiently and reliably and meet the wide range of requirements - whether in the power generation, chemical industry, transportation or other sectors. This enables international trade and contributes to safety, quality and environmental compatibility throughout the electrical infrastructure.



The following is an excerpt and example of some well-known markets and branches of industry with their certification bodies and approval procedures, in order to give an impression of the diversity of the requirements placed on components and in particular to terminal blocks.

Mechanical testing

Protection against accidental contact

- Finger safety (IEC 60529)
- Back of hand safety (IEC 60529)

Shock and vibration

- Vibration test - broadband noise (IEC 61373)
- Vibration test - Sinusoidal (IEC 60068-2-6)
- Shock test (IEC 60068-2-27)

Electrical testing

- Derating curve for plug-in connectors (IEC 60512-5-x)
- SCCR rating (NEC and UL 508A)
- Plug-in cycles (IEC 61984)

Material testing

Electrical properties of plastics

- Comparative Tracking Index CTI (IEC 60112)
- Insulating material properties TI (IEC 60216-1)
- Insulating material properties RTI (UL 746B)

Environmental testing

- Dry heat (IEC 60068-2-2)
- Damp heat, cyclic (IEC 60068-2-30)
- Cold test according to (IEC 60068-2-1)
- Sulphur dioxide according to (IEC 60068-2-42)
- Hydrogen sulphide according to (IEC 60068-2-43)
- Salt spray / corrosion test (IEC 60068-2-11/52)

Corrosion and surface condition on metallic surfaces

- Surface corrosion protection (DIN EN ISO 4042, DIN EN ISO 19598, DIN 50965, DIN EN ISO 4521, DIN EN ISO 27874)

Requirements and certifications for raw materials of terminal block

In addition to the product-specific standards, there are a large number of other standards and certificates relating to the fire behaviour of the insulation materials used. The railway industry in particular sets higher requirements here in terms of flammability and surface flammability, smoke generation, smoke gas toxicity and smoke gas density.

But also in other industries, additional requirements are required for the raw materials and the products. A differentiation must always be made here as to whether the standard or certificate refers to the end product (terminal block) or to the raw material, such as the thermoplastic (plastics). A certificate qualifies the respective raw material of the manufacturer and thus also flows indirectly into the end products, such as a modular terminal block.

The following are some standards and certificates that the various raw materials of the Weidmüller terminal blocks meet and include:



Material tests and certificates for the raw material

Halogen-free flame resistant (DIN EN ISO 1043-4)

Flammability testing of plastics for parts in devices and applications

- Vertical small flames test (UL 94 und EN 60695-11-10)
- Horizontal small flames test (UL 94 und EN 60695-11-10)

Fire protection on railway vehicles (EN 45545-2)

- Smoke gas development generation (EN ISO 5659-2)
- Oxygen index (DIN EN ISO 4589-2)
- Toxicity of smoke gas (NF X70-100-2 (600°C))

Standard for rail-based local transport and passenger transport systems NFPA 130

- Surface inflammability ASTM E 162
- Smoke gas development ASTM E 662
- Smoke gas toxicity SMP 800 C



Certification bodies and approval processes

The conditions in different countries are not always the same and are often historically conditioned. Different grids, voltages, currents and safety requirements lead to country-specific certificates or approval procedures. For the recognition of the respective tests from the IEC or the performance of special tests there are so-called third-party bodies that verify tests or carry out tests for the manufacturer of the products and document them.

Examples of tests for specific countries include:

- SCCR rating (NEC and UL 508A)
- Cold test according to (IEC 60068-2-1)
- Insulating material properties RTI (UL 746B)



IECEE-CB Scheme
(in combination with certifiers)



Canadian Standard Association (CSA)



cURus



DEKRA Certification B.V.



Verband Deutscher Elektrotechniker e.V. (VDE)



China Compulsory Certification



Korean Certification Mark



Explosion protection

Harsh industrial environments and explosive risk zones, such as in the oil and gas industry, make extreme demands on safety, robustness and quality of products and devices. Numerous standards describe what has to be considered in Ex environments. They serve as the basis for extensive approvals.

Examples of standards for the explosion-proof area:

- IEC 60079-0 Equipment - General requirements
- IEC 60079-7 Equipment protection by means of increased safety „e“



International Electrotechnical Commission



Canadian Standard Association (CSA)



cURus



FM Approvals



Korean Certification Mark for Ex-products



National Institute of Metrology



China Compulsory Certification



ATEX Directive



Ship building

Many industrial products find their way into maritime applications. However, the approval requirements for use in the ship building sector are different from those for use in conventional industrial plants. About the individual classification societies, which also define the standard values for the type examinations. Many countries do not tolerate ships without classification certificates.

Examples of specific tests in the area of ship approvals include:

- Hydrogen sulfide to (IEC 60068-2-43)
- Salt spray / corrosion test (IEC 60068-2-11/52)
- Surface corrosion protection (DIN EN ISO 4042, DIN EN ISO 19598, DIN 50965, DIN EN ISO 4521, DIN EN ISO 27874)



DNV - MARITIME
(in combination with certifiers)



Bureau Veritas



Lloyds Register of Shipping

ClassNK

Nippon Kaiji Kyōkai



Polski Rejestr Statków



Korean Register of Shipping



American Bureau of Shipping



Registro Italiano Navale



Railway

For automation and communication technology on board of a train and outside at the Railway track the environmental conditions are highly ambitious. All components and interfaces must be able to withstand both the vibrations and shocks caused by a train passing over a Railway switch as well as temperature and weather condition in extreme climates like in the mountain's arctic region or even in the desert. On top, high fire protection requirements have to be fulfilled to ensure the safety of the passengers. Ultimately, the quality and reliability of railway products throughout the supply chain also play an important role which will be ensured by a quality assurance system.

