Technical Product Overview

March 2023

750V Gen 4 SiC FETs extend performance leadership in lowest on-resistance surface-mount, TOLL package

Qorvo (UnitedSiC) has expanded its breakthrough Gen 4 SiC FET portfolio, extending performance leadership with a 750V/5.4 mOhm SiC FET offered in a new surface-mount TO-leadless (TOLL) package. This first product is first in a family of 750V SiC FETs that will be released in the TOLL package with on-resistance ranging from 5.4 mohm to 60 mohm. These devices are ideal for use in space-constrained applications such as AC/DC power supplies ranging from several 100s of Watts to multiple kiloWatts, as well as solid-state relays and circuit breakers up to 100A level.

In the 600/750V class of power FETs, Gen 4 SiC FETs offer unmatched performance across the main figures of merit (FOM) for on-resistance and output capacitance. Additionally, in the TOLL package, at 5.4 mohm, the devices have 4-10x lower on-resistance than competing best-in-class Si MOSFETs, SiC MOSFETs and GaN transistors. The 750V rating of the SiC FETs is also 100-150V higher than the alternative technologies, providing a significantly enhanced design margin for managing voltage transients.

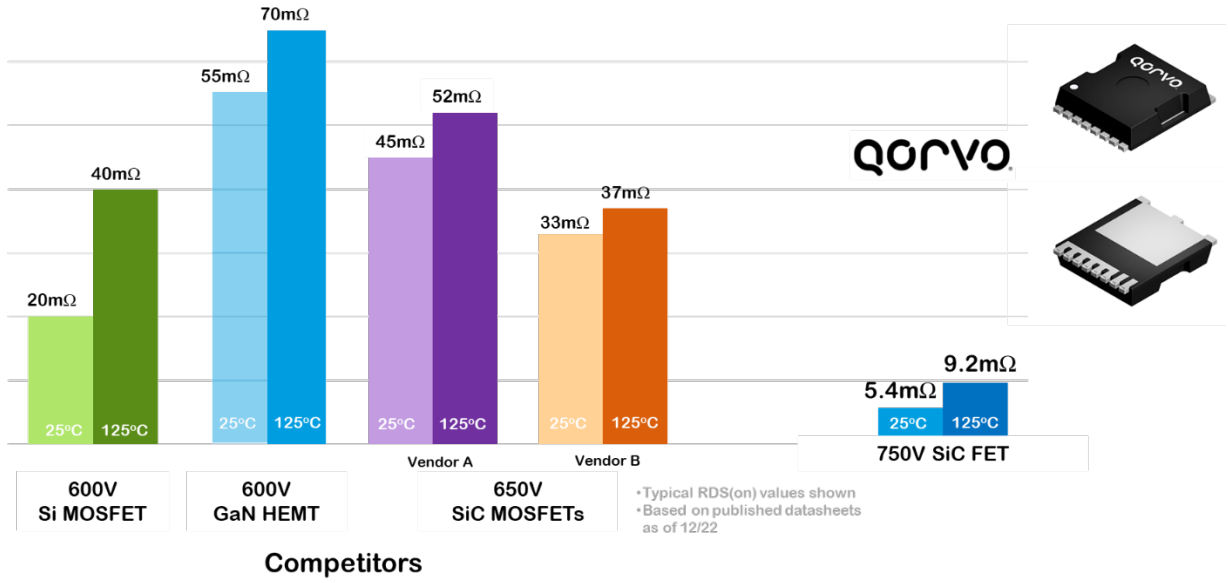

Figure 1. Lowest on-resistance FETs (rated 600V and above) offered in surface-mount, TO-leadless (TOLL) packages.

The TOLL package is 30% smaller in footprint and (at 2.3 mm) half the height of comparable alternative D2PAK surface-mount offerings. A Kelvin-source connection is also provided in the TOLL package for reliable, high-speed switching of large currents with cleaner gate waveforms.

