

Busbar Connectivity and Integration: A Critical Element for Power Applications

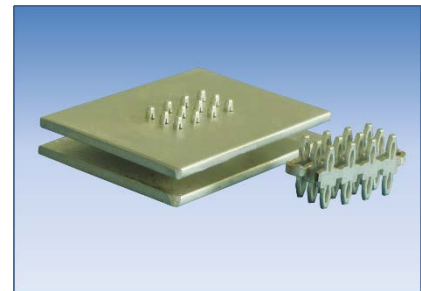
***Minimizing contact resistance, streamlining ease-of-assembly
and assuring lifecycle thermal performance are keys to success***

Overview

Busbars are the backbone for most power applications. They provide the critical interfaces between the power module and the outside world. This is true despite the many design iterations that have occurred over the past few decades, during the evolution on the power, motor, industrial and automotive industries. It will continue to be true as the need to conduct substantial amounts of current in such applications continues to grow.

However, as power applications are becoming smaller, faster and more complex, the integration of busbar functionality is undergoing significant evolution as well.

This Tech Bulletin provides a brief overview of these emerging challenges and explores how new high-force solderless interconnects can improve manufacturability while delivering reliable lifecycle thermal performance.



Fundamentals of Busbar Functionality

In power-intensive electrical applications, a busbar (often also spelled bus bar or bussbar) is a critical element for conducting significant current levels between functions within the assembly. Typically, they are a strip, a bar or sometimes a tube made of copper, brass or aluminum optimized for the particular application's current requirements and performance specifications. While busbars primarily perform electrical rather than structural functions, designers always need to consider how busbars mesh within the form factor constraints as well as the heat dissipation parameters.

Copper bus systems like the DC-link bus systems in inverter assemblies maximize high current transmission, minimize power losses and provide a high level of heat transfer. However, connecting the busbar systems to either components like DC-link capacitors or to the input of the power module has, up until recently, been a difficult process. The conventional methods used in larger power applications, such as bolting, welding, or clamping connections to busbars, are not always feasible as new-gen power applications get smaller and more complex.

Soldering is also problematic because a busbar's heat dissipation may make soldering impractical as part of mainstream automated assembly processes and often requires specialized secondary manual soldering steps. Not only is this time consuming and costly, the exposure of populated sub-assemblies to the heat of secondary soldering processes can risk damage to sensitive components.

Use of High-Force Press-Fit for Busbar Interconnects

Solderfree interconnects, such as press-fit technology, offer a straightforward solution to these issues because they provide excellent conductivity and eliminate the need for soldering.

However, some designers have been hesitant to adopt press-fit to connect directly with copper busbars. There has been a misconception that at high temperatures, the copper creep (or its tendency to move slowly and deform permanently) may weaken the interconnects over time and degrade overall performance.

Fortunately, extensive testing has now been conducted on new high-force press-fit interconnects in copper busbars, including accelerated creep testing at high temperatures that allay these fears.

As part of the testing, multiple holes were created in copper busbars that ranged from just above to just below the standard tolerance window for the press-fit part (Figure 1).

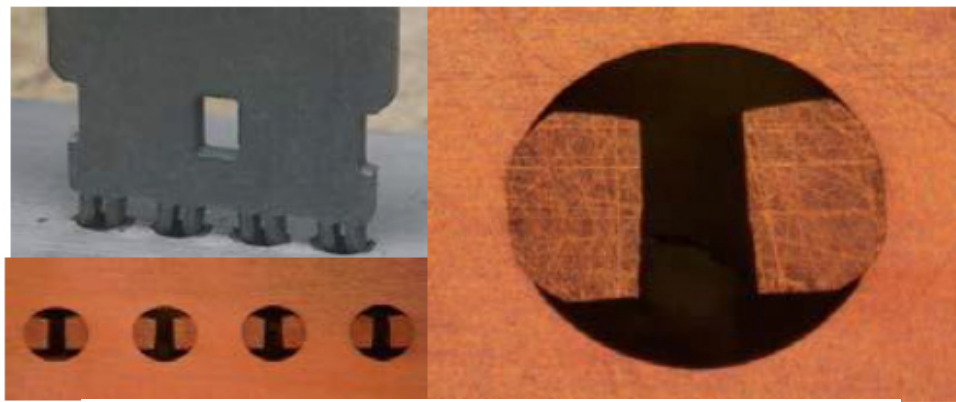


Figure 1 - Copper busbar and press-fit connection test rig

The test scenarios included busbars and holes of a variety of sizes and tin plating. For example, the test set up shown in Figure 1, used a 0.80 mm press-fit gauge part with 4 press-fit eyes per coupon and a 1.6 mm thick busbar.

The test samples were then exposed to 150° C for 6 months to allow for accelerated creep to occur.

Normal forces of the press-fit test coupon were evaluated before and after prolonged temperature soaks.

Test results confirmed that the high-force interconnects maintained consistent resiliency throughout the cycle.

Final normal forces were well within an acceptable range for a well-functioning power connection (See Figure 2).

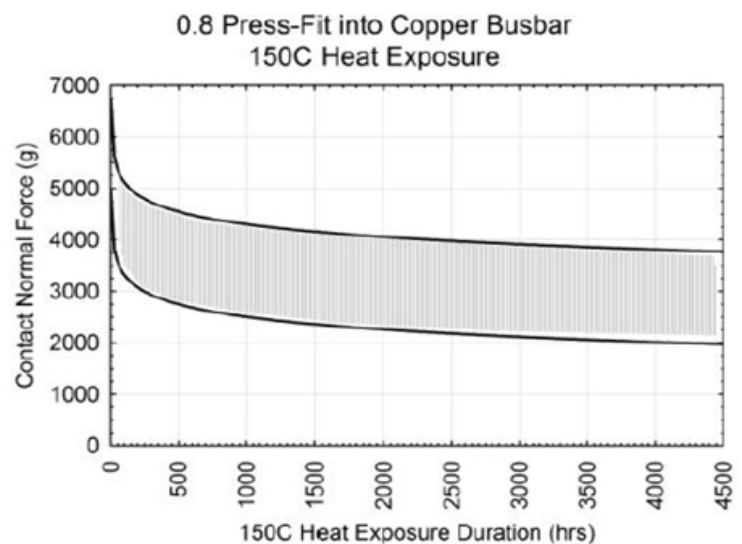


Figure 2 - Thermal profiling of busbar connection contact force over time

Even though these test results verify that the functionality of the high force press-fit connection is well-maintained through the creep of the copper busbar, we are also continuing to define additional test variations to qualify busbar interconnects for even more aggressive environments.

Summary

The test results suggest that high force and high power solderless interconnects are optimum solutions for many types of busbar connections, opening the design window for more solderless designs to be developed, carrying even more current.

Using pluggable solderless connections between busbars and other subassemblies also overcomes one of the key challenges that power module designers have always faced – dealing with dissipated heat and thermal cycling issues. New high-force press-fit interfaces provide excellent current carrying capacities and robust electrical interfaces, along with spring-based retention force that handles thermal expansion (CTE) without the risks of failure that are inherent to solder joints.

Extensive testing has shown these interconnects to be well-suited for implementing busbar interfaces that can deliver reliable performance over extended product lifecycles.

The full integration of busbars within power applications by using pluggable, high-force, press-fit technology can significantly improve power efficiency, reduce the bill-of-material costs, decrease assembly complexity and shrink the overall physical size of the power assembly.

More information regarding new and emerging power management technologies and products can be found on the web by visiting www.interplex.com or by calling (718) 961-6212.