Examples of specific tests in the railway industry include:

- Vibration test - broadband noise (IEC 61373)
- Surface flammability ASTM E 162
- Smoke emission (EN ISO 5659-2)

EN 50155

European Standard for
Electronic Equipment used on
Rolling Stock

EN 61373

Shock and Vibration for
application used in Rolling
Stock

EN 45545

Fire and Smoke

**NFPA 130
/ ASTM E**

Fire and Smoke criteria used in
American Market

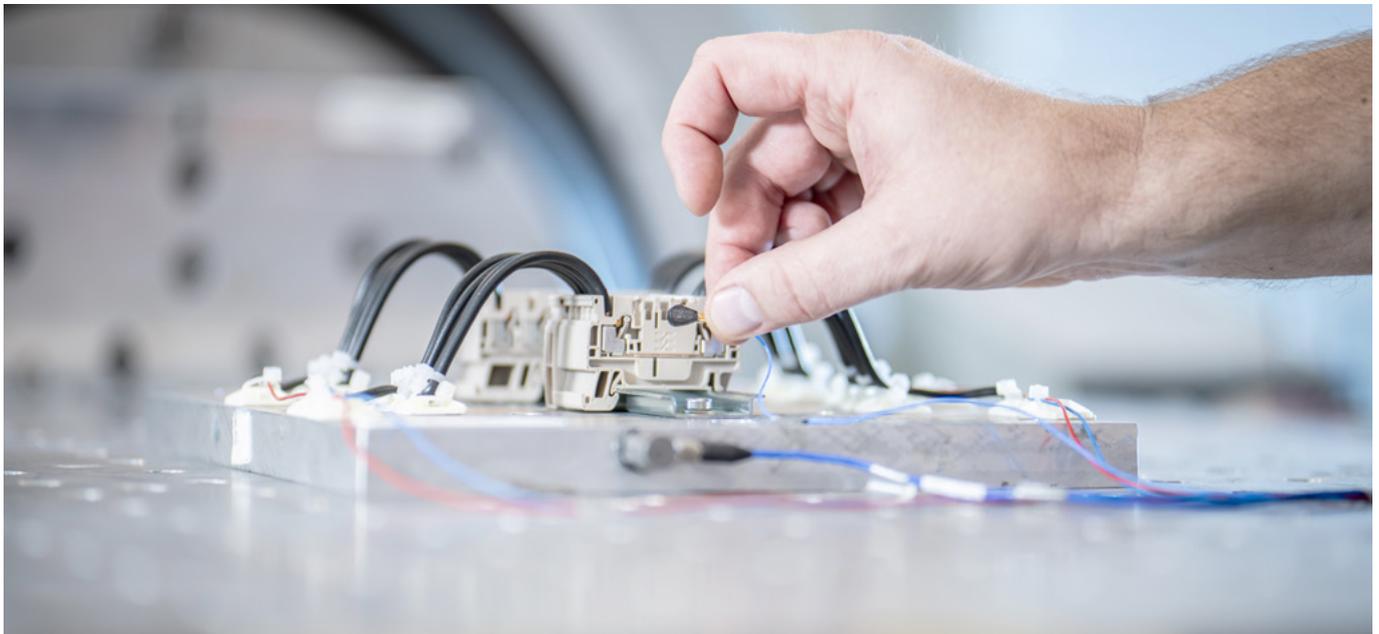
IRISTM
Certification

International Railway Industry
Standard-CertificationTM

Shock and vibration

The proof of the respective shock and vibration tests ensures the safe use of the terminal blocks and the contact reliability under the mentioned fault influences. Electrical switchgear and its installed individual components are exposed to various vibrations and shocks in many industries. For example, in railway vehicles or rotating machines and drives. In the laboratory, shocks and vibrations can be applied to the test setup and simulated using a „ vibration table „.

For the tests, terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. The DIN rail is mechanically fixed on the vibrating table, so that the shocks and vibrations are directly transmitted to the terminal rail.



Vibration test - broadband noise (IEC 61373)

The category 1b test defines an acceleration with an effective value of 5.72 m/s^2 and a frequency range from 5 Hz to 150 Hz. The simulation moves the test setup for 5 hours in all three axes (x, y, z).

Vibration test - Sinus (IEC 60068-2-6)

The test simulates an acceleration with the effective value of 50 m/s^2 and a frequency range from 5 Hz to 150 Hz. This frequency range increases by one octave every minute. The simulation moves the test setup for 2 hours in all three axes (x, y, z).

Shock test (IEC 60068-2-27)

The test setup experiences an acceleration of 50 m/s^2 with a shock duration of 30 ms. Furthermore, IEC 60068-2-27 requires three positive and negative shocks (18 total) in each of the three axes (x, y, z).

