# 2018 Semiconductor Packaging Solution's Newsletter: Featuring μMaxPak WBG Near Chip-Scale Power Modules

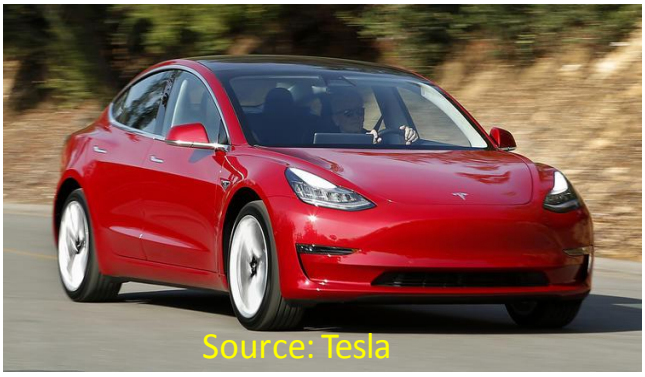
## Greetings to 2018

2018 μMaxPak IP: Bringing you up to date on our recent activities, and new EV Inverter Architecture including future potential applications.

## Ultra-Thin μMaxPak for SiC EV Inverters

As we go into 2018, our article covering high current high voltage packages for Electric Vehicle (EV) Inverters is published in Power Systems Design (PSD) December issue (1). SiC μMaxPak technology is ideal for EV applications, and we are showing how our μMaxPak packaging technology immediately enables EV SiC inverter designs that can achieve higher efficiency, lower cost, smaller outline, and lighter inverters with a 200kW Inverter example.

In late 2017 I began looking at Power EV Inverter requirements, and designed SiC half-bridge (HB) μMaxPak packages for EV Inverters. Three of these 650V/650A SMD HB package create a 200kW EV Inverter, and is easily scalable to 400kW. You can see details in the December 2017 issue of PSD. The EV μMaxPak builds on extensive experience designing International Rectifier power 600/1200V IGBT modules and motor controllers, and on SPS power inverter designs for companies like Ford & IXYS.




**OUTPUT POWER: 200kW = (1.732 x $V_{out}$ x $I_{out}$ x PF Efficiency), Assuming:**

- **Vout = 233$V_{rms}$ (@ 330VDC)**
- **Iout = 648$A_{rms}$ (@6.65A/mm2)**
- **Power Factor = 0.77**
- **Efficiency = 99.0% (99.5% Coming Soon)**

The 200kW SiC Inverter assumes efficiencies 99%, whereas Si IGBT Inverters are typically 97%. The Ultra-Thin μMaxPak double-sided (DS) cooled SMD package do not inhibit the SiC performance as is the case with traditional Si IGBT packages. More details are provided in the PSD article (1). The ultra-thin HB μMaxPak packages are each rate at 650V/650A, and only 1.142" long, 0.689" wide & 0.030" thick (29.0x17.5x0.75mm). See 650V/650A SiC μMaxPak HB size and thickness in Figure 1.

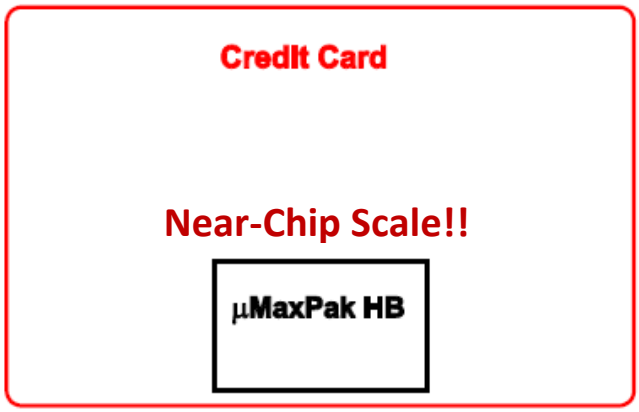



**Figure 1: Credit Card Size Comparison. Thicknesses are Identical at 0.75 mm.**

The much smaller/lighter Inverters, hardware and interconnects using three SiC μMaxPak modules are impressive, but when you add equivalent reductions to the Motor Controller size and weight (20-25% reduction), the advantage for automobile makers is very significant. Furthermore, with reduced power dissipation (25-33%), off-line cooling system size and weight can be reduced proportionally. See basic structure of the 200kW Inverter in Figures 2a and 2b.

**FIGURE 2a: TOP-VIEW 200kW EV Inverter with 3 μMaxPak HB SMD Modules (Top Side Isolators and heatsink/Cold Plate are not shown)**

