

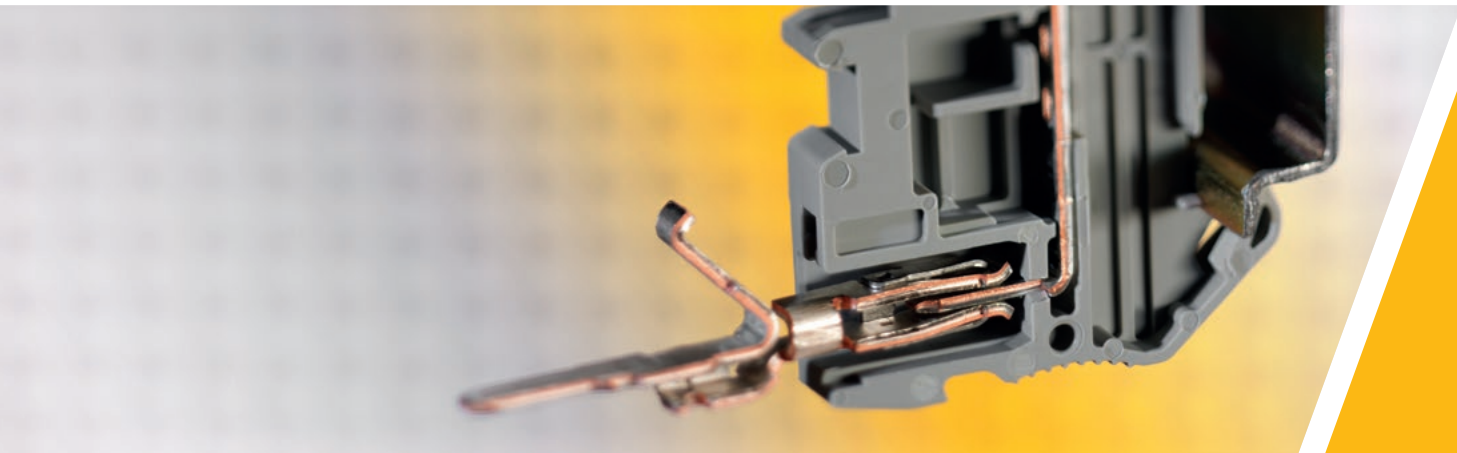
your global specialist

Special knowledge

Keeping contact.

Speciality lubricants for electrical contacts





Klüber speciality lubricants – always a good choice

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Quality put to the test

- Klüber Lubrication has more than 110 test rigs, which include standardised equipment as well as tools Klüber Lubrication has developed to regularly test the quality of its products.
- Test results prove the high quality level and provide you with a solid basis for selecting the right lubricant.
- You can obtain products made by Klüber Lubrication in consistent quality at our production plants worldwide.

Benefit from experience

- Close cooperation with OEMs and operators since 1929
- Series supplier to many OEMs on all continents
- OEMs in all industries recommend Klüber lubricants for their components
- Alliances with partner companies for maximum user benefit
- The product range comprises oils, greases, pastes, waxes and bonded coatings, so the right lubricant for any application can be selected.

Time is money – we help to save you both by enabling

- Optimised processes
- Higher productivity
- Compliance with legal requirements and quality standards
- Reduction of maintenance times and repair costs
- Development partnerships giving you a head-start in innovation and differentiating yourself from the competition

Humans and the environment – what really counts

- Products that last a lifetime and enable minimum-quantity lubrication to be used help to save resources and reduce disposal quantities.
- Speciality lubricants optimised for higher efficiency reduce energy consumption and hence CO₂ emission.
- Clean, safe products that are easy to handle are the fundamental criteria used in the lubricant development by the Klüber experts.
- Comprehensive consulting and technical support
- Development of plant lubrication charts
- Automatic lube point monitoring
- Analysis of your used lubricants and components
- We are where you are - consulting at your facility
- Tailor-made training for your staff

Why lubricate electrical switches and contacts?

Lubricants are basically insulators – nevertheless they have a positive effect on the performance of electrical contacts.