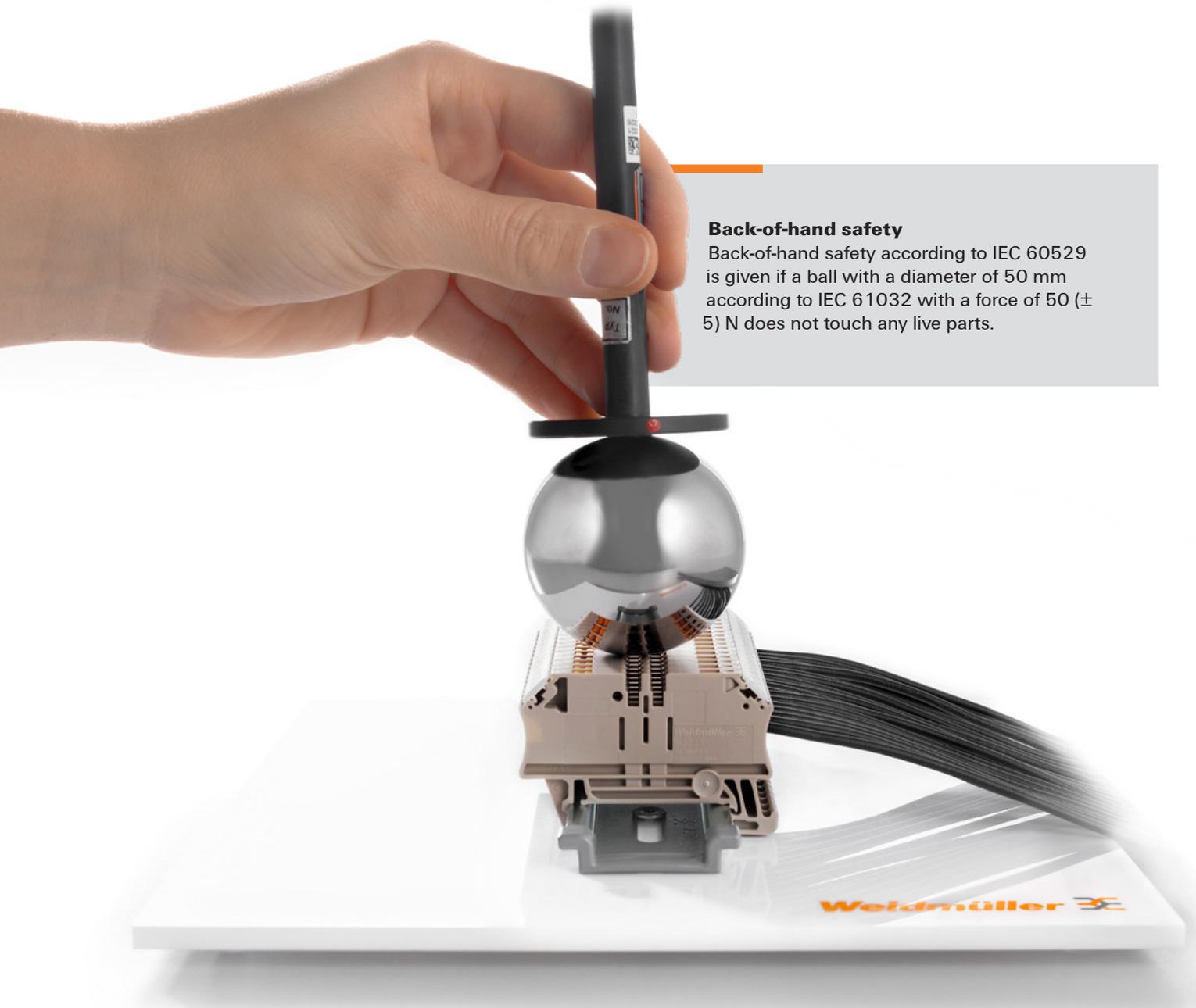
The tests are considered to be passed if there is no damage to the terminal block and further use is guaranteed.



Protection against accidental contact (IEC 60529)

The proof of touch-safe protection ensures protection against direct (accidental) contact. The IP degree of protection, for example IP40 against direct contact, refers to the enclosure of electrical switchgear and not to the installation components such as terminal blocks. The design of the terminal blocks takes into account the so-called finger safety and back-of-hand safety according to IEC 60529. Verification is performed by the articulated test finger or test ball according to IEC 61032.

For the test, Weidmüller normally installs 10 terminal blocks on a standard-compliant DIN rail and wires the terminal points with the rated cross-section. Following this, the test is carried out with reference to the test finger or test ball.



Back-of-hand safety

Back-of-hand safety according to IEC 60529 is given if a ball with a diameter of 50 mm according to IEC 61032 with a force of 50 (\pm 5) N does not touch any live parts.

Finger safety

Finger safety according to IEC 60529 is given if the articulated test finger according to IEC 61032 cannot touch any parts at risk of contact in all actuation directions. The articulated test finger applies a test force of 10 N to the terminal block. This may enter up to its 80 mm length and not touch any dangerous live parts.



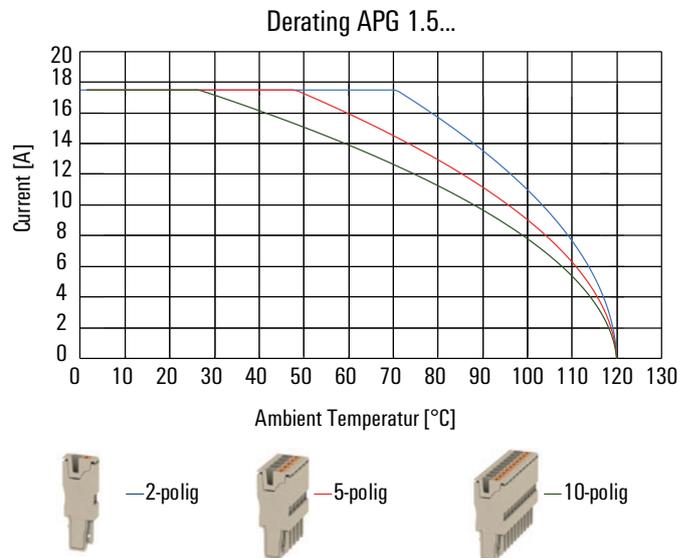
The test is considered to be passed if the test finger or the test ball cannot touch any live parts. This ensures protection against unintended contact in accordance with IEC 60529 IPXXB or IPXXA.

Derating curve for plug-in connectors (IEC 60512-5-x)

With the proof of the derating curve, the current carrying capacity is documented as a function of the pole number and the ambient temperature. Since no derating is required in the IEC 60947-7-1/-2/-3 terminal block standard, the pluggable terminal blocks are treated like plug-in connectors with regard to the derating curve and are therefore tested in accordance with IEC 61984.

For the test, pluggable terminal blocks are mounted on a DIN rail and the connection points of the terminal blocks are wired with the rated cross-section. The current-carrying capacity curve, which is dependent on the ambient temperature, the so-called base curve, results from the upper limit temperature of the insulating material. For the material WEMID, this is 130 °C. In order to compensate for measurement inaccuracies or a scattering of the contact resistance in the contact area, IEC 60512-5-2 requires a correction of the load capacity curve by a factor of 0.8 to the base current.

The derating curve is calculated and visualized from the measured values.



SCCR rating (NEC and UL 508A)

Proof of the SCCR rating (Short Circuit Current Rating) ensures the safety of the switchgear in the case of a short circuit against electric shock, fire and secondary risks. Terminal blocks have a short-circuit rating known as SCCR, which defines the level of short-circuit current that the particular device can safely withstand when protected by a specific overcurrent protective device as identified by SCCR. According to Table SB 4.1 in UL 508A, 10 kA is required as the default value for non-specified components such as terminal blocks.

