UnitedSiC Is Now Qorvo | TECHNICAL PRODUCT OVERVIEW

May 2022

1200V Gen 4 SiC FETs with industry-best performance deliver optimal SiC power solutions to high-voltage markets

UnitedSiC (now Qorvo) has expanded its 1200V product family, extending its breakthrough Gen 4 SiC FET technology to higher voltage applications. Six new products in the new UF4C/SC series ranging from 23milliohm to 70milliohm are now available in TO247-4L (kelvin connected) packages with 1200V/53milliohm and 70milliohm SiC FETs available in TO247-3L packages. These newly released SiC FETs offer superior performance and are excellent options for the growing EV market evolution towards 800V Bus On-Board Chargers (OBC) and DC/DC converters. As with previous generations, the new FETs are also well suited for industrial battery chargers and power supplies, PV converters, UPS and various other power conversion applications.

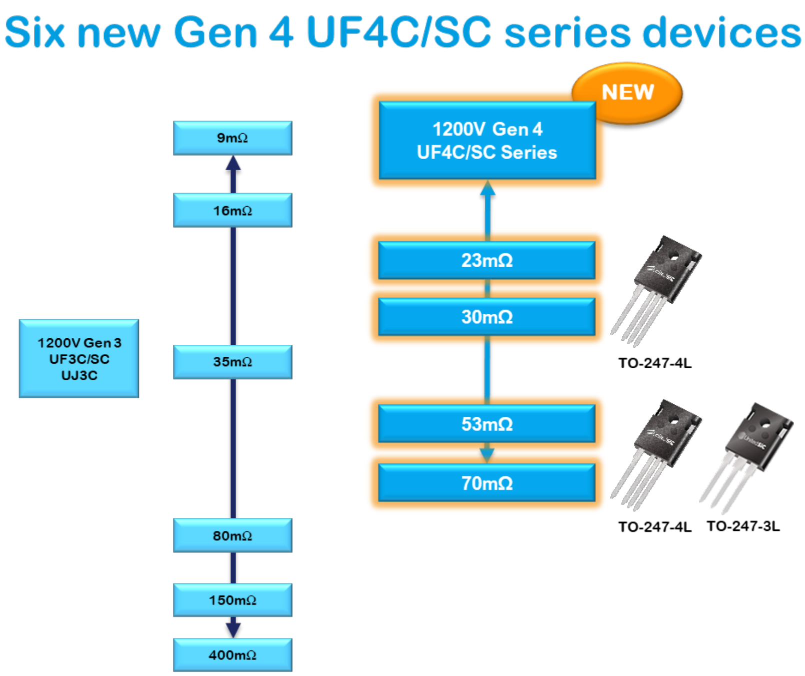


Figure 1 New 1200V Gen 4 UnitedSiC FET products along with existing 1200V Gen 3 family by $R_{DS(On)}$

Leveraging the world's best on-resistance x Area (R_{On} x A) achieved with its advanced vertical trench device structure, these new parts offer the industry's best performance Figures-of-Merit (FoM) including lowest $R_{DS(on)}$ x Area, lowest $R_{DS(on)}$ x E_{oss}, $R_{DS(on)}$ x $C_{oss,(tr)}$ and $R_{DS(on)}$ x Q_g. As with the rest of Gen 4 portfolio, the new 1200V FETs can be easily driven with a 0-12V or 0-15V gate drive. With a +/-20V $V_{GS,Max}$ and a high threshold voltage (4.8V), these SiC FETs offer plenty of gate voltage design and noise margin and are compatible with Si or SiC gate drive voltages. The 1200V FETs offer an excellent integral diode, with superior forward voltage (1.0-1.5V typically) and low reverse recovery charge (Q_{rr}).

To take full benefit of ultra-low specific on-resistance, the new 1200V SiC FETs employ an advanced Ag-sinter die attach process that gives them superior thermal performance. The devices maintain good power handling capability allowed by their best in-class thermal resistance, $R_{th,\ j\text{-}c}$ while achieving a die shrink with lower capacitance and reduced switching losses. The benefit of improved thermal resistance is depicted in Figure 2 illustrating the relative die size of Gen 4 1200V SiC FETs to competing technologies along with a 26%-60% reduction in thermal resistance compared to other FETs in their class.

