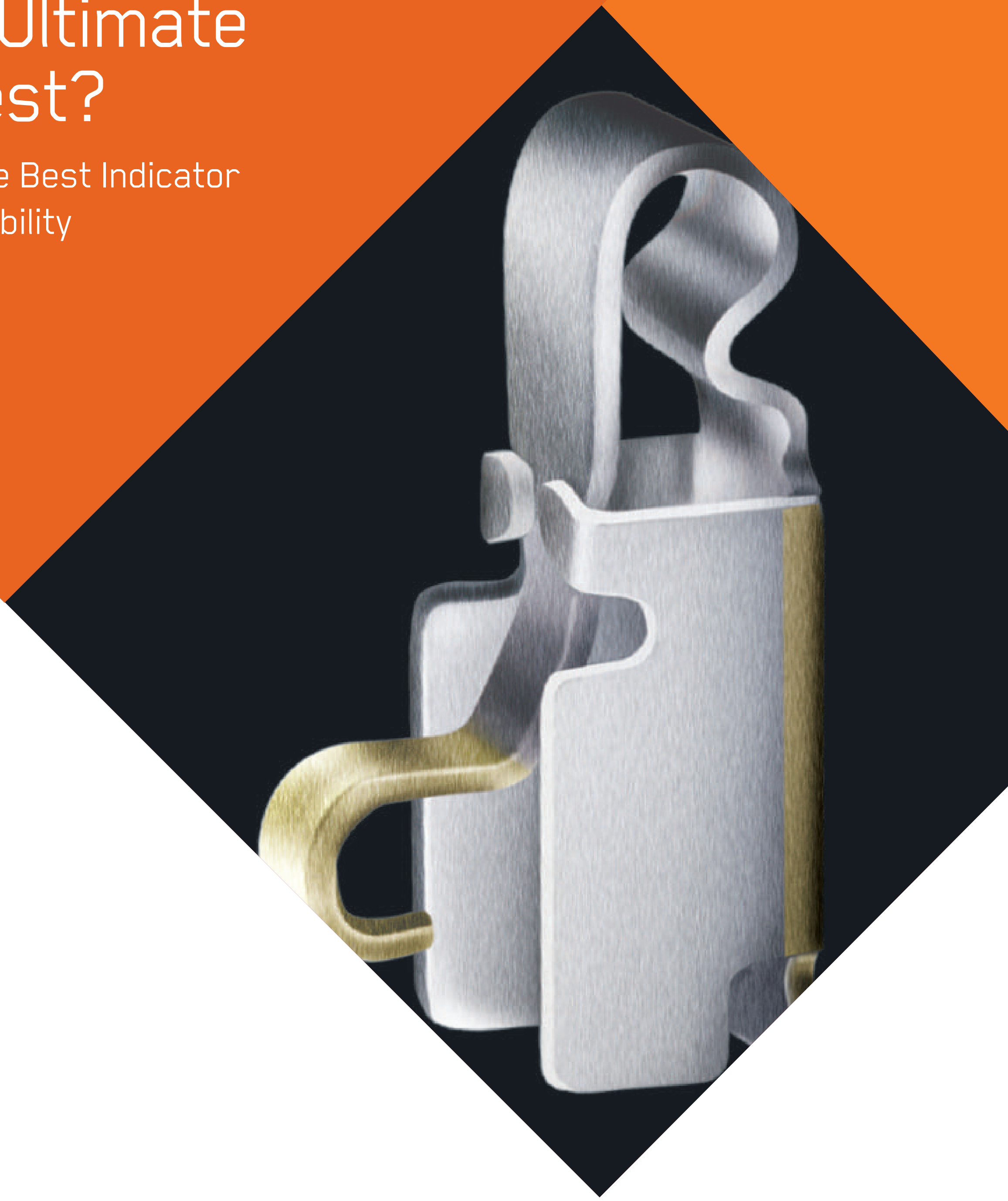
cannon

Can Your Connectors Pass the Ultimate Stress Test?

