Technical Product Overview

September 2021

New 750V/6mΩ Gen 4 SiC FETs extend performance leadership while enabling new levels of design flexibility

UnitedSiC has expanded its UJ4C/SC 750V SiC FET series to 13 total devices while also extending performance leadership. Lead by a new industry-best 6mΩ $R_{DS(on)}$ SiC FET (figure 1), this series also includes options specified at 9, 11, 18, 23, 33, 44 and 60mΩ. A robust short-circuit withstand time rating of 5µs is an added feature of the 6mΩ option (figure 2). Now, with this level of performance and additional options, designers can achieve an optimum cost/efficiency trade-off while maintaining generous design margins and circuit robustness in their power designs.

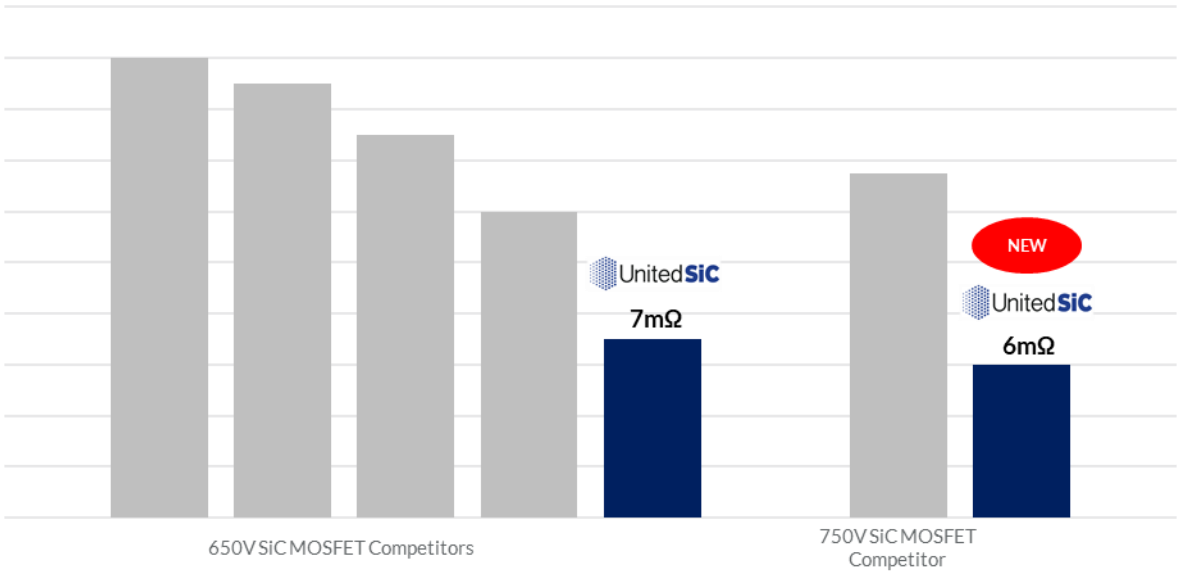

Figure 1. Lowest 650V Gen 3 & 750V Gen 4 UnitedSiC FET $R_{DS(on)}$ values compared to SiC MOSFET competitors

