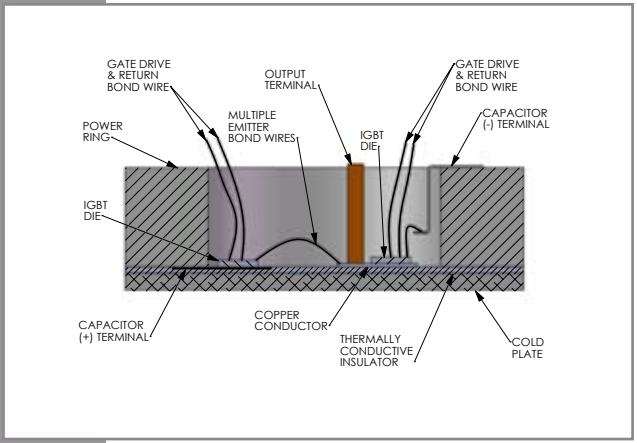
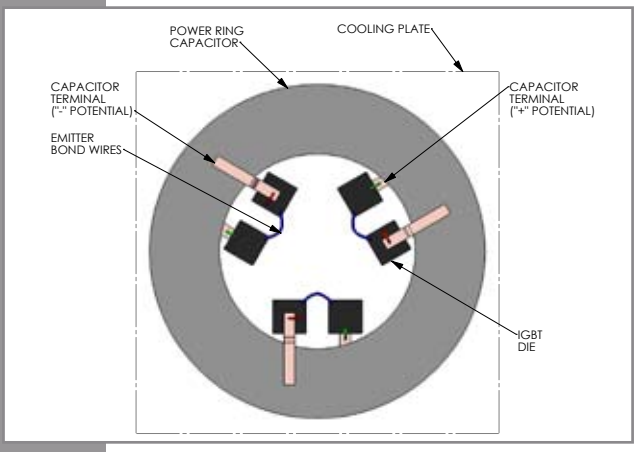
Improve Your Inverter Performance

with SBE's Innovative Power Ring Capacitor Design





We are pleased to introduce SBE's Power Ring Film Capacitor™ and the significant effect that it can have on inverter performance. SBE has demonstrated less than 5°C temperature rise in a 200Arms+ DC Link application for HEV inverters when used in configurations such as shown in this document. Our Patent Pending designs are all intended to reduce temperature rise under heavy DC Link ripple current applications, to provide for minimum ESL (system inductance), to potentially lower EMI, and to reduce capacitor and bus structure cost. When properly implemented, these designs may also eliminate the need for separate cooling systems in HEV applications.

The cost of the Power Ring Film Capacitor is similar to conventional film capacitor array solutions which are commonly in use today for HEV applications: the films used are similar in cost and our proprietary winding technology produces Power Rings at the same rate as conventional film capacitors. The monolithic ring is less costly to assemble than a complex array of "capacitor sections" and produces better performance than any DC Link solution currently available or known to be under development.

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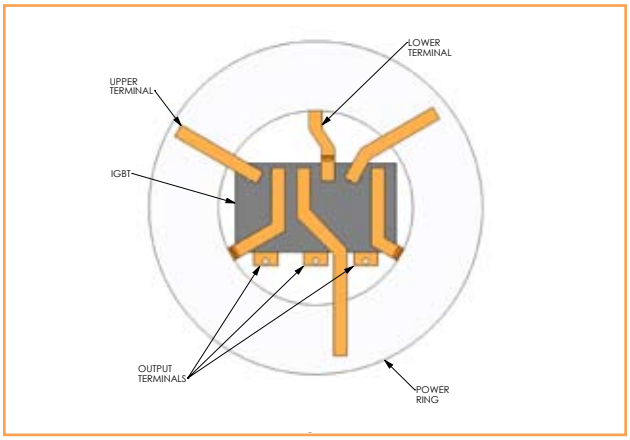
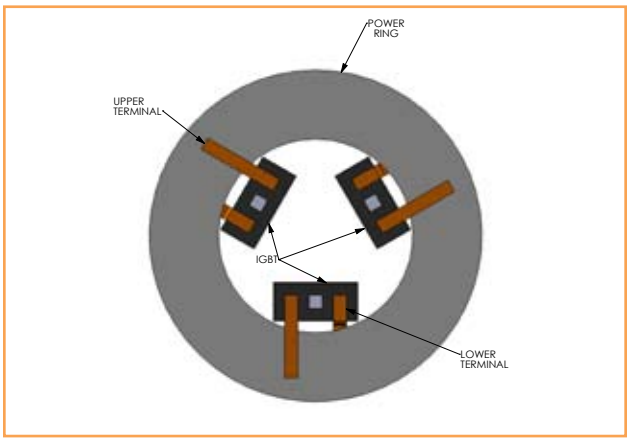
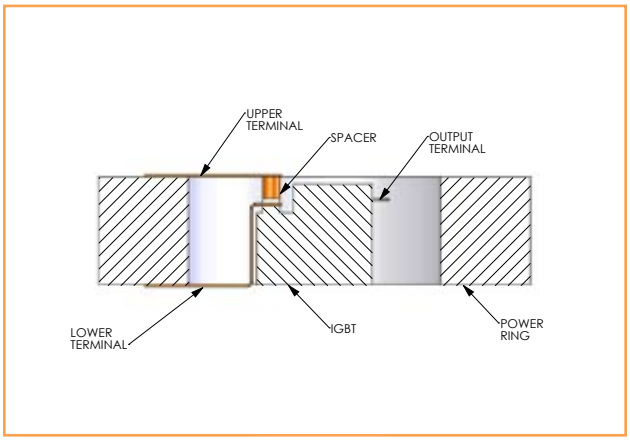


