

# Technical Tidbits

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It's not how old the contact is; it's how old the contact feels !! This discussion will explain how design forces can affect end-of-life contact force.

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- Permanent Set
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The next issue of *Technical Tidbits* will include an informative discussion about the importance of contact force.

## Reliability and End-of-Life Contact Force

An electrical connector is designed to pass an electric signal from one component to another. These components may either be in the same device or different devices. In any case, for the signal to pass through with minimal alteration, the contacts within the connector must maintain good contact force and resist corrosion over the life of the contact. Connectors must be designed to meet all performance requirements at the end of the useful life of the component. Since performance will degrade over time, this means that the designer must carefully consider how long the component is expected to last, and how many cycles the contact is expected to see.

Every electrical contact is designed to provide a certain amount of normal force at the contact interface. This **design force** is usually calculated under the assumption that all part dimensions fall exactly at the midpoint of the allowed **dimensional tolerances**. In reality, the actual force experienced by the contact will typically be different from the design force, because of actual product variation within the specified dimensional tolerances. With luck, these variations may serve to provide a contact force greater than the designed value. However, it is equally likely that the actual contact force may be lower than what the designer anticipated.

To further complicate matters, the normal force generated by the contact will change over time, due to several factors. The **end-of-life contact force** will almost certainly be lower than the force generated by the first contact cycle. Therefore, the design force must be increased to ensure that the end-of-life force is adequate to maintain good electrical contact. Figure 1 shows how the end of life force may decrease below the required force, even though the design force is well above the requirement.

**Permanent set** is one method by which the contact force decreases over time. If a contact has yielded during the initial deflection, it will not return to its original shape when the load is removed. This means that any subsequent deflection of the contact will be smaller, and the corresponding contact force will be reduced as well.

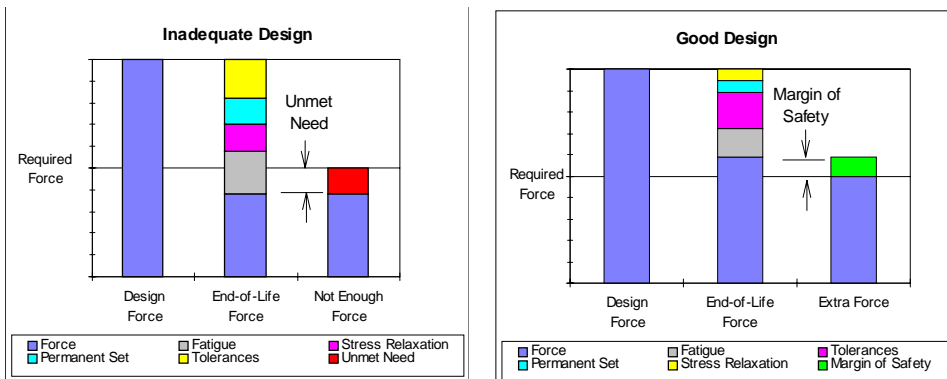
**Stress relaxation** is another phenomenon that results in loss of contact force. When a contact is under deflection, a certain amount of stress will be generated in the metal. Under a steady deflection, this stress will relax (decrease) over time. Since the stress is what generates the contact force, the force will decrease as well. Additionally, the reduction in stress will also mean that the contact will not return to its original configuration when disconnected. Therefore, stress relaxation can also be thought of as a delayed permanent set.

Stress relaxation is dependent upon time, temperature, the initial stress level, and material. The longer a contact is deflected, the more the stress will relax. In addition, the relaxation rate increases with temperature. The rate is also dependent on the initial stress level- as the stress approaches the yield strength, the rate increases. Also, some materials will relax much more easily than others.

**Fatigue** also affects the end-of-life contact force, but in an indirect manner. The number of deflection cycles a contact can be expected to experience without breaking depends on the initial stress level. As the stress increases, the expected number of cycles decreases. Therefore, as the contact needs to see more and more deflection cycles, the stress level must be reduced to allow this to happen. However, if the stress level is reduced, the contact force is reduced as well.

It is possible to improve the end-of life performance through careful material selection. Materials with higher yield strengths will allow for greater contact forces to be generated, since they allow for greater stress. Materials with greater stress relaxation resistance will be able to retain a greater amount of the design force over time. Materials with greater fatigue strength can generate greater force over the same number of cycles, or can last longer at the same amount of force. Figure 2 shows the same contact as in figure 1, this time using a material that retains enough of the design force to be viable at the end of life.

In order to maintain adequate end-of-life contact force, the contact must be designed to give an initial force greater than the minimum required for electrical signal integrity. The length of service time, number of cycles, and the temperature extremes experienced must all be carefully considered when choosing a material. In this age of decreasing part size, there is less room to increase the contact dimensions in an effort to increase the force. Indeed, miniaturization often results in lower forces and higher stresses. Therefore, the best material for the job will be the one that most effectively retains greatest percentage of the initial contact force over the life of the contact.



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REFERENCE: The Influence of the Bauschinger Effect in the Performance of Connector Materials - John Ratka

Please contact your sales representative, for further information about reliability and end-of-life contact force or other questions pertaining to Brush Wellman or our products.

## Technical Tidbits

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