Lubricants often have to be used on electrical contacts if the contact resistance and the actuating forces are to remain constantly low for as long as possible under taxing operating requirements, e.g.

- if a high number of plug or contact cycles is required (e.g. Smart Card connectors and plug-in connectors in automation technology) – in these cases the focus is on wear reduction.
- if low plug and unplug forces are required (back planes in telecommunications, multi-pin plug-in connectors for data lines) – in these cases the focus is on friction reduction.
- where long service life and contact reliability are required also when operating under vibration and frequent temperature cycles (automobiles, automation technology) – in these cases the focus is on the reduction of fretting corrosion.
- if contact erosion due to switching arcs is to be reduced.

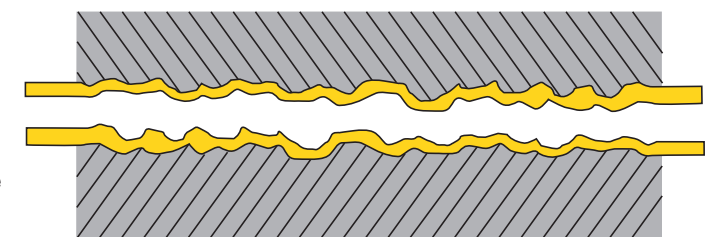
Without a lubricant, electrical contacts are unlikely to meet the ever increasing requirements of today's applications. Even electroplating or chemical coating of the contacts does not always have the desired or required effect – besides, this treatment can become prohibitively expensive if layers of a certain thickness are required.

The reason why even fairly thick layers of corrosion-resistant metals do not always bring about the desired results lies in the fact that material pairings like Au-Au, Ag-Ag or Zn-Zn are tribologically detrimental. Opposing bodies made of the same material tend to suffer from pronounced adhesive wear. Furthermore, ambient and operating conditions are often such that the contact surfaces get coated by layers of foreign matter or change chemically.

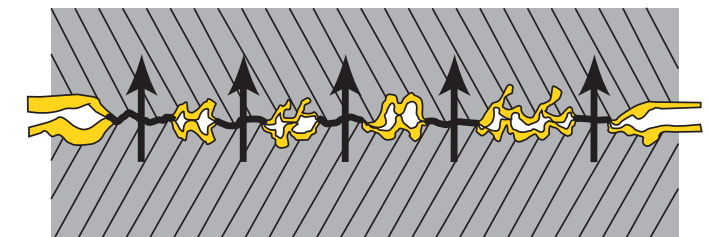
What causes the transition resistance in electrical contacts?

Even contact surfaces that appear very smooth to the naked eye show a certain degree of roughness when seen under a microscope. Consequently, the electrically effective surface is a mere 1 % to 0.01 % of the apparent contact surface, depending on the contact force applied. It is this very small actual contact surface that is responsible for the so-called constriction resistance (see Fig. a, b).

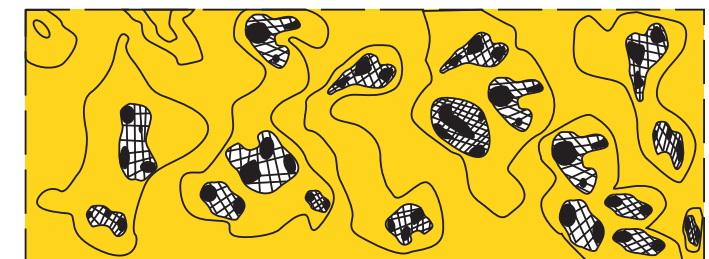
The resistance is increased by the foreign layers that are frequently found on the contact surfaces (e.g. metal oxide layers or plastic deposits). It takes a sufficiently high contact force or heat generation due to the power loss to penetrate these layers. If the heat is too extreme, micro-welding occurs, leading to the so-called “spot sticks”. The remaining electrically effective contact surface is termed “a-spots” (see Fig. c).