Hertz Stress is the Best Indicator of Connector Reliability



ITT

ENGINEERED FOR LIFE

ABSTRACT

Connectors are the "nerve system" in countless applications, from medical handheld monitors and military radios to smartphones and tablets. Users depend on these devices to save, improve and enjoy their lives, but too often they encounter connector reliability issues that compromise product performance. The dissatisfaction and negative reactions that come from poor performance harm the reputation of the application makers who sold the end product.

Fortunately, there is a proven and near foolproof way to predict connector reliability: Hertz stress. Electronic system designers can look to this single indicator – which considers the primary factors that generate current flow and resistance – to ensure the connectors they choose won't fail them or their end-users.

INTRODUCTION

Connector reliability can't be left to chance, and there's no reason it ever should. Fifteen years ago, an IBM analysis proved that one single indicator – high Hertz stress – virtually guarantees good connector performance.

Amazingly, that's still news to many electronic systems designers and product manufacturers who depend on connectors to make their devices work. Connectors are seen as interchangeable components; one is as good as the next. That false belief leads to failures and costly and disruptive corrective actions, all of which can be avoided simply by using connectors designed to produce high Hertz stress.

PROBLEM:
Connector Failure Isn't Detected Until Field Use

While the connector industry continues to introduce many innovations and important advances, customers are still encountering far too many issues with connector failure. In many cases, these issues only become apparent once the finished products are being used out in the field. In any application – from medical devices to military radios – if end users are discovering issues and errors, it can lead to serious consequences for the makers and providers of the faulty electronic systems that include these connectors.

The companies that buy connectors for their equipment don't want to use their customers as product testers, but feel they have no choice because they aren't aware of any proactive, predictive test that can assure a connector will operate reliably in all conditions.

In short, they aren't aware that the use of Hertz stress as specification parameter for connectors can prevent most failures and avoid wasting many dollars on corrective actions.

THE SOLUTION:

Use Hertz Stress As A Predictive Performance Indicator

There is a near foolproof way of predicting connector reliability: Hertz stress.

Hertz stress, also known as Hertz force, is the calculation of the amount of stress created when two curved surfaces come in contact and deform slightly under the imposed loads. In this case, more stress is good because it means there is more material contact, which is the essence of strong and reliable contact and connector performance.

This was proven definitively several decades ago by IBM engineers who analyzed different contact designs to determine if there was a common denominator that could predict a connector's failure or success. The analysis revealed that "unsuccessful connector contact designs always exhibit low Hertz stress, whereas successful ones exhibit designs with Hertz an order of magnitude higher."

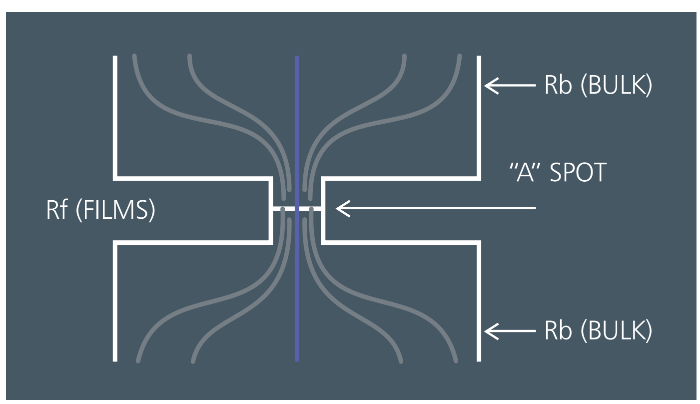
This finding has been validated through the years and has become an increasingly important indicator as the design of connectors continues to evolve to include smaller, lighter connectors, lower profile contacts and ones that can withstand harsh environments, such as vibration and shock conditions.

The Hertz stress indicator is the best way for electronic system designers to ensure they are including good-performing connectors in their products.

THE PHYSICS BEHIND HERTZIAN STRESS

In order to understand why high Hertz stress almost guarantees good performance, it's important to understand the physics of how connector systems work.

All metallic electrical connections are achieved when deformable metallic bodies are brought together, creating microscopic metal-to-metal contact touchpoints or asperities – called "A-spots" – through which the current will flow. The number and location of these A-spots is determined by surface finish, contact geometry, hardness of the metallurgy and the force used to press the two pieces together.



