

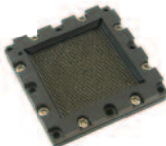
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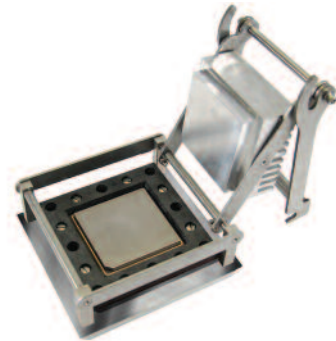
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THE DEATH OF TRADITIONAL BURN-IN SOCKETS IS NEAR

David Pfaff
Plastronics Socket Co.
Irving, Texas.
plastronicsusa.com



Semiconductors are a complex technology. Gate sizes continually shrink and transistor counts continually rise. Every company's business plan calls for products with better performance, whether for multi-die packages or more feature sets on a single piece of silicon.

This rapid evolution in semiconductor technology creates challenges throughout the supply chain, creating a need for better equipment

and consumables, while keeping any cost impact to a minimum.

One key component in the supply chain is the burn-in socket, a connector that is typically used at high temperatures and elevated voltage to accelerate the electrical failure of a semiconductor device.

CRITICAL FOR QUALIFICATION

Burn-in sockets are critical in the qualification of all new semiconductors and in the final quality control phase of most processors, memory chips and anything for the aerospace, military and automotive industries.

Since the 1960's, burn-in sockets typically have employed a single-piece stamping for the
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Burn-In Sockets

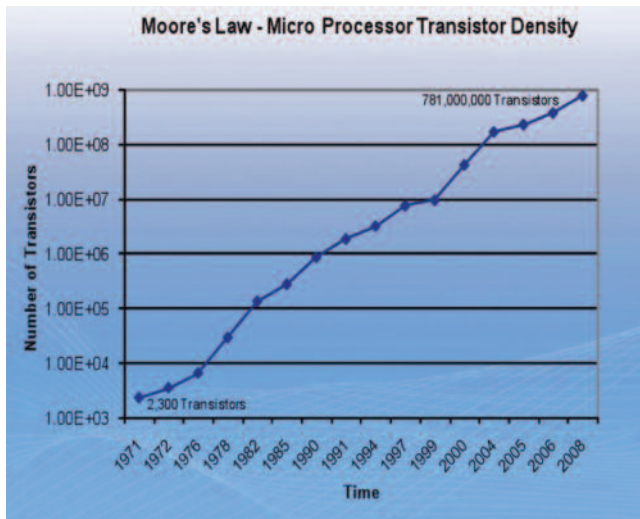


Chart 1. Transistor Count

metal contact that makes the connection between the burn-in board and the device under test. The single-piece stamping is made from a stamping die on a high-volume stamping press.

METAL STAMPING

The process typically runs at over 60k parts per hour, and the dies can coin, cut and form the metal into almost any shape needed for the design.

This has served the connector industry well and provided high volume, cost-efficient contacts for high-volume socket production.



Examples of burn-in contacts

CONTACT ELEMENT FUNCTIONS

The contact element in a burn-in socket serves two main functions: mechanical and electrical.

Mechanically, the contact must have enough compliance and force to make a good connection to the device under test.

It also must keep this same compliance and force at high temperature (150°C) and provide good cycle life of over 10k device insertions (See Chart 2).

Electrically, the contact must have a stable resistance over time, be able to carry the maximum amount of current the DUT draws and allow the device to run at its specified testing frequency without too much signal degradation.

These two main functions create a series of trade-offs for a single stamped contact piece.

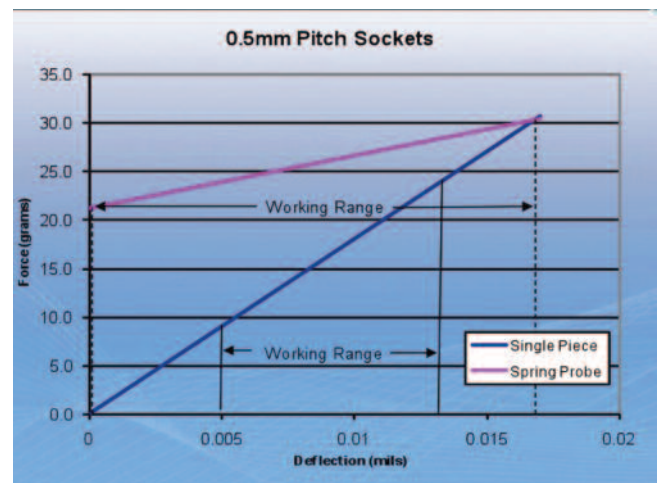


Chart 2. Force/Deflection Curves

The mechanical aspect of contact travel is one of the main reasons companies use connectors in the first place.

