# GeneSiC SEMICONDUCTOR

# GA06JT12-247

## Normally – OFF Silicon Carbide Junction Transistor

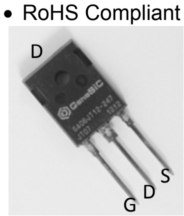
| | | |
|---|---|---|
| $V_{DS}$ | = | 1200 V |
| $V_{DS(ON)}$ | = | 1.3 V |
| $I_D$ | = | 6 A |
| $R_{DS(ON)}$ | = | 220 mΩ |

## Features

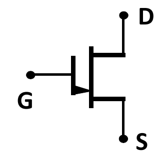
- 175 °C maximum operating temperature
- Temperature independent switching performance
- Gate oxide free SiC switch
- Suitable for connecting an anti-parallel diode
- Positive temperature coefficient for easy paralleling
- Low gate charge
- Low intrinsic capacitance

## Package

- RoHS Compliant




**TO-247AB**




## Advantages

- Low switching losses
- Higher efficiency
- High temperature operation
- High short circuit withstand capability

## Applications

- Down Hole Oil Drilling, Geothermal Instrumentation
- Hybrid Electric Vehicles (HEV)
- Solar Inverters
- Switched-Mode Power Supply (SMPS)
- Power Factor Correction (PFC)
- Induction Heating
- Uninterruptible Power Supply (UPS)
- Motor Drives

## Maximum Ratings unless otherwise specified

| Parameter | Symbol | Conditions | Values | Unit |
|---|---|---|---|---|
| Drain – Source Voltage | $V_{DS}$ | $V_{GS}$ = 0 V | 1200 | V |
| Continuous Drain Current | $I_D$ | $T_{C,MAX}$ = 90 °C | 6 | A |
| Gate Peak Current | $I_{GM}$ | | 5 | A |
| Turn-Off Safe Operating Area | RBSOA | $T_{VJ}$ = 175 °C, $I_G$ = 1 A, Clamped Inductive Load | $I_{D,max}$ = 6 @ $V_{DS} \leq V_{DSmax}$ | A |
| Short Circuit Safe Operating Area | SCSOA | $T_{VJ}$ = 175 °C, $I_G$ = 1 A, $V_{DS}$ = 800 V, Non Repetitive | 20 | µs |
| Reverse Gate – Source Voltage | $V_{SG}$ | | 30 | V |
| Reverse Drain – Source Voltage | $V_{SD}$ | | 40 | V |
| Power Dissipation | $P_{tot}$ | $T_C$ = 25 °C | 146 | W |
| Storage Temperature | $T_{stg}$ | | -55 to 175 | °C |

## Electrical Characteristics at $T_j$ = 175 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **On Characteristics** | | | | | | |
| Drain – Source On Voltage | $V_{DS(ON)}$ | $I_D$ = 6 A, $I_G$ = 500 mA, $T_j$ = 25 °C | | 1.3 | 1.7 | V |
| | | $I_D$ = 6 A, $I_G$ = 1000 mA, $T_j$ = 125 °C | | 1.7 | 2.2 | |
| | | $I_D$ = 6 A, $I_G$ = 1000 mA, $T_j$ = 175 °C | | 2.2 | 3.0 | |
| Drain – Source On Resistance | $R_{DS(ON)}$ | $I_D$ = 6 A, $I_G$ = 500 mA, $T_j$ = 25 °C | | 220 | | mΩ |
| | | $I_D$ = 6 A, $I_G$ = 1000 mA, $T_j$ = 125 °C | | 280 | | |
| | | $I_D$ = 6 A, $I_G$ = 1000 mA, $T_j$ = 175 °C | | 370 | | |
| Gate Forward Voltage | $V_{GS(FWD)}$ | $I_G$ = 500 mA, $T_j$ = 25 °C | | 3.1 | | V |
| | | $I_G$ = 500 mA, $T_j$ = 175 °C | | 2.9 | | |
| DC Current Gain | β | $V_{DS}$ = 5 V, $I_D$ = 6 A, $T_j$ = 25 °C | 45 | 53 | | |
| | | $V_{DS}$ = 5 V, $I_D$ = 6 A, $T_j$ = 175 °C | | 33 | | |
| **Off Characteristics** | | | | | | |
| Drain Leakage Current | $I_{DSS}$ | $V_R$ = 1200 V, $V_{GS}$ = 0 V, $T_j$ = 25 °C | | 0.5 | 10 | µA |
| | | $V_R$ = 1200 V, $V_{GS}$ = 0 V, $T_j$ = 125 °C | | 1 | 50 | |
| | | $V_R$ = 1200 V, $V_{GS}$ = 0 V, $T_j$ = 175 °C | | 2 | 100 | |
| Gate Leakage Current | $I_{SG}$ | $V_{SG}$ = 20 V, $T_j$ = 25 °C | | 20 | | nA |