CONTACT RESISTANCE DIAGRAM

Once these metallic bridges are formed, the goal is to reduce and/or stabilize the factors that will lessen the flow of current through the A-spots. Total contact resistance is created by the sum of three types of resistance.

$$R_t = R_b + R_c + R_f$$

Rt = total contact resistance
Rb = bulk resistance (caused by the metallurgies of the contact members)
Rc = constriction resistance (caused by size, quantity and distribution of the A-spots)
Rf = film resistance (caused by formed by oxides, water vapor and other film barriers)

Film is the most significant resistance variable. All metals have films – ranging from "thin" or "normal" films found in base metals such as copper, aluminum, iron and nickel up to "thick" films in aging metals.

The thicker the film, the higher the current resistance and the lower and more unstable the Hertz stress levels. The solution isn't simply to increase the force that brings the two metal parts together because that will lead to material fatigue and connector failure. Instead, the answer lies in the design of the contact.

To achieve the optimum, stable Hertz stress levels and good connector performance, the ideal connector is designed not with flat surfaces, but with domed surfaces. The diagram below shows the typical difference between two contact designs. When "normal force" – the force that pushes these two metallic parts towards one another – is applied to both of these connectors, the Hertz stress is higher in the connector on the right.

This diagram shows that the accepted practice of depending on normal force as the predictor of contact performance is flawed. The domed connector on the right will deliver greater reliability because the normal forces are being channeled through a smaller area. This means that there is more force per unit area available to penetrate the one obstacle standing in the way of stable contact resistance: contact films.

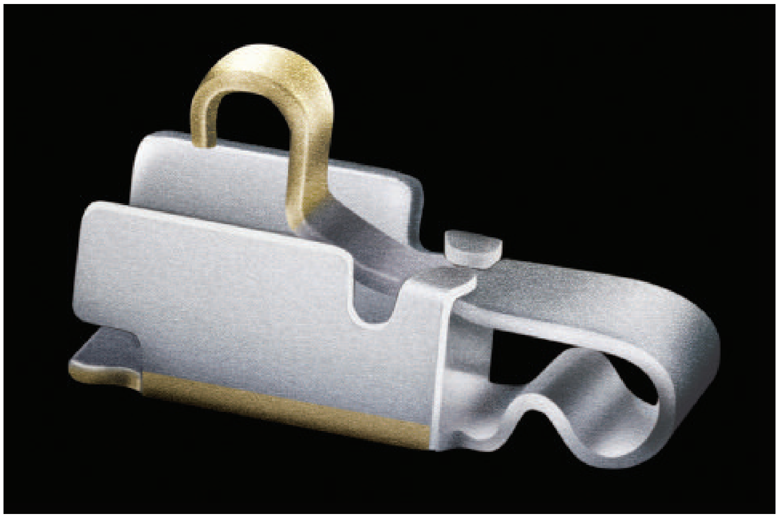
However, if the film is too thick – like those on aging metals – no amount of force on two static metal parts will allow A-spots to form and current to flow. In these cases, the solution is contact "wipe" that brings motion into the equation. Wipe is defined as the action of a moveable contact against a stationary one to push aside films and debris to the point where stable contact resistance is realized.

This isn't easy to achieve. If there's not enough movement or force, the film won't be penetrated. However, if the movement of the contact plowing through the film is too great, it creates some additional debris, which increases contact resistance. As the IBM study stated "Those geometries that create the greatest contact stress are also those that provide the smallest collision area. When the force-per-unit area is high enough to shear the film and move the debris, the contact will not ride up onto the film and stable contact resistance is maintained. Once again, Hertz stress is key, both in the formation of asperities at the end of travel and in a contact's capability to stay in contact while sliding."

THE ITT ADVANTAGE

The IBM study that proved Hertzian stress is the key indicator of connector reliability was conducted in conjunction with connector engineers from ITT. Based on those findings, ITT engineers redesigned many connector lines to achieve high levels of Hertz stress, and today the ITT product portfolio includes a number of ITT Cannon brand connectors proven to deliver high Hertz stress for a wide range of applications.