For the test, 3 terminal blocks are mounted on a DIN rail and the connection points of the terminal blocks are wired with the rated cross-section. While maintaining the rated voltage, a short circuit is generated in the circuit, which is safely interrupted by the upstream fuse element (see UL file with the number E60693). All UL-certified terminal blocks from Weidmüller have an SCCR value (short-circuit rated current) of 10 kA. Different measured or proven SCCR values above 10 kA are documented and can be viewed in the UL file with the number E60693.

The verification is considered to be passed if there is no damage to the terminal blocks and further use is guaranteed. Furthermore, at the end of the test, the measured voltage drop must comply with the specified values.

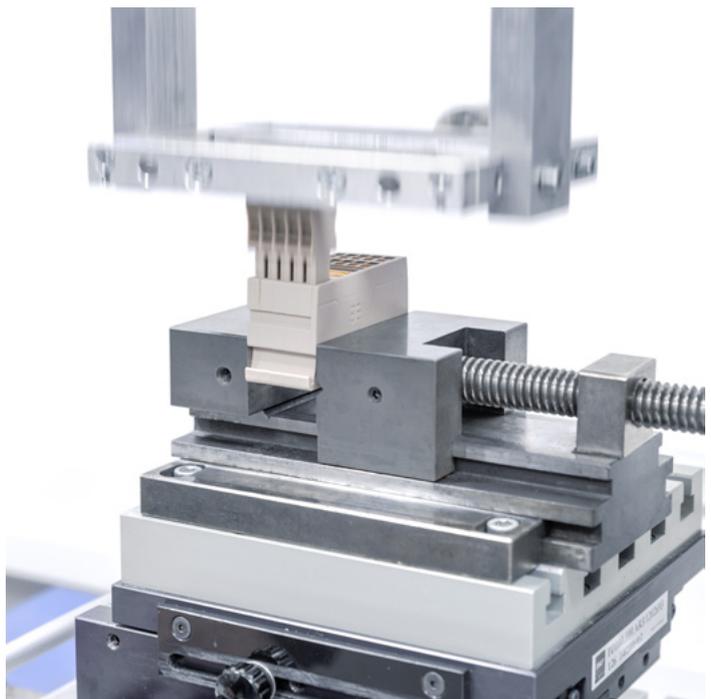


Plug-in cycles (IEC 61984)

The proof of the plug-in cycles ensures the contact quality over the service life of a plug-in contact. Since the terminal block standard IEC 60947-7-1/-2/-3 does not specify any requirements for mating cycles with regard to pluggable terminal blocks, these are tested on the basis of the connector standard IEC 61984.

For the test, pluggable terminal blocks including plugs are mounted on a standard-compliant DIN rail. With a speed of 3-4 plug-in cycles per minute, the service life test is simulated.

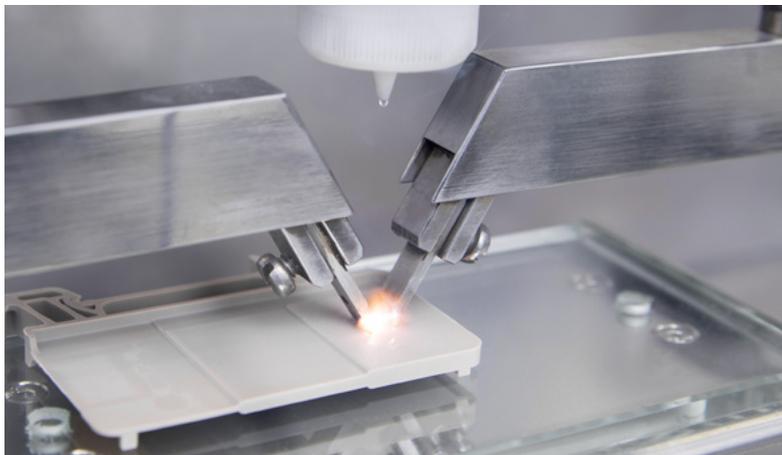
The test is considered to be passed if there is no damage to the terminal block including the plug connection and further use is guaranteed. Furthermore, at the end of the test, the measured voltage drop must comply with the specified values.



Comparative Tracking Index CTI (IEC 60112)

The verification of comparative tracking index or surface leakage resistance ensures the insulation strength of the surface of insulating materials under the influence of humidity and pollution.

For the test, a test sample consisting of the insulation material is fixed on the test table. Two platinum electrodes are placed on the test specimen at a distance of 4 mm and a defined test voltage is applied between them. 50 drops of a defined electrolyte solution are dropped between the two electrodes at intervals of 30 seconds and the creepage current is measured.



The test is considered to be passed if, at a defined voltage and application of the 50 drops, the measured leakage currents are less than 0.5 A. The applied voltage corresponds to the CTI (Comparative Tracking Index) value.





Glow wire test (IEC 60695-2-11)

The glow wire test is used to verify the safety of the terminal blocks in the event of overheating or overloading. The plastic of the terminal block must be flame resistant.

For the test, a terminal block is fixed at right angles to the glow wire. With a temperature of 750° C and a force of 1 N, the glow wire presses in on the terminal block. A tissue paper pad is positioned under the test set-up, which must not be ignited by dropping plastic during and after the test.

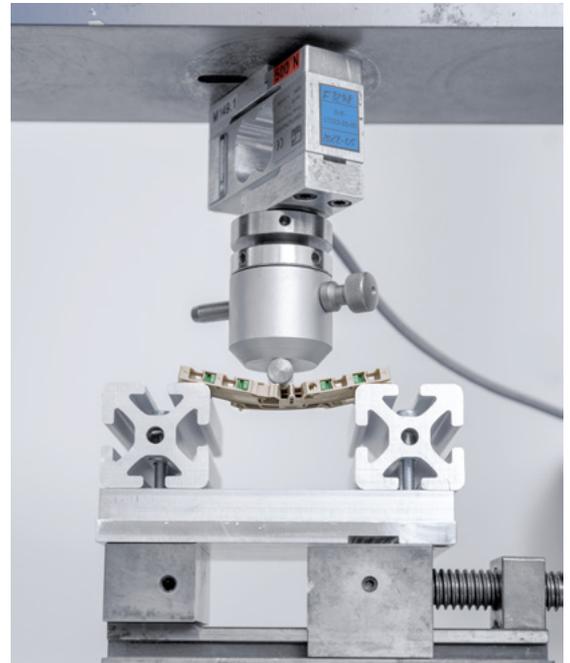
The test is considered to have been passed if no inflammation of the tissue paper has occurred. Any flames or glowing processes that occur must be extinguished within 30 s after removal of the glow wire, i.e. $t_e \leq t_a + 30$ s.