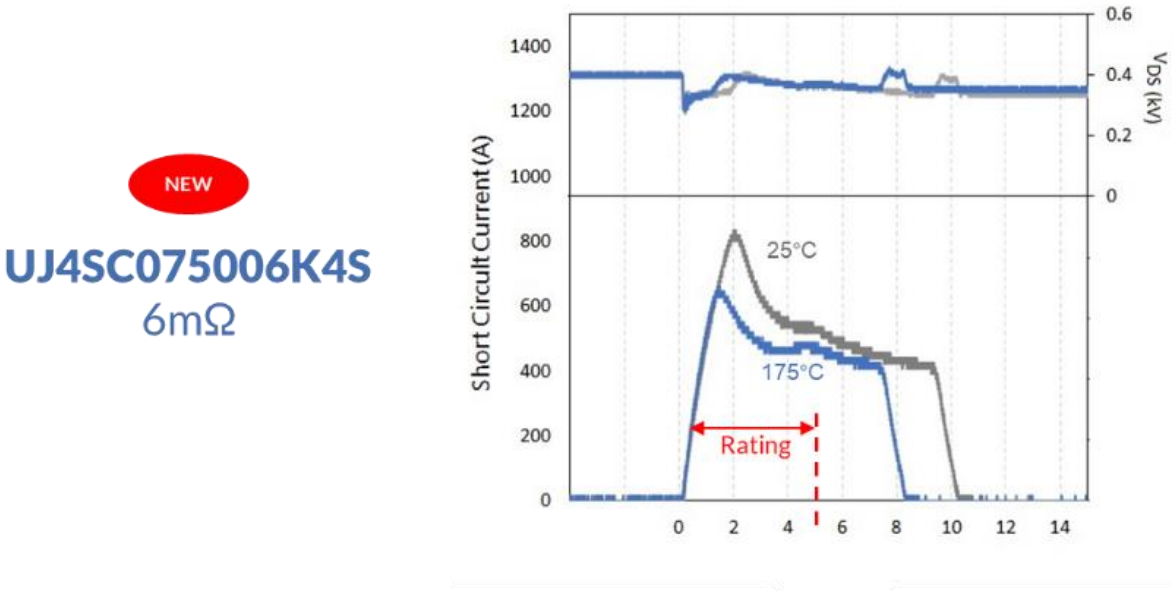

Figure 2. Lowest $R_{DS(on)}$ SiC FET with 5µs short-circuit withstand time rating

Performance and Flexibility

Leveraging the industry's best on-resistance x Area (R_{on} x A), UnitedSiC has broadened its Gen 4 SiC FET portfolio across a range of power levels that offer best in class Figures-of-Merit. 750V SiC FETs are now available with on-resistance from 6mΩ to 60mΩ in TO-247-3L and TO-247-4L packages. Figure 3 illustrates the expanded 750V portfolio, now with 9 new devices offering designers more flexibility to optimize their system for efficiency, thermal management complexity, and cost without having to compromise with a limited selection. The full selection of 750V devices also allows designers to address many applications and power levels with the same benchmark technology supplied by UnitedSiC, rather than designing in multiple different manufacturers' SiC components to cover their range of products.