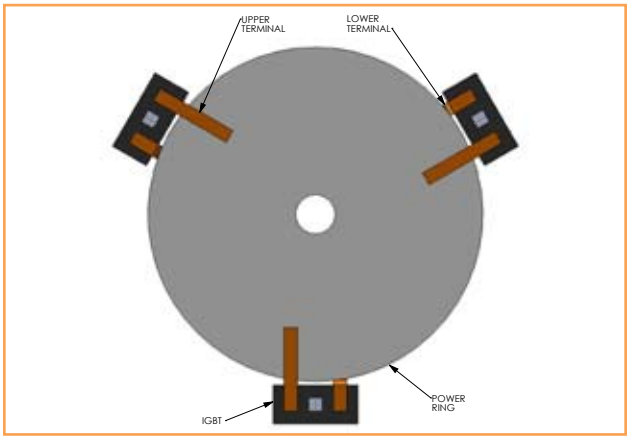
SBE has developed the Power Ring Film Capacitor™ in an annular form factor specifically designed for the Inverter Applications of HEV and PHEV Power Drive-Trains and Alternative Energy systems. SBE has recently been awarded a patent on using this shape in concert with an electrical use within the hole. One such use consists of inserting a standard inverter "Brick" inside the hole and distributing the 3 phase connections symmetrically around the ring.



The symmetry is important because, by distributing the ripple current around the Power Ring Film Capacitor in a generally equal fashion, the temperature rise within the capacitor is minimized and cooling requirements are simplified. To even further improve inverter performance, separate IGBT modules can be split up and connected with the shortest possible leads for lowest overall inductance. This can decrease the total DC Link Capacitance need and result in smaller size, lower weight, and lower cost.



This side view of an IGBT module attached to the Power Ring Film Capacitor demonstrates a low inductance design using standardly available IGBT packages. The Power Ring Film Capacitor can be designed, in many cases, to equal the height of the module desired to achieve this effect. SBE's proprietary Film Winding technology gives great flexibility to the designer to choose the optimum low inductance width yet still producing the desired total capacitance by increasing the outside diameter of the ring as needed.



Here is another example of an innovative and Patent Pending design using the Power Ring Film Capacitor, specifically wound to the required capacitance and dimensions of the system. In this case, the IGBT modules are distributed around the outside of the ring circumference. This achieves the desired ripple current distribution in the ring for the lowest possible temperature rise and may provide an equally balanced and low inductance current path to the system's bus structure.