Insulating material properties TI (IEC 60216-1)

The proof of the TI value (temperature index) is used to determine the long-term thermal stability of electrical insulating materials. For example, the tensile strength (mechanical flexibility) of the plastic after storage at different temperatures can be used as a criterion.

For testing, the test samples are stored in a heating cabinet at least three different temperatures. Test specimens (tensile bars) are taken at specified intervals and the tensile strength is determined on them. The values measured over the period (500 h to 5,000 h) are documented and extrapolated to 20,000 hours.

The temperature index in terms of tensile strength can be derived from the recorded time-temperature curve. This value corresponds to the time span of 20,000 hours with a property loss of 50% and allows statements to be made about the mechanical lifetime.



Surface corrosion protection (DIN EN ISO 4042, DIN EN ISO 19598, DIN 50965, DIN EN ISO 4521, DIN EN ISO 27874)

The proof of surface corrosion protection ensures contact reliability under demanding environmental conditions. Corrosion resistant contact areas with low contact resistances form the basis for a safe and efficient contact.

Depending on the connection technology, various types of corrosion-resistant, high-alloy spring steels or additional corrosion protection systems for ferrous or copper materials are therefore used for surface corrosion protection.

Basic material	Coating	Coating function
Iron	Zinc / Passivation	Corrosion protection
Copper	Nickel	Corrosion protection
Copper	Tin	Corrosion protection / solderability
Copper	Nickel / Tin	Diffusion barrier / solderability
Copper	Silver / Passivation	Improved conductivity / solderability
Copper	Nickel / Gold	Improved conductivity
Copper	Nickel-Phosphorus / Gold	Improved conductivity

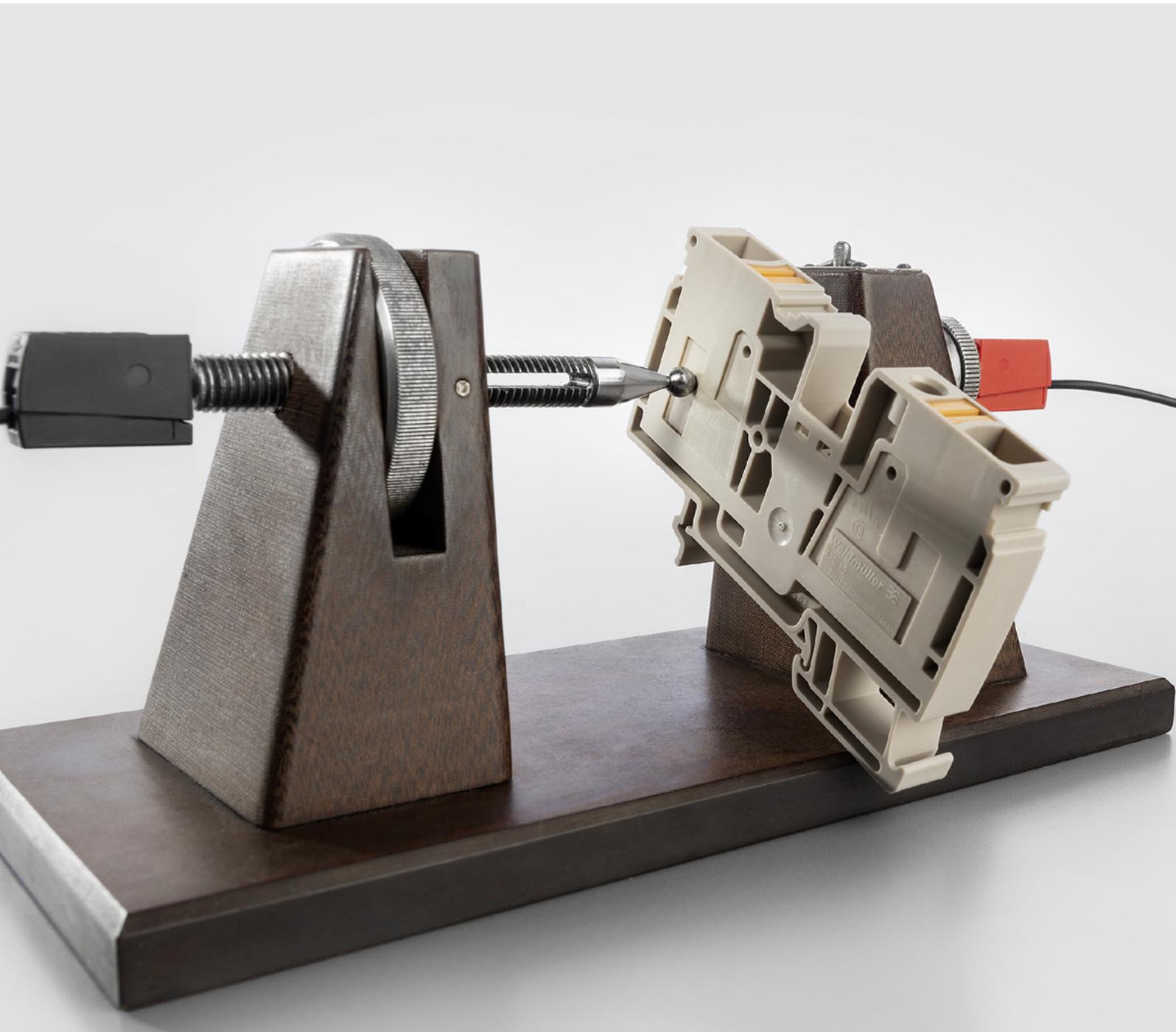
Insulating material properties RTI (UL 746B)

The RTI value (Relative Temperature Index) is used to determine the long-term thermal stability of electrical insulating materials. For example, the insulation resistance of the plastic after storage at different temperatures can be used as a criterion.

For testing, the test samples are stored in a heating cabinet at least three different temperatures. Test samples are taken at specified intervals and the insulation resistance is determined from them.