Connectors create the ability to mate two different interfaces together temporarily, and the compliance of the stamping takes up any warpage or flatness issues of the interface.

MECHANICAL BEAM LENGTH

However, to have a more compliant contact pin in a single stamping, the mechanical beam length has to be longer.

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Burn-In Sockets

These longer contacts display the negative effect of higher inductance and greater electrical resistance.

CONTACT FORCE

In addition to compliance, contact elements in burn-in sockets must keep the contact force of each pin under 30 grams.

With semiconductor package connection counts going higher (in some cases more than 3000 connections) and damage to pads or solder balls on the packages needing to be minimized, a low contact force is needed.

The only way to create a low force in a single stamped contact is to reduce its cross-sectional area.

The only way to create a low force in a single stamped contact is to reduce its cross-sectional area, which limits the amount of current the contact can carry (See chart 3).

Finally, all single piece stamped contacts have a movement in the **X** or **Y** direction during compression (**Z**).

With the growth of grid array packages moving to tighter and tighter pitches, the **X-Y** constraints are becoming increasingly difficult to design around.

This creates even thinner metal pins, which exponentially decrease the current-carrying capacity in the contact pin.

If we assume the trends in semiconductor manufacturing and packaging continue, a day will come in the near future where single stamped contact pins simply cannot be designed to provide adequate mechanical and electrical properties to function.

FUTURE TECHNOLOGY

The technology of the future has to decouple the electrical properties from the mechanical properties in a cost-effective manner.

This means using designs that can meet the tight pitch requirements, have a wide working travel range at low forces, are able to carry the current necessary to test the device and be available in high-volume production.

One technology that seemed acceptable in the late 1990's and early 2000's was just using a coil spring for an electrical connection.

One technology that seemed acceptable in the late 1990's and early 2000's was just using a coil spring for an electrical connection.

This solved the mechanical problems of contact travel, and the contact did not have to travel in the **X** or **Y** directions.

However, the electrical properties—where the current traveled around the loops of the spring wire—were not acceptable for high-power devices, and the end coils of each side did not make a good connection to pads or to solder balls.

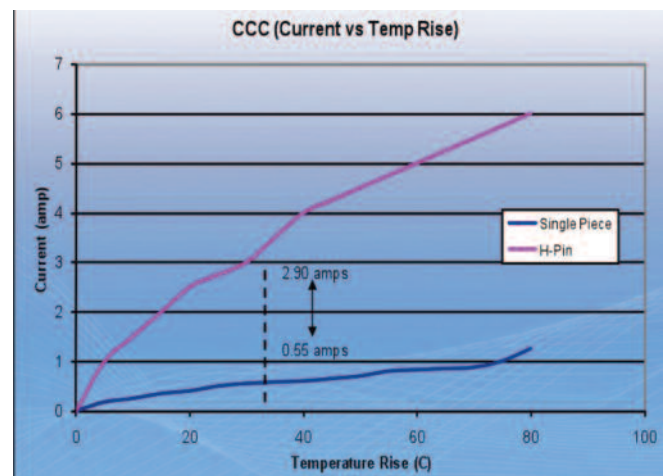


Chart 3. Temperature Rise of Single Stamping Versus Spring Pins

Another technology that does have good mechanical and electrical properties uses spring probes, typically made from 2 or 3 screw machine parts and a coil spring.

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Burn-In Sockets

The screw machine parts stay in intimate contact with each other for good electrical performance, and the coil spring provides the compliance and contact force.

THE DOWNSIDE

The downside is that the process for making the pins from screw machines is expensive, and the assembly process for the most part is not set up for high-volume production.

Today's most innovative designs take a hybrid approach of traditional stamping and coil spring technology.

To reduce cost and automate the process, socket suppliers are using stamped contacts for the interface to the DUT on top and the circuit board on bottom, using a compression spring for the mechanical travel.

This hybrid approach has allowed excellent electrical performance through the stampings and good mechanical life through the compression spring.

At last count, over five suppliers of test and burn-in sockets offered this new type of stamped spring probe.

CONCLUSION

While each type of probe offers its own merits, the future of the industry will continue to trend towards these types of solutions as the traditional single stamped contact pin runs its finite course.

Mr. Pfaff is president of the Plastronics Socket Company. He earned a BA degree from Pomona College and an MBA from the University of Texas, Austin. david@locknest.com