Railway industry
Connection technology and electronic components
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 12,900 people worldwide. A sales network with over 50 sales subsidiaries and more than 30 additional sales partners guarantees customer proximity directly on site, anywhere in the world.

Our range of services consists of products surrounding various different 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 automobile production, wind energy, photovoltaics, the process industry or applications in the field of water supply, power 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.
Partner of the railway industry

For years, Phoenix Contact has been a reliable partner of the railway industry and offers products for use in rail vehicles and signal technology. Our high level of innovative expertise, combined with extensive industry know-how, is the basis for reliable and economic components and solutions. Select your tailor-made connection and system solution from our extensive product range. Our team of experts will gladly provide you with the necessary support.

"You will find our innovative and economic components and solutions on and at rails throughout the world!"
Products for rail vehicles

Highest quality, reliability and zero maintenance are three essential requirements that must be met by products used in rail vehicles. Besides shock and vibration resistance of the components, the behavior of the materials used in case of a fire plays a particularly important role. Naturally, the rail-specific products from Phoenix Contact meet the rail standards DIN EN 50155, DIN EN 50121 and DIN EN 45545.
Products for rail vehicles

Wherever systems and products in rail vehicles have to be supplied with energy and signals and data have to be distributed, products from Phoenix Contact are being used. Modular terminal blocks with an overall width of only 3.5 mm are perfectly suited for the smallest installation spaces. Power supplies guarantee an uninterruptible availability of safety-relevant systems, and Ethernet network isolators ensure a fault-free network in the entire train.

Perfect for smallest installation spaces
The space-optimized push-in modular terminal blocks distinguish themselves particularly for use in space-sensitive applications. With an overall width of only 3.5 mm, conductors with rated cross sections from 0.14 - 1.5 mm² can be installed.

Reliably switching signals
The highly compact and bridgeable PLC... RW relay modules feature an extended input voltage and temperature range up to class TX. The pluggable, sealed relays are insensitive to dust, noxious gases and humidity. With the electrical isolation, interference signals in the signal path are reliably filtered out and an interference-free operation is ensured.

For additional information, visit www.phoenixcontact.com.
Extremely reliable
Reliable and permanent connections are important requirements on the connection technology in rail use. The connector and PCB terminal block program COMBICON includes high-quality contact systems and locking systems, such as screw flanges, lock & release or locking flanges.

High availability
Rail vehicles are subjected to permanent voltage fluctuations and current peaks. The QUINT POWER power supplies with their robust design and preventive function monitoring ensure the secure energy supply of safety-related systems.

Secure and fault-free network
The Ethernet network isolator of the FL ISOLATOR series ensures a fault-free network in rail vehicles. Customizable and molded M12 connectors with rail-compliant cables are available for transmitting PROFINET and sensor-actuator signals.
Components that are used in signal technology should not only be resistant to vibration and shock, but also withstand environmental influences. It does not matter at all whether the components are exposed to extreme heat or cold, humid or dry air. For use in signal technology, Phoenix Contact provides products that meet increased requirements and excel through quality, reliability and robustness.
Products for signal technology

Supplying signaling systems with energy, protecting them against surge voltages and lightning strikes, and establishing a reliable connection to the signal are the tasks which our products take on in signal technology. Modular terminal blocks in different connection technologies securely and reliably maintain the electrical connection. Surge voltage protective devices meet all the required proofs of safety, and FO media converters ensure that data can be transmitted trouble-free.

Contacting within seconds

Fast connection technology from Phoenix Contact is characterized by the patented insulation displacement contact and the space-saving connection. It is used to connect conductors without pretreatment. The reliable setting of the switching states is ensured with snap-on swiveling levers.

For additional information, visit www.phoenixcontact.com.
Rail-specific marking materials
MARKING system offers halogen-free terminal marking, conductor and cable marking, device marking and system marking that have been perfectly matched to their application in rail applications with respect to their fire protection properties.

Perfect surge protection
In control command and signaling, MCR-PLUGTRAB protective devices are used to protect switch towers and other signaling systems against lightning and surge voltage. All required proofs of safety are achieved by a system-specific circuit technology.

Interference-free data communication via fiber optics
In signaling technology, data have to be transmitted over large distances, quickly and reliably. Our FO media converters meet these requirements. Extensive measures for shielding and equipotential bonding can be omitted.
Quality from the start

Rail vehicles are subjected to vibrations and shock due to operational reasons and therefore require extremely high standards of reliability for the electrical connections and fault tolerance of electronic components. Constant product quality that corresponds to the highest requirements of the railway industry is guaranteed through permanent controls in the development and production cycle of the products. This is also documented by the IRIS certification required by the railway industry.

