

Effective locking of electrical screw connections

According to the motto: "A reliable locking element for electrical screw connections", teckentrup has developed a new washer – the NSK-E. In the world of electrical engineering, loose screw connections lead to system failures and a high risk of damage occurring. According to a survey by a Canadian energy supplier, almost 40% of all power failures can be traced back to loose contact parts. Today, locking elements from mechanical screw connections are very often used, which are only partially – or not at all – suitable for the specific requirements of electrical screw connections.



The reason we developed this new locking element for electrical screw connections was a production facility that came to a standstill because of an electrical screw connection that had worked loose. This led initially to increased contact resistance and then to a loss of voltage. The teckentrup company was not able to find a suitable screw locking element that would solve this problem over the long term, and therefore developed the NSK-E – a lock washer that meets the specific requirements of electrical connections and the related standards.

In practice, loose screw connections lead to the following types of damage:

- Increased contact resistance
- Voltage drops/fluctuations (flickering)
- Heating of contact points until the contact point itself or surrounding equipment combusts.

Contact connections that work loose cause significant damage, which calls for a new approach.

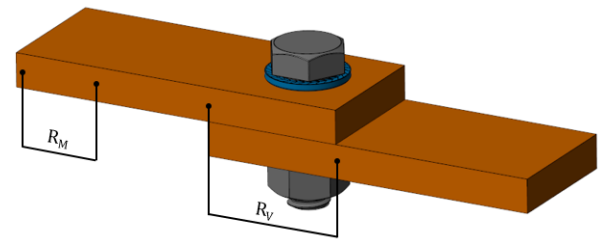
THE DIFFERENCES BETWEEN ELECTRICAL AND MECHANICAL SCREW CONNECTIONS

Relevant characteristics	Mechanical	Electrical
Materials screwed	Steel and high-strength aluminium alloys (hard counter-support)	Copper/aluminium, as well as tin, silver and nickel coatings (soft counter-supports lead to increased settling phenomena and risk of splintering)
Main task/installation situation	Force transmission, usually with longer clamping lengths	Power transmission, very short clamping lengths

Load type	Axial force, dynamic cross loads	Vibration, thermal expansion
Material combination	The counter-supports and connection elements are usually made of the same material	Copper/aluminium counter-supports and steel connection elements lead to clamping elements and joining elements exhibiting different thermal expansion

CHARACTERISTICS AND REQUIREMENTS OF A SCREW CONNECTION IN ELECTRICAL APPLICATIONS

The main task of an electrical connection is to transmit power. Quality factor k_u is decisive for assessing the joint quality/screw connection quality. This represents the ratio between the resistance in the joint and the resistance in the busbar.



$$\text{figure of merit } k_u = \frac{\text{connection resistance } R_V}{\text{material resistance } R_M}$$

The aim of a joint is therefore to ensure that the quality factor is kept as constant as possible over the course of its life. It is necessary to maintain soft conductor materials' required contact pressure over the life of the joint, in order to keep the quality factor, and therefore the resistance, constant. To achieve stable contact pressure, a screw connection must fulfil two functions:

1. Elasticity function

The elasticity function is necessary because:

- a.) Different thermal expansion coefficients and heavily fluctuating operating temperatures lead to varying mechanical tension in the screw connection
- b.) Settling processes must be compensated for. Settling is where the surfaces of connection elements level off. The number of joints and the soft conductor material compound matters in this respect.

Due to the short clamping lengths, the elasticity required of the screw connection can only be achieved by flexible locking elements.

2. Screw locking element functions

When screws work loose as a result of vibration and lateral displacement, this can also lead to a reduction in the electrical screw connections' contact pressure, and therefore the types of damage already described.

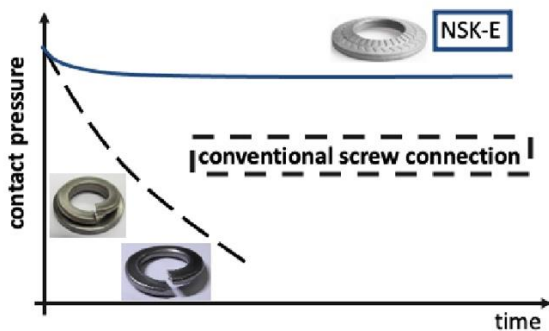
Screw connection failure can have the following causes:

- Thermal expansion with different expansion coefficients, due to the use of different materials (steel, copper or aluminium)
- Settling within the joint
- Vibration, for example at high frequencies or as a result of motion transmission from the overall system.

Unsuitable spring and screw locking elements

The 1990s saw examinations of the spring and screw locking effects of the elements in use at that time.

As a result, the standards governing spring rings, serrated washers and toothed washers were withdrawn, meaning they therefore no longer represent the state of the art. The use of two screw locking elements, for example a spring ring and washer, similarly also does not meet the requirements.



A SOLUTION RESULTING FROM KNOWHOW AND INNOVATION

The company teckentrup GmbH + Co. KG set itself this challenge, and developed the NSK-E detent-edged washer especially for the electrical industry.

Thanks to the company's many years' experience in mechanical screw locking elements, teckentrup was able to react to the specific requirements and, as a result of appropriate



testing methods, develop an optimum solution. In partnership with end users and external test labs, the NSK-E was also successfully tested under extreme conditions.

The test procedures it was subjected to include, among others, DIN 25201-4 (Annex B), DIN 267-26 and IEC 61373.

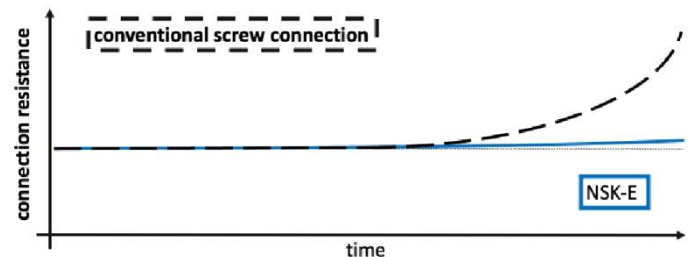
The NSK-E demonstrated outstanding performance in all quality inspections, meaning that the washer can be used as a locking element in accordance with most common standards:

- DIN 25201-3: Electrical bolted joints
- DIN 46200: Current-carrying connection bolts
- DIN 43673-1: Screw connections for busbars
- DIN EN 50343: Installation of cabling
- ...

The NSK washers are available in two variants: coated spring steel and stainless steel 1.4401. The washers are currently available in sizes M3–M16, and can be used in combination with conventional screws.

CUSTOM-MADE PRODUCT

Thanks to its **arched shape**, the NSK-E has an especially pronounced spring effect, meaning the contact pressure, and therefore the joint's connection resistance, can be kept virtually constant over a long period of time.



The enhanced **teeth** on the top side ensure a positive-locking fit with the bolt head/nut. This ensures the components cannot work loose when subjected to cross loads. And to prevent the soft connecting elements becoming damaged, the NSK-E's underside features a **runner-like contour**. When fitted in a tightened screw joint, the washer lies on the counter-support, so that despite its short installation size, the risk of exceeding the surface pressure is reduced.

In the NSK-E, the user has at his or her disposal a **one-part** screw locking element, made from spring steel or stainless steel, which has been especially developed to meet the requirements of electrical screw connections, and which represents the state of the technological art.

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