a) Open contact



b) Closed contact



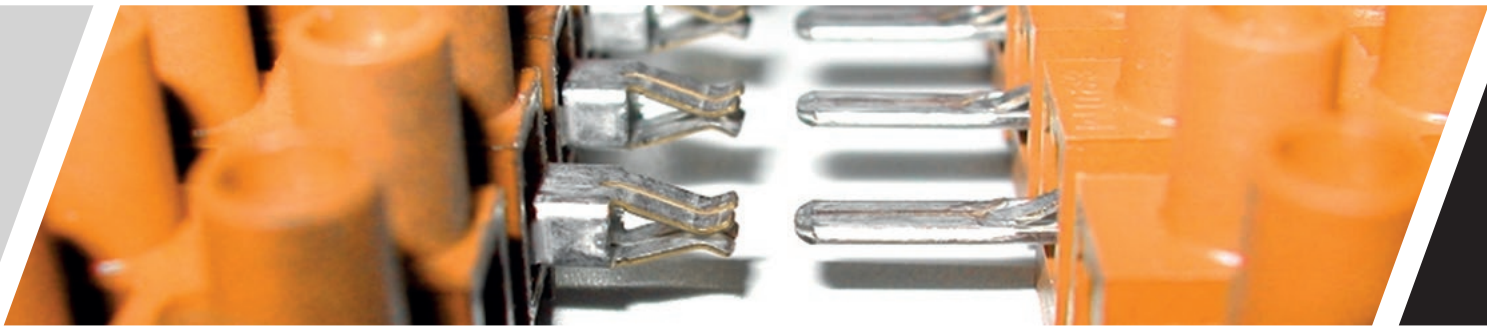
c) Closed contact (top view)

With frequent repetition of these processes – which may be caused by plug and unplug cycles, vibration or temperature cycles – the contact surface changes, rendering penetration of the foreign layer ever more difficult. The electrical contact will soon no longer have a constantly low transition resistance; the contact becomes unstable.

Conclusion:

Lubricants made by Klüber Lubrication enable metallic contacts to last longer. The lubricant is an insulator..

How do lubricants work on the electrical contact?



Lubricants are basically insulators. For this reason, it may appear hard to comprehend how these products would help to influence positively the operation of electrical contacts. The way a lubricant works, and the requirements it is expected to meet in electrical contacts, can be described as follows:

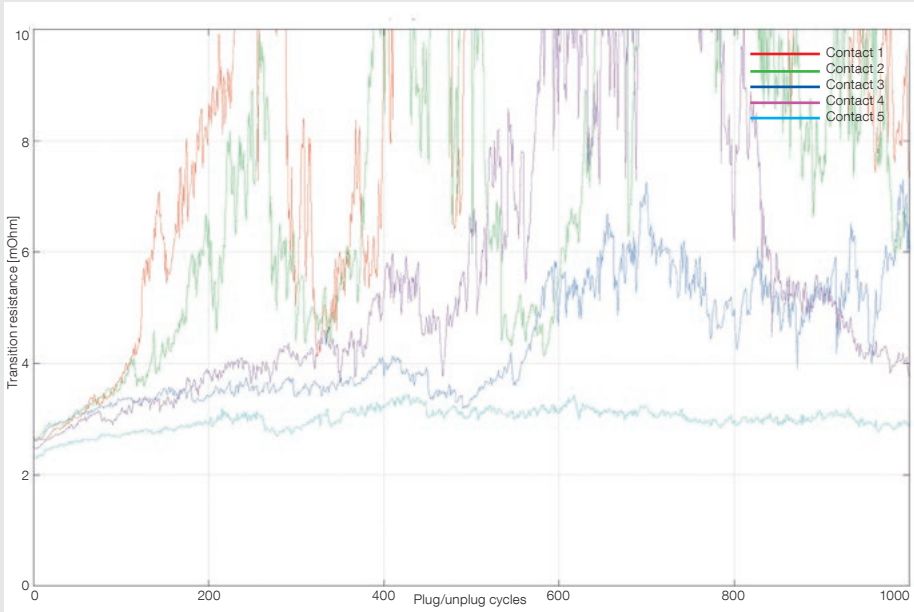
- The lubricant covers the open contact (during storage), thus preventing the formation of a detrimental layer of foreign matter (e.g. oxide) on its surface.
- When the electrical contact is closed, the lubricant forms a separating film due to the relative motion of the two contacts, despite the contact force pressing the contacts together. This lubricant film reduces the friction coefficient and wear (abrasion) notably.
- Due to the contact force, the lubricant is displaced from between the roughness peaks while the contact is stationary, so there is direct metal-to-metal contact between the surfaces. The result is a low electrical contact resistance.