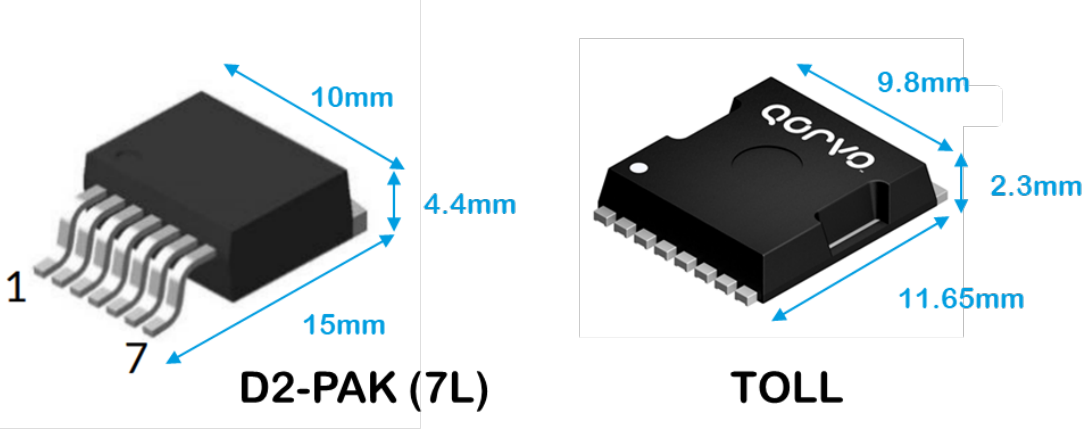

Figure 2. Size of low on-resistance surface-mount offerings, D2PAK7L compared to TO-leadless TOLL

These SiC FETs leverage Qorvo's unique cascode circuit configuration, in which a SiC JFET is co-packaged with a Si MOSFET to produce a device that better realizes the efficiency advantages promised by wide bandgap switch technology and the simpler gate drive of Silicon MOSFETs. The ultra-low on-resistance in the small TOLL footprint is enabled by the Qorvo SiC FET technology's world's best on-resistance x area ($R_{DS(On)}$ x A), along with the best-in-class FOM.

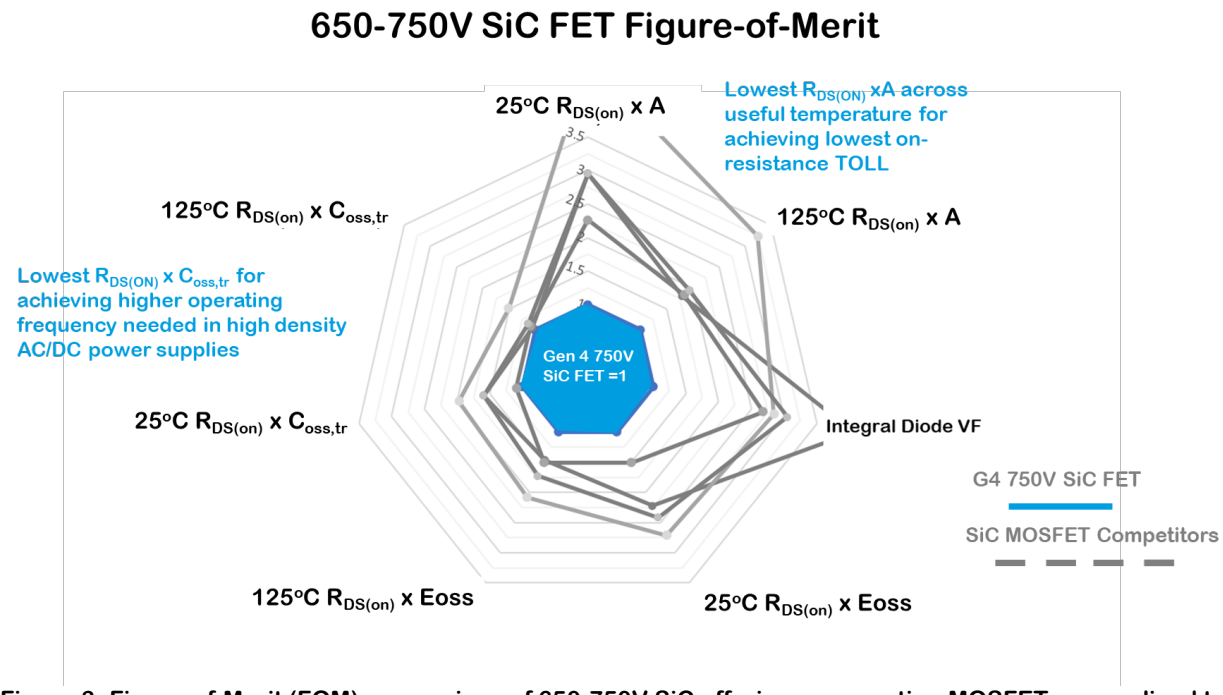

Figure 3. Figure-of-Merit (FOM) comparison of 650-750V SiC offerings, competing MOSFETs normalized to Qorvo SiC FET=1, lower value is superior for all parameters

Despite the significant size reduction, advanced manufacturing techniques including sintered die attach, the new FETs achieve an industry-leading 0.1°C/W thermal resistance from junction to case. The continuous current rating of the new 750V/5.4 mOhm UJ4SC075005L8S is 120A up to case temperatures of 144°C, while the pulsed current rating is 588A up to 0.5 millisecond.