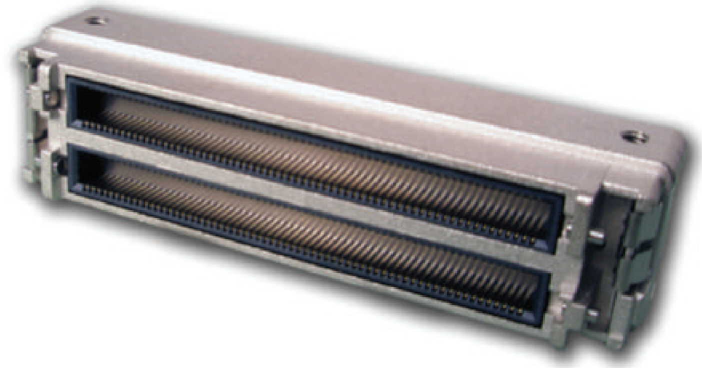
Front and center is the ITT Cannon Universal Contact, which features a domed mating area that follows the ideal design specifications for achieving high Hertz stress.



THE DOMED MATING AREA OF THE ITT UNIVERSAL CONTACT GENERATES HIGH HERTZ STRESS.

The domed design produces many other benefits, including .3N of force with only .1 mm of deflection and X-Y-Z movement that allows a robust connection between the contact and the component. Customers in many different markets – medical handheld devices, smart phones, smoke detectors, security alarm systems, military radios, memory sticks, GPS devices and dozens more – can count on the ITT Cannon Universal Contact to meet their functional needs with the confidence that the connector's high Hertz stress guarantees reliable performance.

ITT has other connectors designed to deliver high Hertz stress, including the ITT Cannon quad lock connect (QLC) line of connectors that suit a variety of medical, industrial and instrumentation application needs, including those of portable ultrasound machines, patient monitoring systems, end-scope and test equipment, and even semiconductor manufacturing equipment.



THE SUPERIOR CAM SYSTEM OF THE ITT CANNON QLC ZIF CONNECTOR LEADS TO HIGH HERTZ STRESS LEVELS.

Similar to the DL Series connectors, the QLC connector is highly reliable and features a high pin count—up to 260 contacts in PC board-mount style. With technology advances for small portable imaging equipment, ITT reduced the spacing from the standard DL to 0.8mm, thus reducing the overall size by more than 60 percent with the same number of contacts. The high pin count allows the engineer to utilize various grounding schemes to maintain signal integrity.

The interface of the QLC connector utilizes EMI springs and a shield-locking mechanism to ensure uniform mating pressure around the perimeter of the mated connector, creating an EMI/RFI shield. High Hertz stress is achieved through the superior cam system, which brings the contact system into its mated position.

Using Hertz stress as an essential design parameter, ITT product developers and engineers are ensuring that connector reliability is on equal footing with connector functionality. ITT connectors are designed to perform their jobs in the best way possible for customers, including the assurance that there will be no field failures.

CONCLUSION

By all measures, Hertz stress is the best predictor of connector performance. Companies that use, develop or sell devices that rely on connectors, should judge these components based on their ability to deliver optimal, consistent Hertz stress.

ABOUT ITT'S CANNON BRAND

ITT Cannon is a world leader in interconnect solutions that designs and manufactures a broad range of highly engineered connectors for customers in the aerospace and defense, medical, energy, transportation and industrial end markets. Our customers depend on us to solve their most critical problems, and we focus on partnering with them to find solutions to their unique challenges. ITT Cannon is part of the family of brands that make up Interconnect Solutions, a business division of ITT. For more information, visit **www.ittcannon.com**.

ABOUT ITT

ITT is a focused multi-industrial company that designs and manufactures highly engineered critical components and customized technology solutions. Our customers in the energy, transportation and industrial markets depend on us to solve their most critical problems, and we focus on partnering with them to find solutions to their unique challenges. Founded in 1920, ITT is headquartered in White Plains, New York, with employees in more than 35 countries. The company has sales in approximately 125 countries and generated 2013 revenues of $2.5 billion. For more information, visit **www.itt.com**.

Connect with your ITT Cannon representative today or visit us at **www.ittcannon.com**.

© 2014 ITT Corporation, Inc.

The ITT Interconnect Solutions family of brands

cannon veam biw connector systems

Connect with your ITT Cannon representative today or visit us at **www.ittcannon.com**.

© 2014 ITT Corporation, Inc.