The values measured over the period (500 h to 5,000 h) are documented and extrapolated to 20,000 hours.

The relative temperature index with respect to the insulation resistance can be derived from the recorded time temperature curve. This value corresponds to the time span of 20,000 hours with a property loss of 50% and allows statements to be made about the electrical lifetime.



Dry heat (IEC 60068-2-2)

The „dry heat“ climatic test verification ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. Depending on the material properties of the insulating material, the terminal blocks are subjected to thermal aging within the test cabinet at a defined time and temperature. For a terminal block made of the insulating material WEMID, such as WDU 2.5 or A2C 2.5, the defined values are 130 °C for 168 hours.

The test is considered to be passed if no damage has occurred to the terminal block after the test, further use is guaranteed and the measured voltage drop complies with the specified values.

Damp heat, cyclic (IEC 60068-2-30)

The proof of the climatic test „Damp heat, cyclic“ ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. The temperature range within the climatic chamber varies depending on the test severity for one or more cycles with a defined temperature and humidity.

-Class A defines a temperature range of +25 / +40 °C and a humidity of >93%

-Class B defines a temperature range of +25 / +55 °C and a humidity of >93%

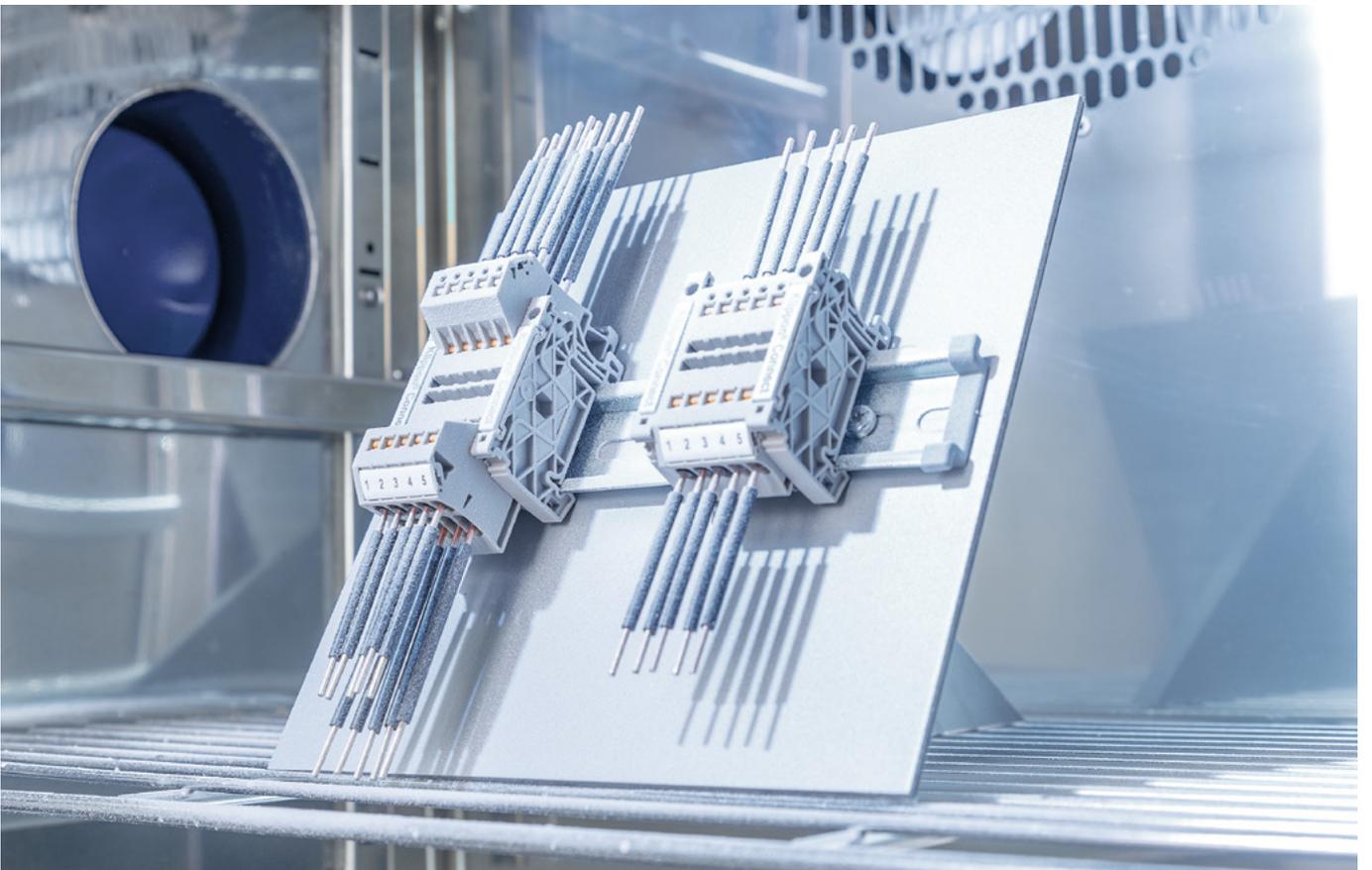
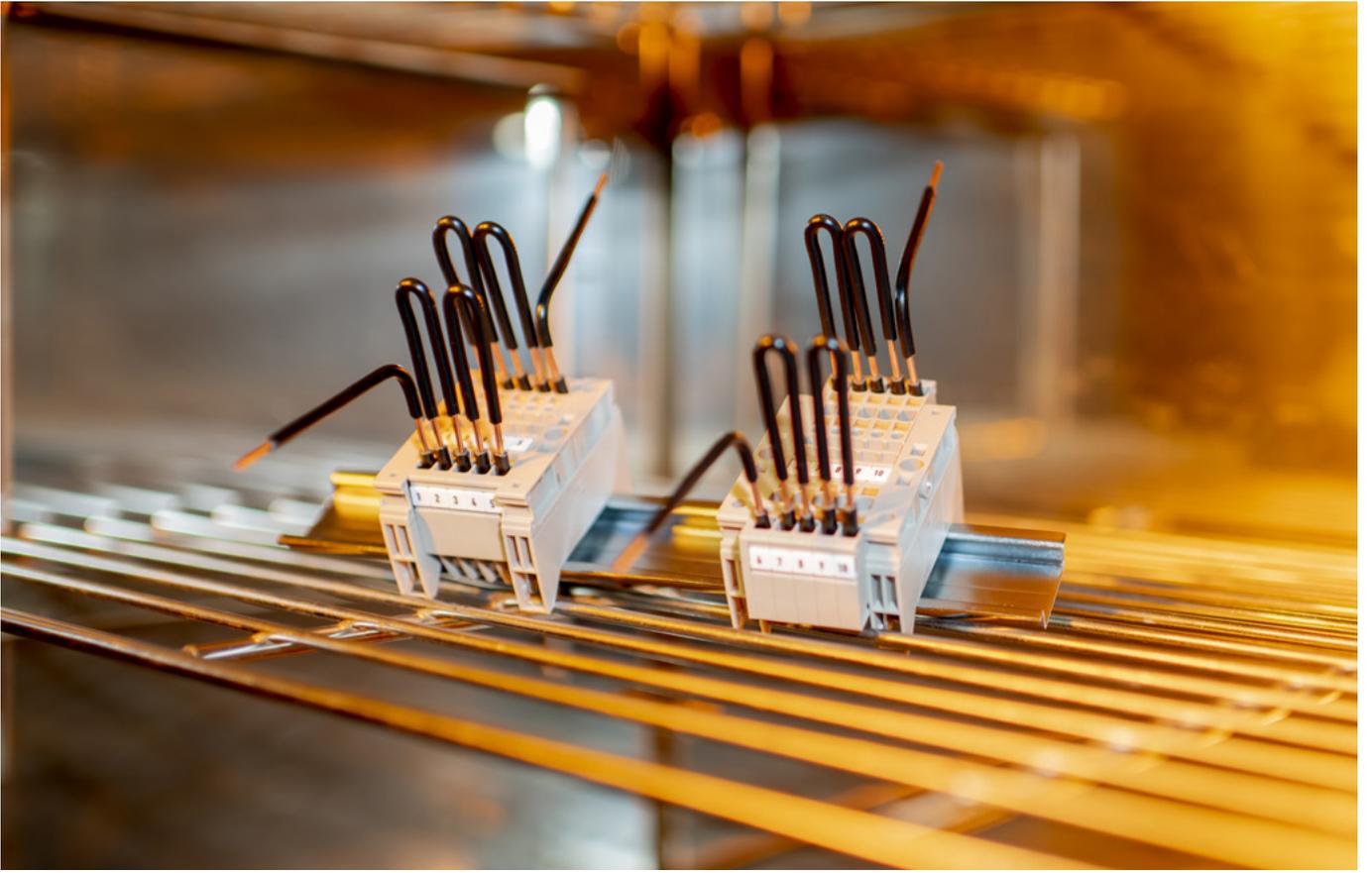
The test is considered to be passed if no damage has occurred to the terminal block after the test, further use is guaranteed and the measured voltage drop complies with the specified values.

