

SiC FETs Offer Faster Switching With Cascode Convenience

Offered in a standard TO-247-3L package, [UnitedSiC's](#) UF3C FAST series 650-V and 1200-V SiC FETs offer increased switching speeds and higher efficiency levels than the company's existing UJC3 series. Based on UnitedSiC's proprietary cascode configuration, this new series provides higher switching speeds while at the same time offering a "drop-in" replacement solution for most TO-247-3L IGBT, Si-MOSFET and SiC-MOSFET parts.

This means system upgrades for greater performance and efficiency can be implemented without requiring changes to the existing gate-drive circuitry. Turn-on losses can be reduced based on a 50% reduction in Q_{RR} . For high current use, a small, low-cost RC snubber is required, which also simplifies EMI design.

Applications suitable for use with the UF3C FAST series include the full range of hard switched circuits such as active rectifiers and totem-pole PFC stages, commonly used in EV charging, telecom rectifiers and server supplies. Key electrical specs for members of this series are given in Table 1.

Built on UnitedSiC's Gen-3 SiC transistor technology, the UF3C FAST series integrates a faster SiC JFET with a custom-designed Si-MOSFET to produce the valuable combination of normally-off operation, a high-performance body diode and easy gate drive of the MOSFET (the cascode convenience cited above). Compared with other wide bandgap technologies, the SiC cascode devices support standard 12-V gate drive, and have assured avalanche ratings (100% production-tested). Fig 1 shows where these parts fit within the company's SiC portfolio.

"UnitedSiC's new FAST SiC FET range is simple to use and offers a great cost-performance option," said Anup Bhalla, VP engineering at UnitedSiC. "The range offers design engineers the opportunity to extract even higher levels of efficiency from high-power designs."

Achieving the faster operation of the UF3C FAST series required only a reduction in the internal gate resistance of the JFET. This change does not affect the JFET's $R_{DS(ON)}$, but leads to lower Q_{RR} as turning off the FET faster reduces the Q_{RR} as illustrated in Table 2. Ultimately, this allows the UF3C FAST series devices to switch at higher switching frequencies without an increase in losses. According to Bhalla, the Q_{RR} achieved in the UF3C FAST series represents the lower limit on what can be achieved with these SiC JFETs.

Achieving the faster switching of the UF3C FAST series does require a small RC snubber to attenuate ringing. However, the losses associated with this snubber are relatively minor as demonstrated in Fig. 2.

There is one tradeoff with the UF3C FAST series devices. Because their faster switching produces more ringing and overshoot than the slower UJC3 series devices, the pc-board layout is more challenging. So the tradeoff in operation for the new devices is simply usability and designers will select the faster UF3C devices when needed and use the UJC3 series otherwise.

Data sheets and a new, more-detailed SiC FET user guide are available at <https://unitedsic.com/cascodes/>. The user guide includes recommended RC snubber values tested by UnitedSiC for optimal performance. Unit pricing ranges from \$14.50 for the UF3C065040K3S to \$24.50 for the UF3C120040K3S in quantities of 1,000. Stock is available at Mouser and other local distributors.

Table 1. Key electrical specs for members of UF3C Fast series of SiC cascode devices.

UF3C Fast Series (Hard Switched)				
Voltage	P/N	Description	Id max(A) at 25C	Package
1200V	UF3C120040K3S	1200V 35mΩ SiC Cascode Fast	65.0	TO-247-3L
650V	UF3C065040K3S	650V 42mΩ SiC Cascode Fast	54.0	TO-247-3L
	UF3C065030K3S	650V 30mΩ SiC Cascode Fast	85.0	TO-247-3L