Norms and standards

**Shock and vibration test**
- IEC 60068-2-27
- IEC 60068-2-6
- DIN EN 61373

**Material test**
- DIN ISO 4589-2
- UL 94 / EN 60695-11-10

**Fire protection**
- DIN EN 45545-2
- DIN 5510-2
- NF F 16-101
- NF F 16-102
- ASTM E 162 (NFPA 130)

**Miscellaneous**
- ASTM E 662 (NFPA 130)
- SMP 800 C
- BS 6853
- AREMA MP 11.5.1 Class C
- AREMA MP 11.5.1 Class D
- AREMA MP 14.1.2

For additional information, visit www.phoenixcontact.com.
Shock testing IEC 60068-2-27 – Shocks (intensity according to DIN EN 50155)

This test is performed to test and document the resistance of a terminal connection to irregular occurring shocks with varying energy content. Intensities from DIN EN 50155 or DIN EN 61373 (European standard for railway applications) are used to simulate the load in rail traffic.

For the definition of the shock, acceleration and duration are specified. IEC 60068-2-27 prescribes three positive and negative shocks on each of the three spatial axes (x, y, z). The simulated accelerations reach 50 m/s² with a shock duration of 30 ms. No damage may occur at the terminal connection that would impair further use. The contact behavior at the test objects is monitored during the test. When the German railway standard is applied, no contact interruptions > 1 μs are permitted.

Phoenix Contact modular terminal blocks achieve this shock resistance and are suitable for applications with the most extreme vibrations.

Vibration test DIN EN 61373 – Broadband noise (intensity according to DIN EN 50155)

In traffic technology, modular terminal blocks are always exposed to vibrations and shocks.

For a practical simulation of the vibration stress, the test objects are subjected to broadband noise-induced vibrations. This means that realistic accelerations are generated at the modular terminal block and the connected conductor.

During the test of category 1b, the objects are exposed to a frequency range of 5 Hz to 150 Hz. The r.m.s. value of the acceleration is up to 5.72 m/s². The test objects are tested for five hours in each of the three axes (x, y, z). In addition to the vibrations, the electrical contact is monitored during the test to make it more difficult.

No damage may occur at the modular terminal blocks that would impair their further use. In addition, no contact interruptions > 1 μs are permitted during the test.

Phoenix Contact modular terminal blocks with all connection methods fulfill this high vibration requirement.

Vibration test IEC 60068-2-6

This test demonstrates the vibration resistance of a terminal connection subjected to permanent vibrations. Harmonic, sinusoidal vibrations are applied to the test object to simulate rotating, pulsating or oscillating forces. The test is performed on each of the three spatial axes (x, y, z).

In the test, the object runs through a frequency range of 5 Hz to 150 Hz at a speed of one octave per minute. The r.m.s. value of the acceleration is up to 50 m/s². The test objects are tested for two hours on each of the three axes (x, y, z). In addition, the electrical contact is monitored during the test. No damage may occur at the modular terminal blocks that would impair their further use. In addition, no contact interruptions > 1 μs are permitted during the test.

All connection technologies meet the requirements of the standard without the electrical contact being interrupted. They are therefore particularly suitable for challenging applications in which the reliable function of the terminal connection must be ensured, even when subjected to the most extreme vibrations.
Determining the oxygen index is the most important fire protection test for electro-mechanical and electronic components besides the smoke toxicity and smoke density test. This test procedure determines the lowest oxygen concentration of an ambient atmosphere that is required for a material to continue burning independently under specified conditions. The burn duration (<180 s) and burn path (<80 mm) are being monitored.

The unreinforced polyamides used for Phoenix Contact modular terminal blocks with flammability rating UL 94 V0 achieve an oxygen index > 32%. These excellent results are responsible for achieving outstanding ratings and classifications, for the expiring national standards as well as the European standard EN 45545-2.

Inflammability classification UL 94 / EN 60695-11-10

The UL 94 standard (harmonized with the test regulations according to EN 60695-11-10) describes inflammability tests that have gained particular importance in the field of electrical engineering. Behavior in fire is the main focus. Items are classified according to either UL 94 HB (Horizontal Burning) or UL 94 V (Vertical Burning). The test setup is such that the 94 V0/1/2 classifications are stricter than the 94 HB classification.

UL 94 V0/1/2
After conditioning, the test bar is vertically clamped and flame-treated several times for ten seconds at a time. Between the flame treatments, the time until the test bar is extinguished is measured. Afterwards, the afterburning times and the drip behavior are evaluated (see the table).