Cold test according to IEC 60068-2-1

The proof of the climatic test „cold test“ ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. In the test cabinet, the terminal blocks are exposed to a constant temperature of up to -65 °C for 48 hours.

The test is considered to be passed if no damage has occurred to the terminal block after the test, further use is guaranteed and the measured voltage drop complies with the specified values.



Sulphur dioxide acc. to IEC 60068-2-42



Storage in sulphur dioxide (corrosive atmosphere) ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions. In particular, the corrosive effect of sulphur dioxide as a component of polluted air on the connection points is the focus of laboratory testing.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. In the climatic cabinet, the terminal blocks are exposed to 10 ppm concentrated SO₂ gas at +25 °C and 75 % humidity for 10 days.

The test is considered to be passed if no damage has occurred to the terminal block after the test, further use is guaranteed and the measured voltage drop complies with the specified values.

Hydrogen sulphide acc. to IEC 60068-2-43



Storage in hydrogen sulphide (corrosive atmosphere) ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions. In particular, the corrosive effect of hydrogen sulphide as a component of polluted air on the connection points is the focus of laboratory testing.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. In the climatic cabinet, the terminal blocks are exposed to 1 ppm concentrated H₂S gas at +25 °C and 75 % humidity for 10 days.

The test is considered to be passed if no damage has occurred to the terminal block after the test, further use is guaranteed and the measured voltage drop complies with the specified values.