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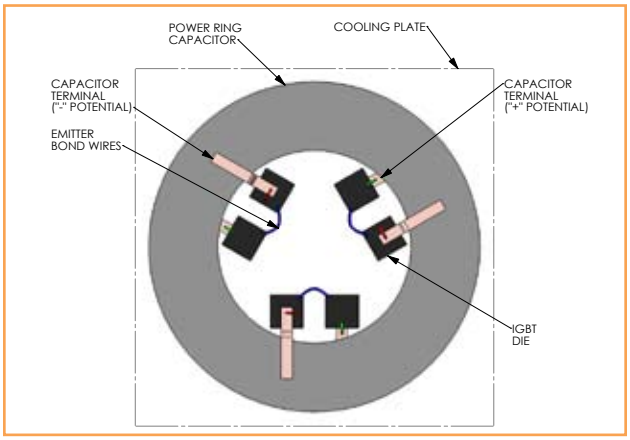
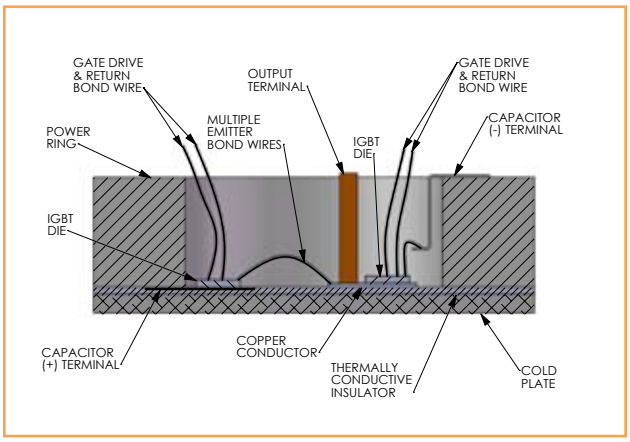
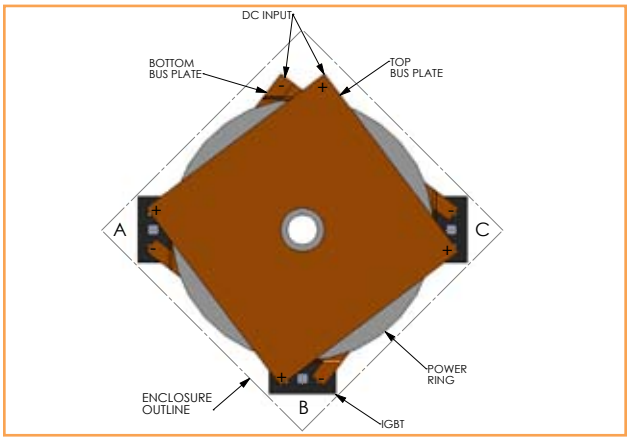
In a different iteration of the same Patent Pending concept, the modules can be replaced by individual die and again distributed uniformly around the ring to minimize temperature rise. This die concept has a number of distinct advantages: highest density of semiconductors within the hole of the ring; direct connection of die to cooling plate which can be co-utilized by the ring; better compatibility with advanced techniques such as Direct Bond on Copper; and potentially the lowest cost implementation due to reduced module packaging.



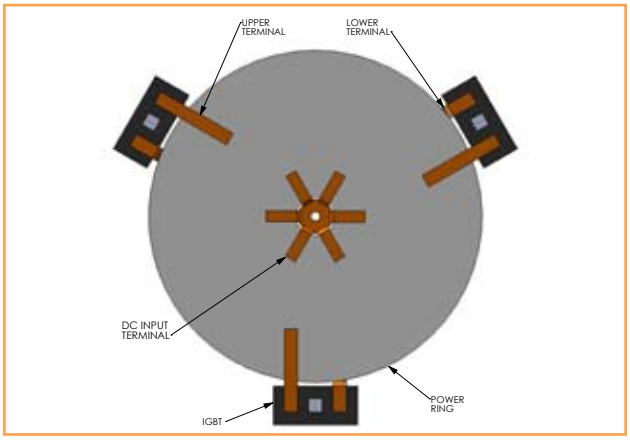
This is a side view of a semiconductor die implementation of SBE's Patent Pending concept. Shown here are a number of design concepts being utilized including the concept of electrically isolating the DC Link Capacitor from the cooling plate to allow the semiconductors to use the plate as a high current conductor. Note that the Power Ring Film Capacitor™ temperature rise is so low that the thermal loss in the insulator is not a deterrent to the successful implementation.



SBE has also utilized this Patent Pending implementation by integrating a top and bottom bus structure in a very simple and cost effective manner. This concept provides for a convenient DC Input connection and even further enhances the total current distribution properties of the Power Ring Film Capacitor for the lowest achievable temperature rise in the industry today. Standard IGBT modules are shown in this example with a "bent tab" approach to making the bottom to top connection on the module.



In a further Patent Pending implementation of SBE's Power Ring Film Capacitor in the inverter application, this example shows the DC Input attaching to the center of the ring. Again, a distributed current approach is used but in this case the inner circumference is used for DC Input current distribution and the outer circumference is used for ripple current distribution. Such a connection concept may also have distinct advantages to the system designer and overall bus connection scheme.



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Improve Your Inverter Performance

with a Custom-designed Power Ring Capacitor

Our Application Design Team is standing by to help you customize an inverter DC Link Capacitor solution to your specific needs. We are experienced in helping you interface the Power Ring Film Capacitor™ to your bus structure and we have modeling and analytical tools to estimate temperature rise and other critical characteristics of your system design.

Please put aside all your current assumptions on film capacitor limitations for inverter needs and contact us. You will not be sorry that you did.

Mark Browning
VP Power Ring Division
MarkB@sbelectronics.com
802-476-4146

SBE

SBE Inc.
131 South Main Street
Barre, VT 05641
www.sbelectronics.com