- Considerably less metal oxide will form, firstly because there is less metal abrasion, and, secondly, because the actual effective metal surface and the abrasion particles are protected against the surrounding media, e.g. air or chemical vapours, by the lubricant. A lubricant with a good backflow behaviour and wetting capacity forms an inert atmosphere around the a-spots.
- Electric arcing during the switching operation is impeded by the dielectric strength of the lubricant, which is higher than that of air. In lubricated contacts, electric arcing occurs only when the distance between the contacts is already very short. When opening the contact, the electric arcs will cease much sooner. Shorter electric arcing times mean a general reduction of contact erosion and hence longer contact life.

This is just a concise summary to explain how an electrically insulating lubricant works if it has the right consistency for the application at hand and offers thermal stability, chemical resistance and optimum adhesion to the contact surface and consequently keeps transition resistance low.

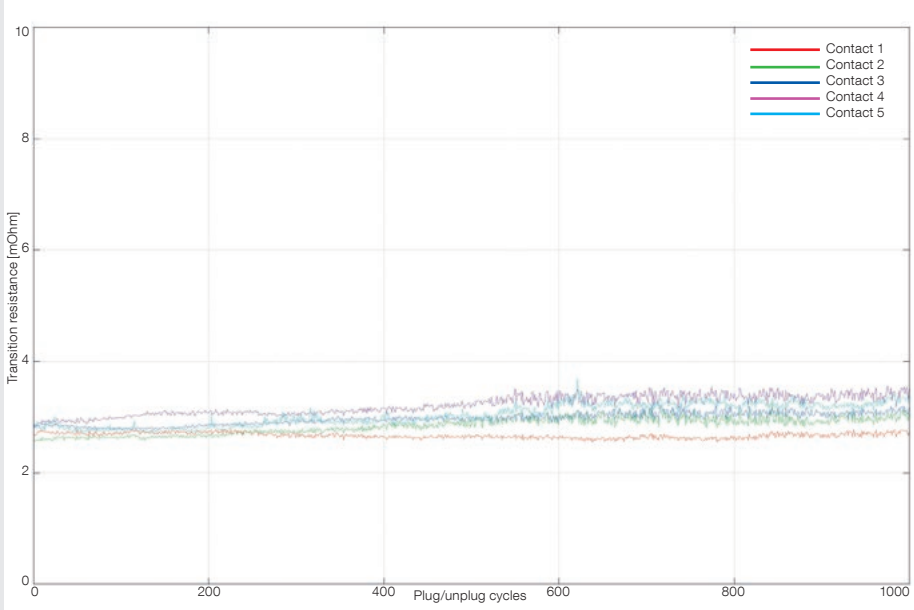
Plug-in contact resistance without lubricant

The diagram on the right shows the development of the transition resistance of 5 non-lubricated contacts across 1000 plug/unplug cycles. The contact is already electrically unstable after approx. 100 plug/unplug cycles.



Plug-in contact resistance attained with Klüberalfa KR-3-730

This diagram shows the effect of Klüberalfa KRA 3-730 on the 5 contacts. With our lubricant, the contacts show little increase of transition resistance across 1000 plug/unplug cycles.



What to observe when selecting lubricants for electrical contacts

Compatibility with surrounding materials like plastics or elastomers

The lubricant used should be compatible with the contact materials and any surrounding materials.

Electrical contacts are normally held by plastic parts. Occasionally, rubber-elastic materials – also referred to as elastomers – can also be found in the vicinity of the contacts.

Primary selection criteria

The selection criteria for a lubricant depend on the parameters that are most important to be optimised. These may be:

- Reduction of plug and unplug forces.
- Resistance to fretting corrosion.
- Increasing the number of plug and unplug cycles without a higher transition resistance.
- Media resistance.
- Intended method of application.