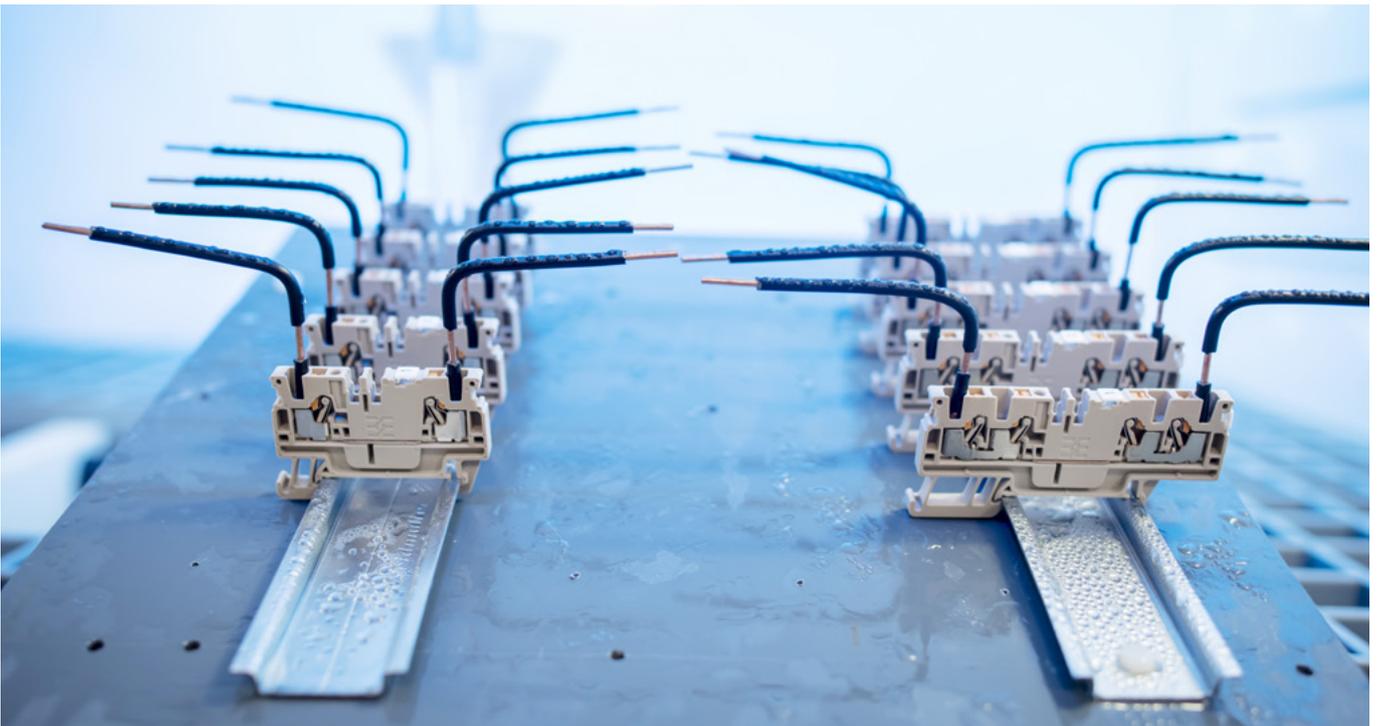
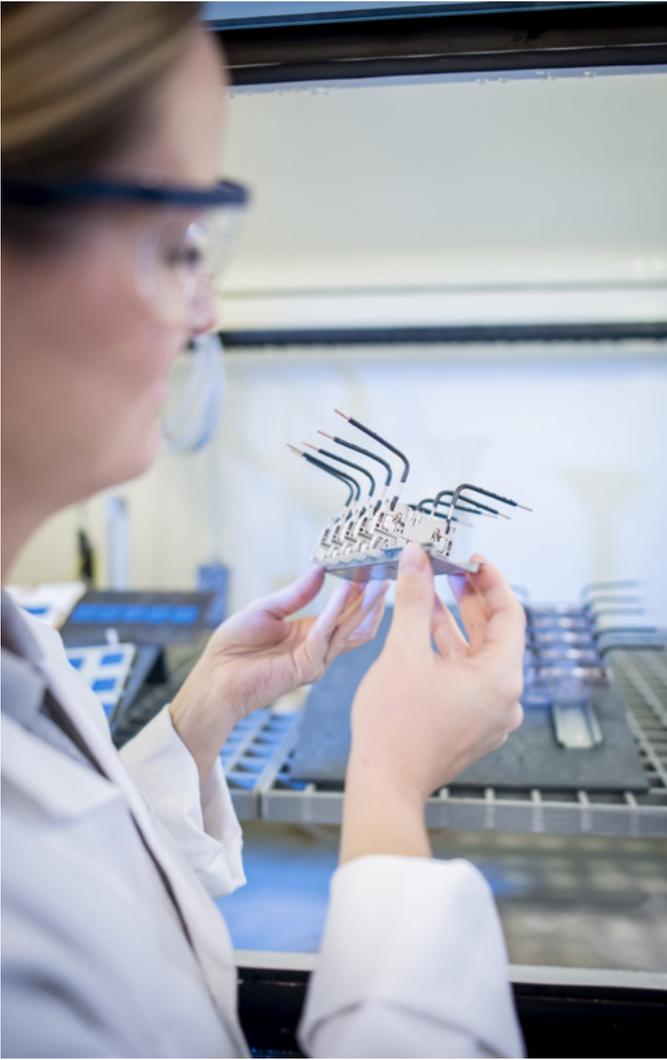
Salt spray testing acc. to IEC 60068-2-11



Storage in salt spray ensures the contact quality of the connections and the safe operation of the terminal block after it has been exposed to the defined environmental conditions. In particular, the corrosive effect of salt spray as a component of polluted air on the connection points is the focus of laboratory testing.

For the test, 5 terminal blocks are mounted on a standard-compliant DIN rail and the terminal connection points are wired with the rated cross-section. In the climatic cabinet, the terminal blocks are sprayed with a defined amount of salt fog (NaCl 50 g/l +/- 10 g/l) at +35 °C for 48 hours.

The test is considered to be passed if no damage has occurred to the terminal block after the test and the measured voltage drop complies with the specified values.





Scratch and wipe resistance

The proof of scratch and wipe resistance ensures that the imprint of terminal blocks remains legible even after handling, mechanical or other environmental influences. Since the terminal block standard IEC 60947-7-1/-2/-3 does not specify any requirements with regard to the printing of terminal blocks, they are tested in accordance with IEC 61439-1 / 2011-08 and IEC 61558-1 Cor 3 / 2011-04.

For the test, the terminal block is mounted in the test set-up with the imprint facing upwards. The stamp of the system is impregnated with a liquid and placed on the imprint of the terminal. At a defined speed and pressure, it is wiped 15 times over the area of the imprint.

The test is considered to be passed if the imprint on the terminal block can still be read, the surface shows no damage and further use is guaranteed.

Weidmüller – Your partner in Smart Industrial Connectivity

As experienced experts we support our customers and partners around the world with products, solutions and services in the industrial environment of power, signal and data. We are at home in their industries and markets and know the technological challenges of tomorrow. We are therefore continuously developing innovative, sustainable and useful solutions for their individual needs. Together we set standards in Industrial Connectivity.

We cannot guarantee that there are no mistakes in the publications or software provided by us to the customer for the purpose of making orders. We try our best to quickly correct errors in our printed media.

All orders are based on our general terms of delivery, which can be reviewed on the websites of our group companies where you place your order. On demand we can also send the general terms of delivery to you.

Weidmüller Interface GmbH & Co. KG
Klingenbergstraße 26
32758 Detmold, Germany
T +49 5231 14-0
F +49 5231 14-292083
www.weidmueller.com

Personal support can
be found on our website:
www.weidmueller.com/contact

Made in Germany
October 2023 / TCTM