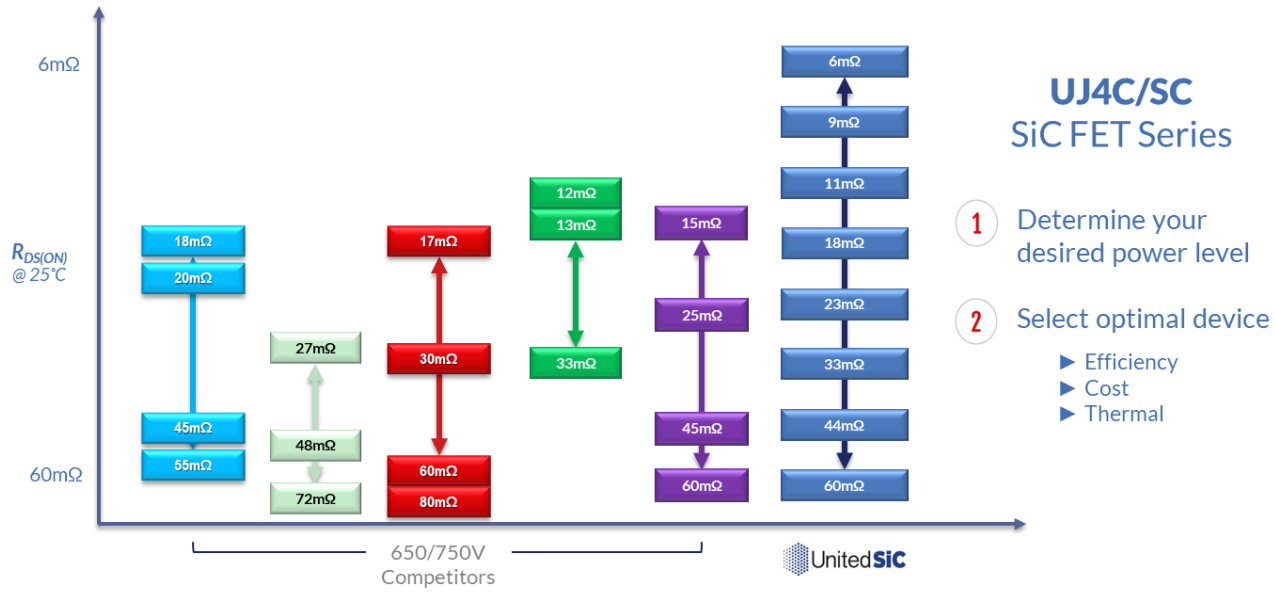

Figure 3. Expanded 750V SiC FET Devices by $R_{DS(on)}$

An example of the new SiC FET's design flexibility is illustrated in Figure 4 where several parts are compared in a 3.6kW Totem-Pole Power Factor Correction (TPPFC) circuit. The TO-247-4L FETs, in either 18mΩ or 60mΩ options, are excellent choices for TPPFC applications. The figure shows the performance obtained with the new 23mΩ, 33mΩ and 44mΩ 750V SiC FETs, reaching peak efficiencies over 99.3%. If optimizing full load efficiency or minimizing the thermal management requirements is of high importance, designers may select the UJ4C075018K4S. If light to mid-load efficiency and cost-performance ranks high on customer demands, the UJ4C075023K4S or UJ4C075033K4S are excellent selections. Meanwhile, tailoring the selection for lower power (e.g. 1.5kW) systems and lower-cost options can lead designers to the UJ4C075044K4S and UJ4C075060K4S products. Each of these options can be evaluated in a wide range of topologies simply by using the UnitedSiC FET-Jet Calculator™ (https://info.unitedsic.com/fet-jet), illustrating the ability to design without compromise with the expanded portfolio of products.