The plastics used for Phoenix Contact modular terminal blocks reach the highest rating UL 94 V0 for the vertical test with a wall thickness of 0.25 mm.

<table>
<thead>
<tr>
<th></th>
<th>UL 94 V0</th>
<th>UL 94 V1</th>
<th>UL 94 V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burning time after each flame treatment</td>
<td>≤ 10 s</td>
<td>≤ 30 s</td>
<td>≤ 30 s</td>
</tr>
<tr>
<td>Total burning time after 10 flame treatments</td>
<td>≤ 50 s</td>
<td>≤ 250 s</td>
<td>≤ 250 s</td>
</tr>
<tr>
<td>Glowing time after the 2nd flame treatment</td>
<td>≤ 30 s</td>
<td>≤ 60 s</td>
<td>≤ 60 s</td>
</tr>
<tr>
<td>Complete burn-off</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Ignition of the absorbent cotton under the sample</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

Fire protection DIN EN 45545-2:2013-08

DIN EN 45545-2:2013-08, which emerged from the technical specification DIN CEN/TS 45545-2:2009-07 and has been ratified since March 2013 and converted to national law, specifies the "Requirements on fire behavior of materials and components". To qualify plastics for certain operating and design classes of rail vehicles, the standard describes testing methods for determining hazard levels (HL) based on different requirement sets (R). In this case, HL 3 corresponds to the highest requirements.

The following tests are performed in order to qualify the plastics for electrotechnical applications:
- Oxygen index according to DIN EN ISO 4589-2
- Development of smoke gas according to EN ISO 5659-2 (25 kW/m²)
- Toxicity of smoke gas NF X70-100-2 (600 °C)
- Glow-wire test according to IEC 60695-2-11
- Vertical small flames test according to EN 60695-11-10

The unreinforced polyamides used for Phoenix Contact modular terminal blocks with flammability rating UL 94 V0 meet the most stringent requirement of HL3 in accordance with the tests described in the requirement sets R22, R23, R24, R25 and R26.
In section 5.2.2.4, DIN 5510-2 “Preventive fire protection in railway vehicles – Fire behavior and fire side effects of materials and parts” requires of insulating materials that fix the energized parts in their position and are not tightly molded to meet the requirement V0 according to DIN EN 60695-11-10, which is comparable with UL 94. As an alternative, an oxygen index OI ≥30% according to DIN EN ISO 4589-2 is required for areas that are not accessible to passengers. Both requirements are met by the unreinforced polyamides used for Phoenix Contact modular terminal blocks with flammability rating UL 94 V0.

Behavior in fire DIN 5510-2

NF F 16-101 describes the behavior in fire of plastics on the basis of two indices (I and F).

The following tests are being run:
• Glow-wire test (NF EN 60695-2-10 and NF EN 60695-2-11)
• Oxygen index (NF EN ISO 4589-2)
• Smoke gas toxicity (NF X 70-100)
• Smoke gas opacity (NF X 10-702)

1. Determination of index I (0 – 4)
Index I is determined from the results of the glow-wire test and the oxygen index, using the following table. Here, I0 is the best classification and I4 the worst.

<table>
<thead>
<tr>
<th>Index</th>
<th>Oxygen index</th>
<th>Glow wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>I0</td>
<td>70 %</td>
<td>960 °C, no ignition</td>
</tr>
<tr>
<td>I1</td>
<td>45 %</td>
<td>960 °C, no ignition</td>
</tr>
<tr>
<td>I2</td>
<td>32 %</td>
<td>960 °C, no ignition</td>
</tr>
<tr>
<td>I3</td>
<td>28 %</td>
<td>850 °C, no ignition</td>
</tr>
<tr>
<td>I4</td>
<td>20 %</td>
<td>850 °C, flame extinguishes quickly</td>
</tr>
</tbody>
</table>

2. Determination of smoke index F (0 – 5)
The F index is based on the measurement of smoke gas opacity and smoke gas toxicity. The following concentrations in mg/m³ for the smoke gas toxicity are considered critical:

- Carbon monoxide (CO) ............ 1750
- Carbon dioxide (CO2) ............ 90,000
- Hydrochloric acid (HCl) .......... 150
- Hydrobromic acid (HBr) .......... 170
- Hydrocyanic acid (HCN) .......... 55
- Hydrofluoric acid (HF) .......... 17
- Sulfur dioxide (SO2) .......... 260

Using the test results, a smoke index is documented and can be assigned to classes F0 – F5 depending on the value. F0 corresponds to the best classification here and F5 the worst.

The modular terminal blocks from Phoenix Contact attain the classification I2/F2.