Combined with the ultra-low on-resistance, high $T_{j,max}$=175°C and excellent transient thermal behavior, this yields an 'I^2t' rating around 8x better than a Si MOSFET in the same package, aiding robustness and immunity to transient overloads, while also simplifying the design effort. This is illustrated in Figure 4, which shows the maximum pulse current versus pulse width of Si and SiC FETs packaged in TOLL. In the modeled example shown, the FETs are modeled assuming they are PCB-mounted with thermal vias, isolating thermal interface material and heatsink held at T_{HS}=50°C ($R_{th,c\text{-}hs}$=1.4°C/W). The steady-state thermal resistance from junction to heatsink limits the FETs' current rating under pulses greater than 1 second, respectively. In this regime, the SiC FETs exhibit >2x current handling advantage, stemming from their higher $T_{j,max}$, lower on-resistance and lower thermal resistance.

However, for shorter pulse widths wherein the transient thermal impedance of the semiconductor material, die attach and lead frame dominates, a much larger transient overcurrent can be withstood (4-6x higher than maximum continuous current). The new TOLL FETs from Qorvo leverage SiC's superior thermal resistance, advanced Ag-sinter die attach, max junction temperature of 175°C and ultra-low on-resistance at high current densities, to offer exceptional surge current performance. The example in Figure-4 shows that the maximum overcurrent of the SiC FETs are 2.8x higher than the lowest on-resistance Si MOSFET in the same package (t_p~0.5ms-1ms).

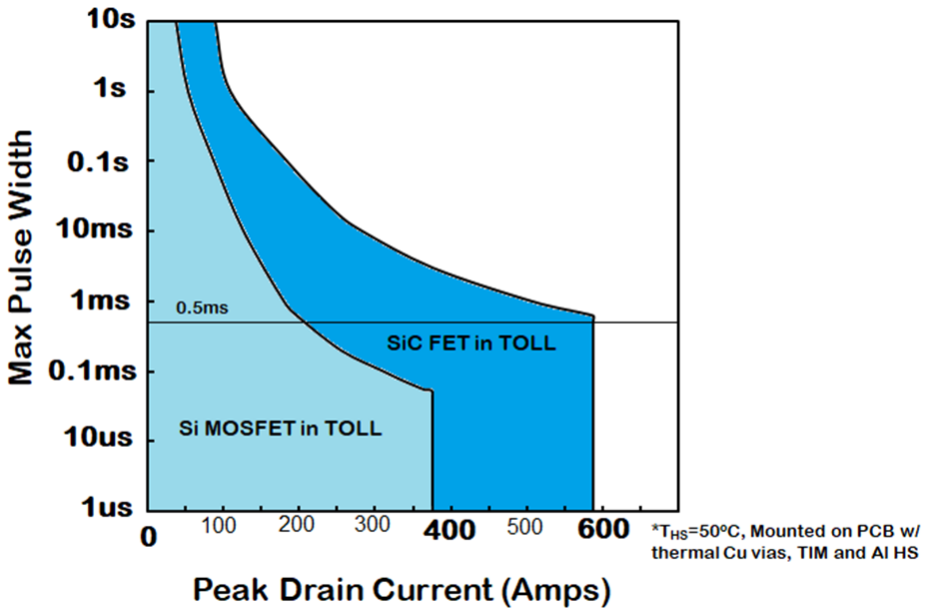

Figure 4. Maximum pulse width versus (square) pulse current of 750V/5.4 mohm SiC FET compared to lowest on-resistance 600V Si MOSFET in TOLL package

The low conduction loss, compact size, high surge ruggedness and excellent turn-off capability make these new ultra-low on-resistance TOLL parts ideal candidates for protection applications that are often thermally challenged in small, enclosed spaces with no active cooling available. They can reduce/eliminate the need to parallel multiple FETs and keep heatsinking to a minimum.

The new 750V/5.4 mohm SiC FET in TOLL further extends Qorvo's performance leadership and adds to the broad portfolio of Gen 4 products offered in both through-hole (TO-247) and surface-mount packages (D2Pak, TOLL).

Qorvo (UnitedSiC) 750V SiC FET Product Portfolio:

750V FET On-resistance (mohm)	 TO-247 (3L)	 TO-247 (4L)	 D2-PAK (7L)	
5	-	UJ4SC075006K4S	-	UJ4SC075005L8S
9	-	UJ4SC075009K4S	UJ4SC075009B7S	More options coming soon
11	-	UJ4SC075011K4S	UJ4SC075011B7S	
18	-	-	UJ4SC075018B7S	
	UJ4C075018K3S	UJ4C075018K4S	-	
23	UJ4C075023K3S	UJ4C075023K4S	UJ4C075023B7S	
33	UJ4C075033K3S	UJ4C075033K4S	UJ4C075033B7S	
44	UJ4C075044K3S	UJ4C075044K4S	UJ4C075044B7S	
58	UJ4C075060K3S	UJ4C075060K4S	UJ4C075060B7S	

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