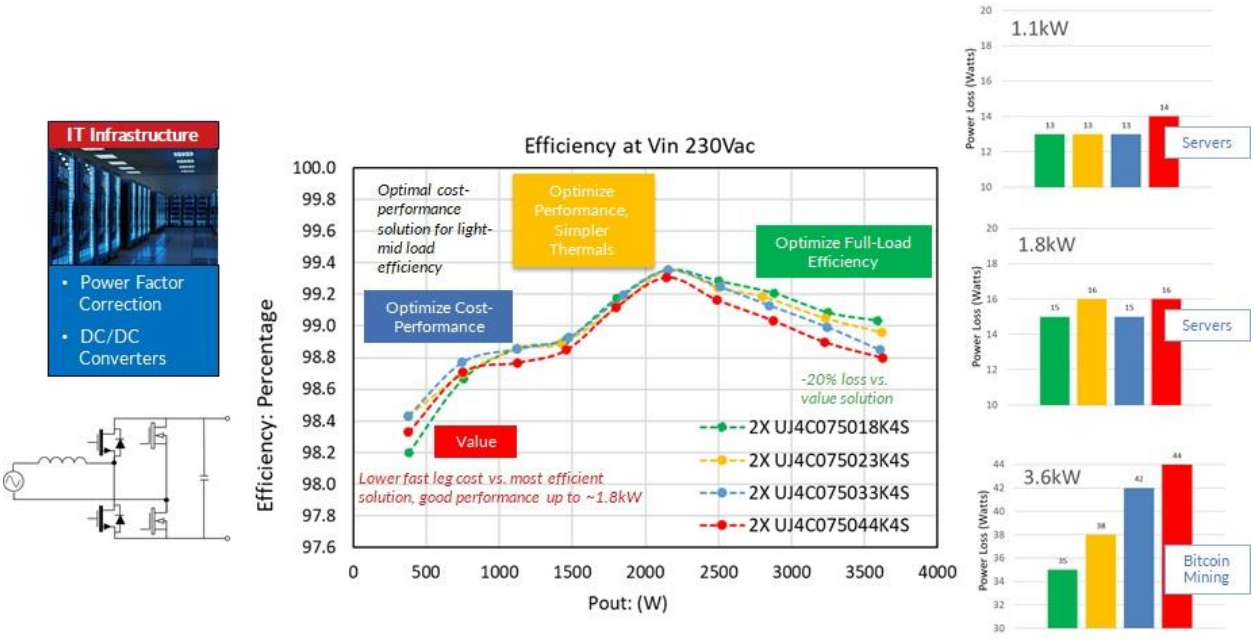

Figure 4. 750V Gen 4 UnitedSiC FET performance in a 3.6KW Totem-Pole PFC. The colored bars indicate the power loss using different devices, all of which can be used, but offer different efficiency at full load.

More Design Margin with 750V

UnitedSiC's Gen 4 SiC FETs offer breakthrough performance levels designed to accelerate WBG adoption in automotive and industrial charging, traction inverters, solid-state circuit breakers, telecom rectifiers, datacenter PFC and DC/DC conversion as well as renewable energy and energy storage applications.

With a 750V rating, additional design margin for 400V or 500V battery/bus voltage applications is available. Despite the increased voltage rating, these new devices employ advanced cell density to reduce the $R_{DS(on)}$ per unit area, delivering the industry's lowest resistance products in all packages. In addition, high current ratings are achieved by the devices' advanced sintered die attach technology offering improved thermal performance. With the best specific on-resistance (shown in Figure 5) comes substantially lower conduction losses across the full temperature range.

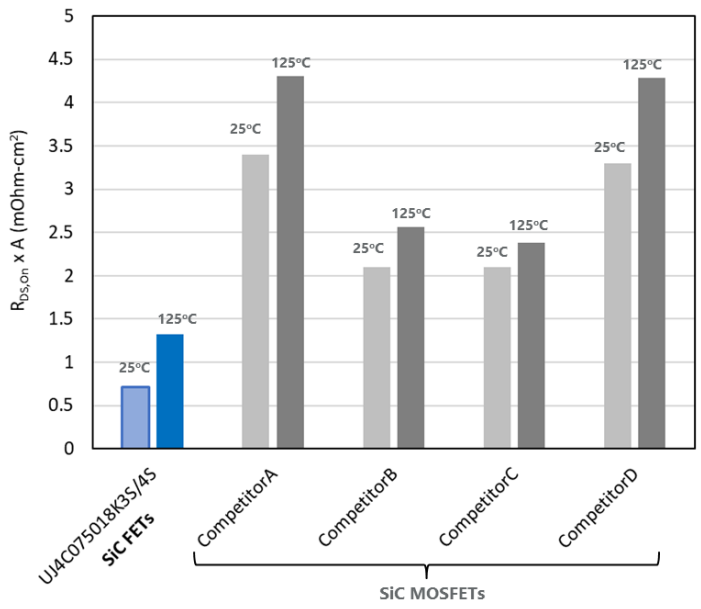

Figure 5. 750V Gen 4 UnitedSiC JFET On-resistance per unit area compared to 650V rated SiC competitors

Design ease-of-use is again featured with UnitedSiC SiC FET switches. All devices can be safely driven with standard 0V to 12V or 15V gate drive voltage. Good noise margin is maintained with a true 5V threshold voltage. Like previous Generations, these new SiC FETs can be operated from all the typical Si IGBT, Si MOSFET and SiC MOSFET drive voltages and include a built-in ESD gate protection clamp.

Figures of Merit

Along with low on-resistance, these new SiC FETs offer improved efficiency in both hard and soft-switched circuits. In hard-switched circuits such as Totem-Pole PFC or standard 2-level inverters, the low on-resistance per unit-area and low output capacitance along with the near-zero stored charge in the low-voltage Si MOSFET combine to offer superior reverse recovery charge (Q_{rr}) and low E_{oss}/Q_{oss}. The devices exhibit a superior and robust integral diode with low voltage drop V_F (<1.75V).