Surface inflammability ASTM E 162 (NFPA 130)

To evaluate the surface inflammability of plastics, a “flame spread index” is devised according to ASTM E 162 to provide information on flame propagation under given test conditions.

For this purpose, a sample (152 x 457 x max. 25.4 mm) is irradiated with a heat source (815 °C) at an angle of 30° and ignited with a naked flame at the top end. During the 15-minute duration of the test, the time in which the flame front reaches two measuring points that are 76 mm apart is determined. The product of this flame propagation time and a calculated heat development factor yields the “flame spread index”.

In the American railroad sector, the maximum limit value is 35. In this test, the drip behavior of the plastic is also observed and evaluated.

The modular terminal blocks from Phoenix Contact achieve a flame spread index of 5, drip without burning, and are therefore well below the maximum permitted values of the Federal Railroad Administration (FRA) of the US Department of Transportation.
**Smoke gas development ASTM E 662 (NFPA 130)**

The standard ASTM E 662 specifies a procedure for evaluating the specific optic density of the smoke during an open fire or a smoldering fire. For this purpose, the percentage of light transmitted in relation to the burning chamber volume is observed.

A sample (76 x 76 x max. 25 mm) is placed in a smoke density chamber (see figure) as defined by the NBS (National Bureau of Standards). The test object is irradiated with a heat of 2.5 W/cm² (see figure). The following processes are then simulated for 20 minutes:

1. Burning with a naked flame
2. Smoldering fire, avoidance of a naked flame.

There are special limit values for the optical smoke density of both processes that are recorded after 1.5 and 4 minutes.

- Specific optical smoke density (Ds1.5) – limit value 100
- Specific optical smoke density (Ds4) – limit value 200
- Maximum smoke density (Dm) during the 20 minutes

The polyamides used for Phoenix Contact modular terminal blocks fulfill all the requirements of the Federal Railroad Administration (FRA) of the US Department of Transportation in accordance with ASTM E 662.

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**Smoke gas toxicity SMP 800 C**

SMP 800 C describes the maximum permissible values of poisonous smoke gases when a plastic is burned.

In comparison with BSS 7239 (Boeing standard), this standard specifies more precise measuring methods for the qualitative and quantitative determination of toxic smoke gases that result when a test object is completely burned.

For this purpose, 6 liter of smoke gas is removed from the NBS chamber during the ASTM E 662 test between the 4th and 19th minute and fed to the analysis.

The polyamides used by Phoenix Contact are many times below the critical concentrations.

<table>
<thead>
<tr>
<th>01.5</th>
<th>4</th>
<th>20</th>
<th>t min</th>
</tr>
</thead>
</table>

SMP 800 C limit values of toxic smoke gases in ppm:

- Carbon monoxide (CO) ........ 3500
- Carbon dioxide (CO2) ......... 90,000
- Nitrogen oxides (NOx) ......... 100
- Sulfur dioxide (SO2) .......... 100
- Hydrochloric acid (HCl) ........ 500
- Hydrobromic acid (HBr) ...... 100
- Hydrofluoric acid (HF) ........ 100
- Hydrocyanic acid (HCN) .......... 100

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**Halogen-free flame protection**

Halogens are, among other things, the chemical elements fluorine, chlorine, bromine, and iodine. One property of halogen compounds, particularly those containing bromine, relates to the reduction in the degree of inflammability when used in plastics. In the event of fire, poisonous corrosive smoke gases are formed, which can also lead to secondary damages.

For this reason, Phoenix Contact does not use any flame protection systems which contain halogens or other additives. Polyamide, polycarbonate, polycarbonate/ acrylonitrile butadiene styrene (PC/ABS) and polyolefines feature halogen-free flame protection systems.

Modular terminal blocks from the CLIPLINE complete system are made of polyamide 6.6 (PA 6.6) with fire protection classification UL 94 V0. These polyamides are placed halogen-free based on state of the art with melamine cyanurate as flame protection agent.

Phoenix Contact modular terminal blocks are thus, without exception, entirely free of halogens.

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For additional information, visit www.phoenixcontact.com.
Worldwide service and support – we are there for you!

Specialists for the railway industry and a globally positioned sales network are available to advise you on site, competently and in person. On top of that, we guarantee quick availability of our products with our worldwide production facilities. Our range of services enables us to assemble and label terminal strips and cabling solutions according to your specifications so that you can significantly reduce your on-site installation effort.
Assembling terminal strips
We equip and wire terminal strips in accordance with your specifications, and these are consistently labeled and delivered to you. Pre-assembled terminal strips enable you to install them directly in your control cabinet, thereby reducing your installation time to a minimum.

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