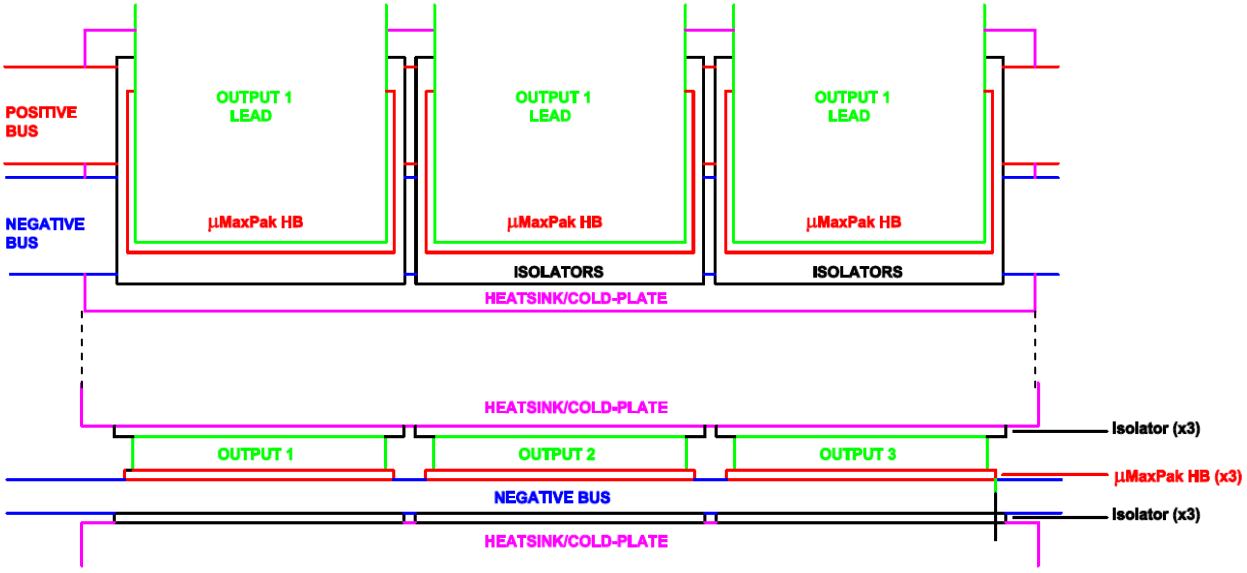



**FIGURE 2b: SIDE-VIEW 200kW EV Inverter with 3 μMaxPak HB SMD Modules**

## Unique Ultra-Thin SiC μMaxPak EV Performance Edge

New Insights into the double-sided cooled μMaxPak architecture's advantages for SiC EV inverters include increased current levels, higher efficiency, lower thermal resistance ($R_{js}$) and robust automotive structure, lower costs and reduced size & weight. All these are essential to EV inverters. Although the improved SiC MOSFETs are at the heart of the improvements, the μMaxPak advantages are SiC enablers.

The μMaxPak advantages are created by innovative package architecture, encompassed in U. S. Patent # 9,214,416 (3). The μMaxPak package has been designed for Power WBG switches. It provides extremely high power density in leadless & wire bondless SMD packages. The key package enablers include:

- Higher Power Density
- Loop-inductance 0.1-0.2nH
- Virtually no common-source inductance
- Extremely low thermal resistance (Enhanced double-sided heatsink/cold-plate)
- Vertically Integrated gate-drivers

Additional attributes are provided in the 2017 μMaxPak Synopsis (4).

## Ultra-Thin μMaxPak Power GaN Products

Although the 200kW SiC Inverter example demonstrates high current μMaxPak for EV applications, these μMaxPak packages are equally suitable for 650V/650A power GaN

applications like Solar Inverters, UPS and Battery Chargers. The power GaN switches can use vertically integrated gate-drivers for higher GaN switching speeds.

## Inevitability of Small Leadless-SMD Packages Replacing both High Powder GaN & SiC Modules

Leadless & wire bondless SMD packages can be hundreds of times smaller than conventional high powers IGBT modules, but more importantly they are essential to reduce GaN and SiC package parasitic, thereby enabling the full performance potential power WBG devices. Furthermore these new SMD packages can be built using simple and cost effective available QFN and LGA technologies. These SMD packages are enabled by smaller WBG die sizes (1/10$^{th}$ the size), but the largest cost reductions come from eliminating complex/expensive package structures and their large screw terminals and external spacing. SMD packages with potting, coating and/or under-fill are already proven, are used inside of traditional Si IGBT power modules Eliminating terminals and isolation spacing which, add package inductance, resistance, size & weight is essential for power WBG devices. And maybe most importantly, reduced WBG power dissipation enables thermal management in small µMaxPak packages. Details about µMaxPak SMD packages are available in May 2017 issues of PSD (5).

### Further information available… on Anagenesis, Inc. web-site

1. SPSarticle_Ultra-ThinEVSiCPowerDS-SMDModulePackagingTechnology.pdf
2. CFurnivalExperience2016.pdf
3. US009214416-uMaxPak121515.pdf
4. 2017Synopsis-uMaxPak.pdf
5. InevitabilitySMD-WBGpowerPkgs.pdf

---


**For technical information and questions:**

**Semiconductor Packaging Solutions**
**P. O. Box 2641**
**Lake Arrowhead, CA 92352**
**Contact: Courtney Furnival**
**CRFurnival@SPSpower.com**
**909-336-6306**

**Representative for Purchasing Information please contact:**

**Anagenesis, Inc.**
**222 N. Sepulveda, Suite 2000**
**El Segundo, CA 90245**
**Contact: Arnold Alderman**
**arnold.alderman@anagenesis-inc.com**
**310-704-7079**