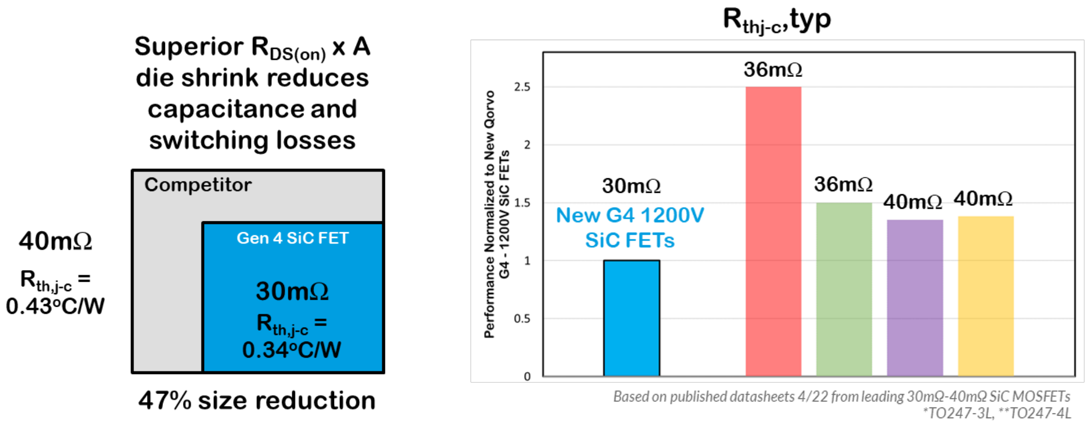


Figure 2 Comparative junction-to-case thermal performance of new 1200V Gen 4 SiC FETs with competing 1200V FET by employing advanced Ag-sintering technology

Figure 3 shows the FoMs for power handling (Rth,j-c), hard-switching ($R_{DS(on)}$ x E_{oss}) and soft-switching $R_{DS(on)}$ x $C_{oss,(tr)}$, and $R_{DS(on)}$ x Q_g when normalized to the new Gen 4 1200V SiC FETs. Superior performance of each parameter in the radar chart is represented by a lower value. One can see that the 1200V Gen4 SiC FETs offer uncompromising performance benefits in both hard switching (i.e., active front end etc.) and soft switching (i.e., isolated DC/DC converters) circuits at both 25°C and at elevated temperature (125°C). Compared to previous generation SiC FETs, the new devices offer up to 40% lower $R_{DS(on)}$ for a given die area, 37% lower 25°C $R_{DS(on)}$ x E_{oss}, and 54% lower 25°C $R_{DS(on)}$ x $C_{oss,(tr)}$.

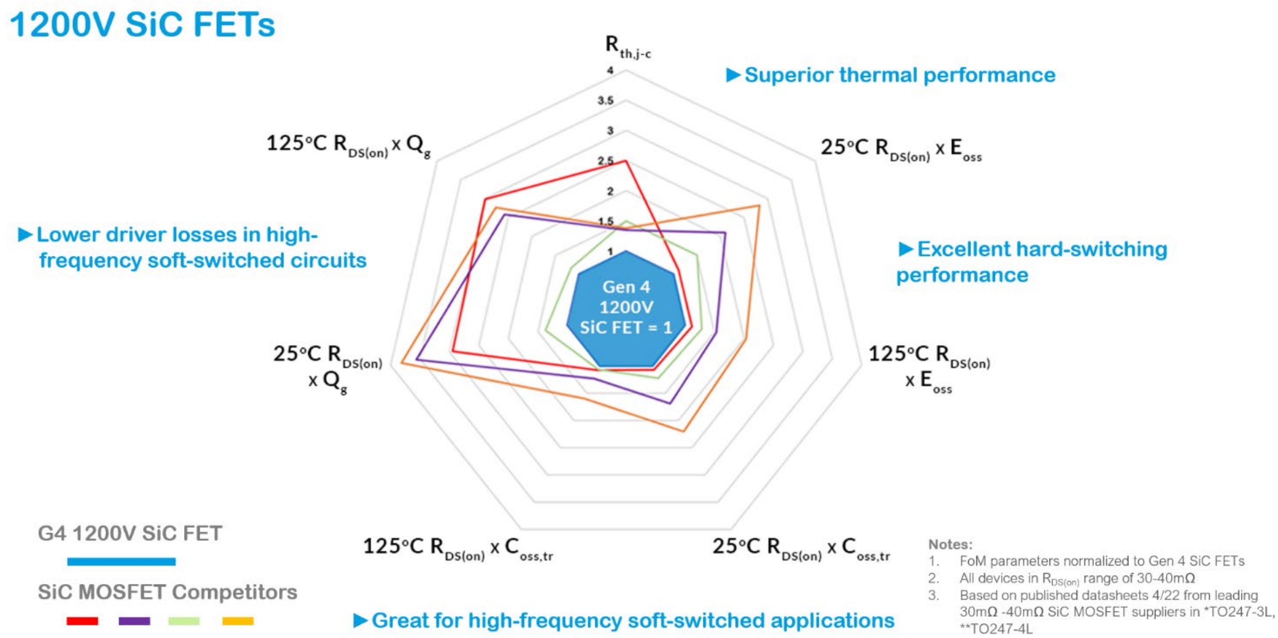
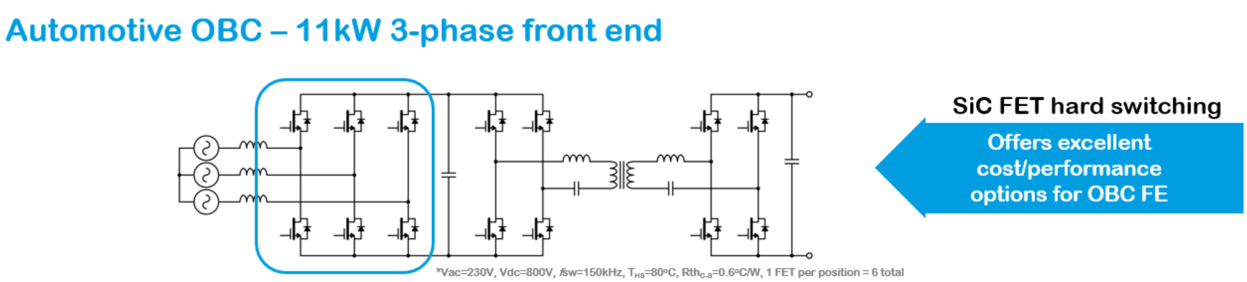


