ISSUE: November 2014

1200-V And 1700-V SiC Junction Transistors Are Positioned To Challenge SiC MOSFETs And Silicon IGBTs

GeneSiC Semiconductor has announced a new family of low on-resistance 1700-V and 1200-V SiC junction transistors (SJTs) in TO-247 packages. According to the vendor, these second-generation devices include the highest-power single-chip transistor on the market—a 1700-V SJT with 25-mΩ on-resistance, which offers more than an order of magnitude lower on-resistance than comparable packaged 1700-V SiC MOSFETs. And compared with GeneSiC's first-generation SJTs, the new devices offer a notable improvement in current gain, better current-gain stability, and lower on-resistance than previously released 1200-V and 1700-V parts. Meanwhile, even as their improved performance puts them in competition with SiC MOSFETs, these new SJTs also aim to supplant conventional, silicon IGBTs. (SJTs are similar to the IGBTs in that they have no body diode.)

Three versions of the 1700-V SJT have been released with different values of on-resistance—25-mΩ (GA50JT17-247), 65 mΩ (GA16JT17-247), and 220 mΩ (GA04JT17-247). These devices specify a current gain (h_{FE}) >90, a T_{JMAX} of 175°C and turn on/off (rise/fall) times of <30 ns typical.

Similarly, four versions of the 1200-V SJT have been released—25 mΩ (GA50JT12-247), 60 mΩ (GA20JT12-247), 120 mΩ (GA10JT12-247), and 210 mΩ (GA05JT12-247). These devices specify similar values for current gain, max junction temperature and turn on/off times as the new 1700-V parts. In addition, all seven of the packaged SJTs listed above are also available in chip form.

According to the vendor, the use of SJTs with high-voltage, high-frequency, high-temperature and low on-resistance capabilities will increase conversion efficiency and reduce the size, weight, and volume of power electronics applications requiring higher bus voltages. These new devices target a wide variety of applications including dc microgrids, vehicle fast chargers, server, telecom and networking power supplies, UPSs, solar inverters, wind power systems, and industrial motor control systems.

These SJTs exhibit ultra-fast switching capability (similar to that of SiC MOSFETs), a square reverse-biased safe operating area (also similar to SiC MOSFETs) as well as temperature-independent transient energy losses and switching times. These switches are gate-oxide free, normally-off, exhibit positive temperature co-efficient of on-resistance, and are capable of being driven by commercially available gate drivers, unlike other SiC switches. Unique advantages of the SJT in contrast to other SiC switches include their higher long-term reliability, >10-µs short circuit capability, and superior avalanche capability.

"These improved SJTs offer much higher current gains (>100), highly stable and robust performance as compared to other SiC switches. GeneSiC's SJTs offer extremely low conduction losses at rated currents as well as superior turn-off losses in power circuits. Utilizing the unique device and fabrication innovations, GeneSiC's transistor products help designers achieve a more robust solution," says Dr. Ranbir Singh, president of GeneSiC Semiconductor.

According to Singh, the on-resistance of these GeneSiC's second-generation SJTs is dramatically lower than that of comparably rated packaged SiC MOSFETs. For example, while one of the new 1700-V SJTs offers an on-resistance of 25 mΩ, the lowest R_{ON} for a commercial available 1700-V SiC MOSFET, says Singh, is 1000 mΩ for a Cree device. However, he also notes that Cree has privately released a 1700-V SiC MOSFET in die form with a claimed on-resistance of 40 mΩ.

Among 1200-V SiC devices, GeneSiC's new 1200-V/25-mΩ device (GA50JT12-247) is said to match the lowest R_{ON} device in the market at 1200 V, another device by Cree. But Singh points out that the 1200-V/25-mΩ SiC MOSFET is 40% larger than the GeneSiC chip. "This has huge implications on the fundamental nature of GeneSiC's SJT technological advantage over state of the art SiC MOSFET technology," says Singh.

According to Singh, SJTs have another advantage over SiC MOSFETs. "SiC MOSFET I-V curves are 'soft'," he says while noting that a comparison of GeneSiC's 1200-V/25-mΩ SJT with a comparable 1200-V/25-mΩ SiC MOSFET shows a V_F at 60 A of ~1.2 V for the SJT versus ~1.8 V for the SiC MOSFET, which is 50% higher. "This is for devices claimed to have the same R_{ON}. Again, the importance of this cannot be understated, because with minimal switching losses, conduction losses play the dominant role in SiC-based power converters," he comments.

Despite the comparisons with SiC MOSFETs, and Singh claims many advantages for SJTs versus SiC MOSFETs, the greater potential for SJTs may be in replacing silicon IGBTs.

“The SJT is technically the ‘IGBT-killer’ because it offers similar functionality but much higher switching speeds, and superior high-temperature capability. With up to 1 MHz soft-switching capability, these SJT devices promise significant reductions in circuit size, weight, volume, and cost over IGBT-based solutions,” says Singh.

All of the new SJT devices are 100% tested to full voltage and current ratings and housed in halogen-free, RoHS compliant TO-247 packages. The devices are immediately available from GeneSiC’s authorized distributors (Digikey, Mouser and Newark/Farnell.) For more information, please visit the company’s SiC Junction Transistors page.