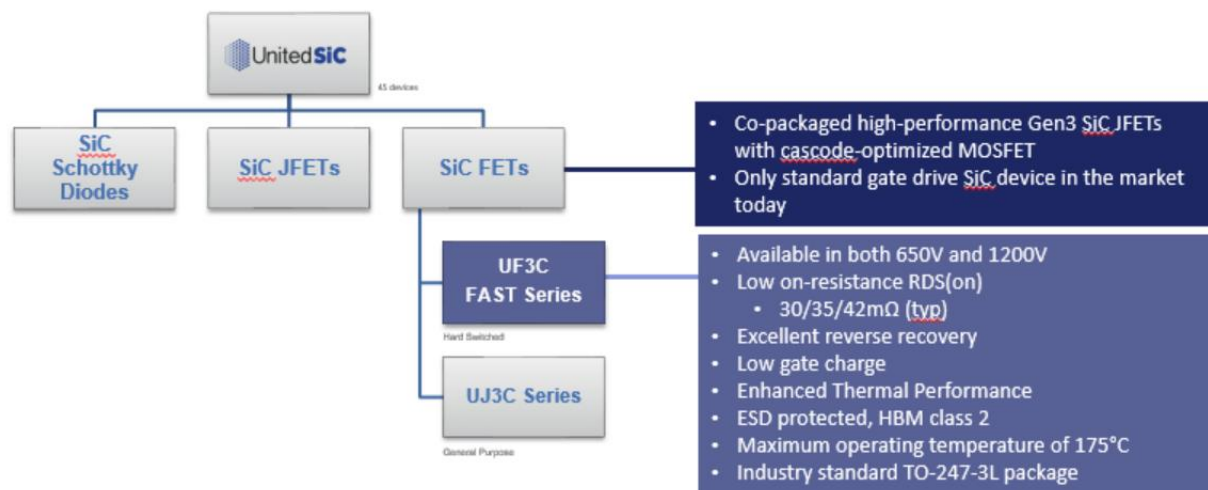

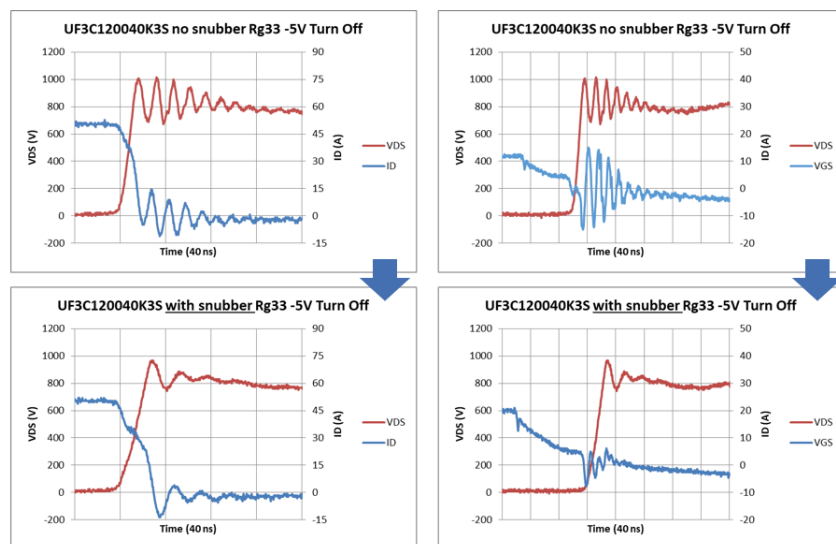


Fig. 1. The UF3C FAST series is an extension of the company's SiC FET product line, which consists of cascode devices combining the company's SiC JFETs with silicon MOSFETs. The cascode approach simplifies gate drive and allows these devices to serve as "drop-in" replacements for most TO-247-3L IGBTs, silicon MOSFETs and SiC MOSFETs.

Table 2. Comparing Q_{RR} of UF3C FAST series devices with Q_{RR} of the UJ3C series devices.

1200V Devices	UJ3C120040K3S	UF3C120040K3S
Q_{rr} (150C)	482nC	289nC 
$R_{ds(on)}$	35mohm	35mohm
$V_F(20A)$	1.5V	1.5V

650V Devices	UJ3C065030K3S	UF3C065030K3S
Q_{rr} (150C)	400nC	188nC 
$R_{ds(on)}$	27mohm	27mohm
$V_F(20A)$	1.3V	1.3V



- Cascode turn-off ringing may be reduced by high $R_{G,OFF}$
 - Leads to long delay times
- V_{DS} and V_{GS} ringing dramatically improve with small snubber circuit
 - Switching FETs at 50A, 800V

Snubber loss is
<2.5% of total $E_{ON} + E_{OFF}$ at 10A and < 1.5% at 50A.

Fig. 2. Snubber design for the UF3C120040K3S series. Snubber loss is less than 2.5% of the total switching losses at 10 A and less than 1.5% of switching losses at 50 A.