Figure 3 Comparative performance FoMs of new 1200V Gen 4 SiC FETs with competing 1200V FETs

The 6 new 1200V SiC FETs are available in the UnitedSiC (now Qorvo) free online design calculator tool FET-Jet Calculator™, which can_be used to evaluate device losses, converter efficiency, temperature rise, and identify optimal drive conditions. Using the FET-Jet Calculator tool, it is clear that the new 23milliohm (UF4SC120023K4S) and 30milliohm (UF4SC120030K4S) FETs are excellent options for the active front end of 800V bus On-Board Charger (OBC) applications. In the 11kW OBC front end design example shown in Figure 4, the new UF4SC120030K4S is able to reduce losses (to 37W per FET), achieve an excellent 98% semiconductor efficiency and run cooler (T_j=115°C), all with a reduced die size. The design shown assumes a hard-switched frequency of 150kHz and a heatsink temperature of T_{HS}=80°C allowing users to achieve excellent power density.

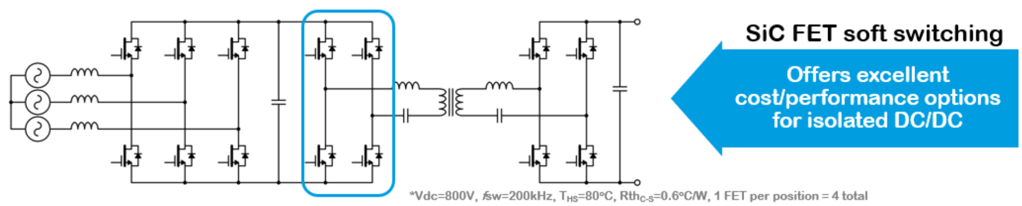


	UF3C120040K4S	UF4C120030K4S	Gen 4 Benefits
Generation	Gen 3	Gen 4	Reduced die size ⬇
Losses per FET	44.3W	37W	Reduced losses ⬇
Semiconductor efficiency	97.6% 88.6W/phase	98.0% 74W/phase	Improved efficiency ⬆
Tj	119°C	115°C	Runs cooler ⬇

Figure 4 11kW OBC example front end design using new Gen 4 UF4SC120030K4S SiC FETs

The new 1200V SiC FET series also offers great choices for the isolated DC/DC converter stage of the OBC. In these high-frequency, soft-switching topologies the Gen 4 FETs' low conduction loss, low diode forward drop, low driver losses (Low V_g, low Q_g) and low $R_{DS(on)}$ x $C_{oss,(tr)}$ are ideal. An 11kW, 800V full-bridge CLLC design example is shown in Figure 5 with 1200V SiC FETs in each of the primary side switch positions. The assumed operating frequency is 200kHz and the heat sink temperature is again T_{HS}=80°C. The performance summary table as predicted with the FET-Jet Calculator™ shows the benefit of the new Gen4 1200V SiC FETs. With a similar die size, the UF4C120053K4S/K3S offer lower losses and excellent semiconductor efficiency (99.5%) and run cooler (T_j < 100°C). The cost-effective UF4C120070K4S/K3S are also attractive cost/performance solutions, offering good efficiency (99.4%) with slightly higher losses.

Automotive OBC – 11kW Full-bridge CLLC



	UF3C120080K4S	UF4C120053K4S	Gen 4 Benefits
Generation	Gen 3	Gen 4	Similar die size
Losses per FET	17.6W	14.1W	Reduced losses ↓
Semiconductor efficiency	99.4% 70.4W	99.5% 56.4W	Improved efficiency ↑
Tj	101°C	97°C	Runs cooler ↓

Figure 5 11kW OBC example Full-Bridge CLLC design using new Gen 4 UF4C120053K4S SiC FETs

In summary, these new 1200V SiC FETs from UnitedSiC (now Qorvo) deliver superior performance in hard and soft switching enabled by the advanced Gen 4 technology in higher voltage circuits. Important performance "Figures of Merit" deliver an overall better performing SiC FET product delivering optimal power solutions in leading-edge designs for high-growth markets.

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