For lubricant selection, it is also of major importance to consider what kind of metal surfaces are moved against one another with what contact force. The adhesion of the lubricant depends on its chemical composition and consistency, but also on the contact material, the surface roughness and the orientation of the roughness. As lubricants applied to live electrical contacts must withstand very high temperatures over a very long period of time, the base oils should show a very low tendency to evaporate and a high resistance to oxidation. If temperatures become excessively high for a short time, the lubricant should evaporate or burn away without residues such that no foreign matter (coking) remains, which would interfere with the function of the contact later. When faced with requirements of this kind, perfluorinated polyethers (PFPE) perform much better than hydrocarbon-based lubricants.

How is the lubricant applied to the contact?

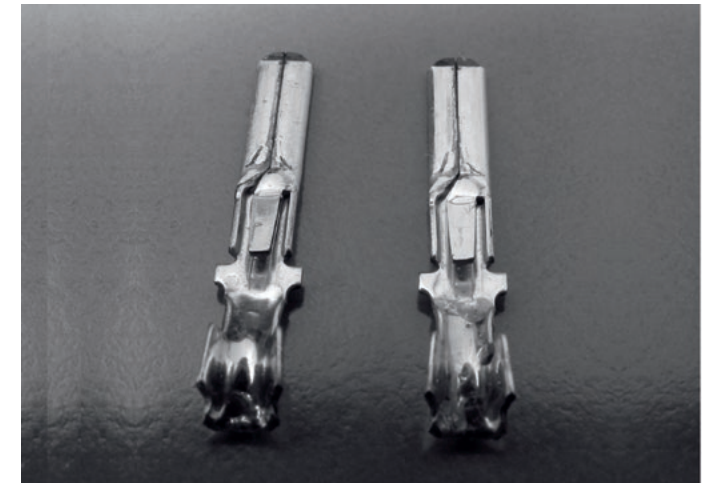
Depending on the manufacturing process used, the contacts leave the electroplating section in varying forms. Punched contacts are normally still connected with the copper band by a thin web. In most cases, the most economical application method is to spray the dissolved or dispersed lubricant onto the contact surfaces with a suitable concentration. Upon evaporation of the solvent, a very thin lubricant film will then form on the contact. Such thin lubricant layers are tribologically highly effective, while at the same time enabling direct metal-to-metal contact between the roughness peaks, which is important for the function of the contact.

Another option can be the use of highly advanced micro-metering systems to apply the undiluted lubricant directly onto the contact at a set production rate.

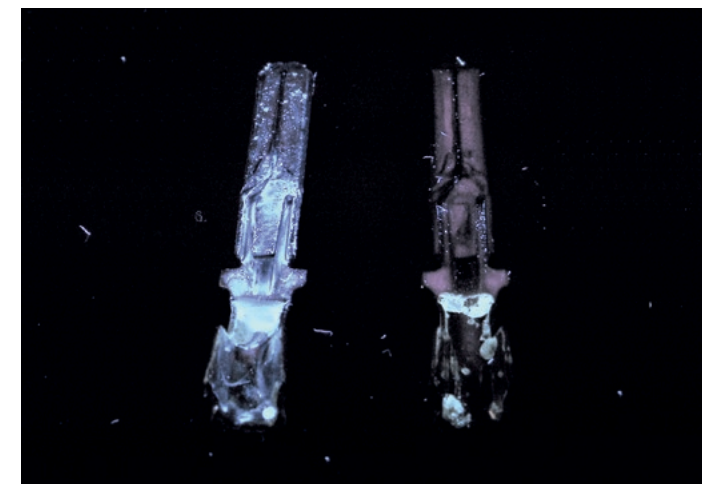
On larger or turned contacts, which are supplied as individual parts, the lubricant may be applied e.g. by means of pad printing. This technique allows any desired layer thickness, e.g. between 2 and 5 µm to be attained.

On high-voltage contacts, where fibrous grease lubricants are desirable to impede electric arcing, thicker layers should be applied. This can also be done by means of a brush or metering equipment (e.g. spraying).