UnitedSiC Gen 4 SiC FETs also offer improved performance in high-frequency, soft-switched resonant converter topologies such as LLC or PSFB. The breakthrough performance of the 750V UnitedSiC FETs comes as the on-resistance has been substantially reduced, while at the same time, offering lower output capacitance, $C_{oss(tr)}$ for any give $R_{DS(on)}$. The soft-switching Figure-of-Merit (represented as $R_{DS(on)}$ x $C_{oss(tr)}$) advantage is best-in-class across the full range of useful operating temperature.

SiC MOSFET Comparison

The radar plot shown in Figure 6 summarizes the comparative advantages of Gen 4 750V SiC FETs with 650V SiC MOSFET competitors. The SiC FETs are unmatched when key hard-switching and soft-switching parameters are considered. The ultra-low on-resistance per unit area allow standard discrete packages with performance levels not achievable with incumbent Si or emerging WBG competing technologies.

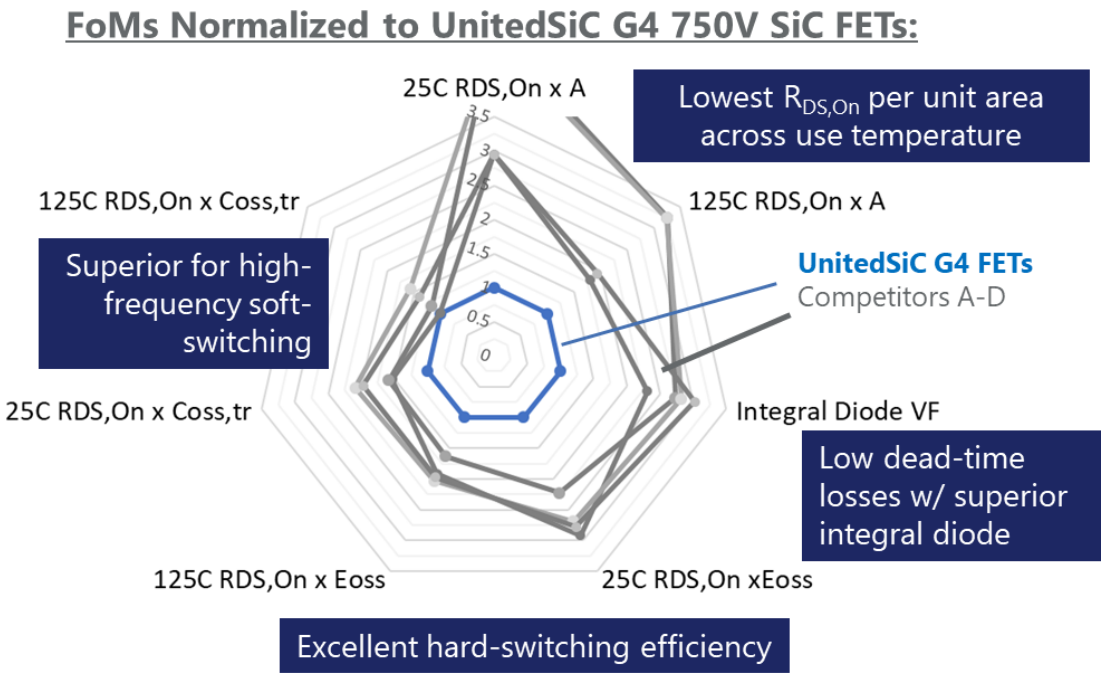

Figure 6. Radar plot of UnitedSiC 750V FETs comparative advantages with key parameters normalized (note: lower values are superior)

Summary

These SiC FETs from UnitedSiC deliver an entirely new level of performance enabled by the advanced Gen 4 technology. UnitedSiC has delivered a new performance benchmark with the introduction of the 6mΩ SiC FET and provides users with much needed design flexibility with the broadest WBG portfolio in this voltage class. By adding a 750V option, designers now have additional bus voltage headroom. Important performance "Figures of Merit" deliver an overall better performing SiC FET product that power designers can now benefit from in their next-generation system designs.

To learn more about these new devices, visit https://info.unitedsic.com/gen4.