To better control the application process, it may make sense to use contact lubricants with integrated UV colour indicators. With the aid of a suitable optical system, 100 % online application monitoring is possible.

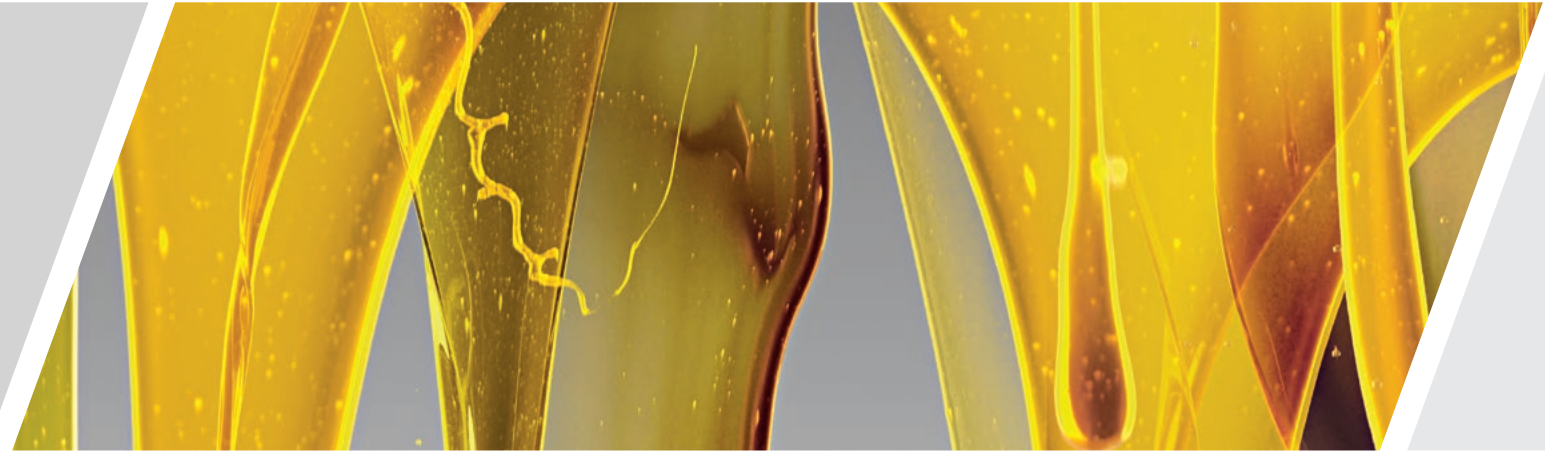


Contacts in daylight



Contacts under UV light

How can you find out how effective the lubricant is on the electrical contact?



Predicting exactly how effective a lubricant will be in a particular application is anything but easy - after all, there are innumerable possible combinations of materials, contact forces, contact geometries, ambient conditions etc. For the prospective series user it is therefore vital that component tests be performed under conditions that come as close to real life as possible.

For optimised customer consulting and support, Klüber Lubrication has designed a contact test rig with variable test modes. This enables Klüber to focus its lubricant development on the individual customer requirement far better than before.

The main tests performed at ambient temperature are:

Plug-in contacts

- Determination of plug and unplug forces over a given number of plug/unplug cycles. The change in contact resistance is also documented during this test.
- Determination of the maximum number of plug/unplug cycles before the transition resistance in the connection exceeds a certain limit. For this purpose, one half of the connector (in most cases the socket) is fixed in its position and connected up to a load cell. The terminals of the connectors are then connected to the resistance meter. A PC and software are used to measure and document the plug and unplug forces as well as the transition resistance in the closed contact.

- Friction corrosion tests with 10–90 µm friction distance for plug-in connector systems from 2 to 100 Hz. The transition resistance is also documented during this test. For this test, the contacts are firmly held to be able to determine the actual relative motion in the contact zone. The defined oscillation is generated by a piezo-drive.

Switches

- Determination of actuating forces over a given number of switching cycles.
- Determination of maximum number of switching cycles before the transition resistance in the switch exceeds a certain limit.

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