## Electrical Characteristics at $T_j$ = 175 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Values min. | Values typ. | Values max. | Unit |
|---|---|---|---|---|---|---|
| **Capacitance Characteristics** | | | | | | |
| Gate-Source Capacitance | $C_{gs}$ | $V_{GS}$ = 0 V, f = 1 MHz | | 660 | | pF |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_D$ = 1 V, f = 1 MHz | | 900 | | pF |
| Reverse Transfer/Output Capacitance | $C_{rss}/C_{oss}$ | $V_D$ = 1 V, f = 1 MHz | | 240 | | pF |
| **Switching Characteristics** | | | | | | |
| Turn On Delay Time | $t_{d(on)}$ | $T_j$ = 25 ºC, $V_{DD}$ = 800 V, $I_D$ = 6 A, "Option #1" Gate Drive $R_{G(on)}$ = $R_{G(off)}$ = 1.5 Ω, $C_G$ = 9 nF $V_{GH}$ = 20 V, $V_{GL}$ = 6 V, $V_{EE}$ = -5 V L = 1.05 mH, FWD = GB05SLT12, Refer to Figure 15 for gate current waveform | | 13 | | ns |
| Rise Time, Drain Current | $t_r$ | | | 7 | | ns |
| Turn Off Delay Time | $t_{d(off)}$ | | | 54 | | ns |
| Fall Time, Drain Current | $t_f$ | | | 51 | | ns |
| Turn-On Energy Per Pulse | $E_{on}$ | | | 175 | | µJ |
| Turn-Off Energy Per Pulse | $E_{off}$ | | | 44 | | µJ |
| Total Switching Energy | $E_{ts}$ | | | 219 | | µJ |
| Turn On Delay Time | $t_{d(on)}$ | $T_j$ = 175 ºC, $V_{DD}$ = 800 V, $I_D$ = 6 A, "Option #1" Gate Drive $R_{G(on)}$ = $R_{G(off)}$ = 1.5 Ω, $C_G$ = 9 nF $V_{GH}$ = 20 V, $V_{GL}$ = 6 V, $V_{EE}$ = -5 V L = 1.05 mH, FWD = GB05SLT12, Refer to Figure 15 for gate current waveform | | 11 | | ns |
| Rise Time, Drain Current | $t_r$ | | | 8 | | ns |
| Turn Off Delay Time | $t_{d(off)}$ | | | 79 | | ns |
| Fall Time, Drain Current | $t_f$ | | | 45 | | ns |
| Turn-On Energy Per Pulse | $E_{on}$ | | | 159 | | µJ |
| Turn-Off Energy Per Pulse | $E_{off}$ | | | 55 | | µJ |
| Total Switching Energy | $E_{ts}$ | | | 214 | | µJ |
| **Thermal Characteristics** | | | | | | |
| Thermal resistance, junction - case | $R_{thJC}$ | | | 1.03 | | °C/W |

## Figures

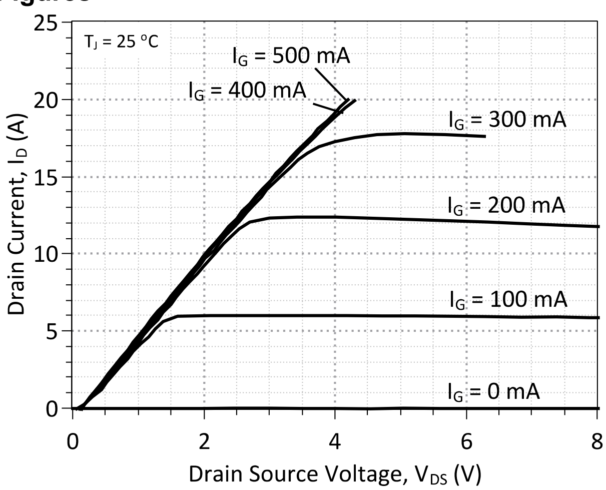



Figure 1: Typical Output Characteristics at 25 °C

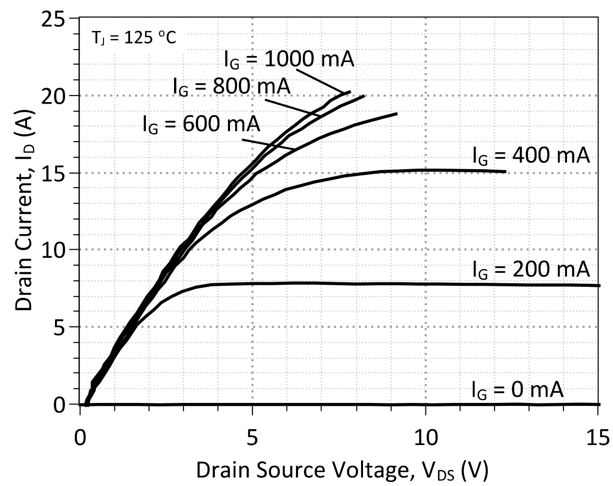



Figure 2: Typical Output Characteristics at 125 °C

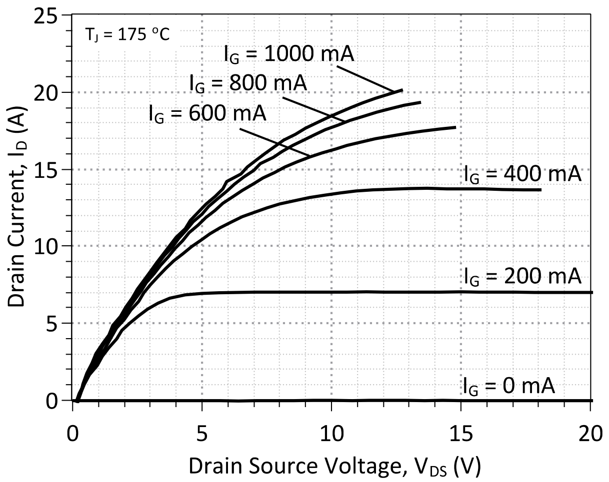



Figure 3: Typical Output Characteristics at 175 °C

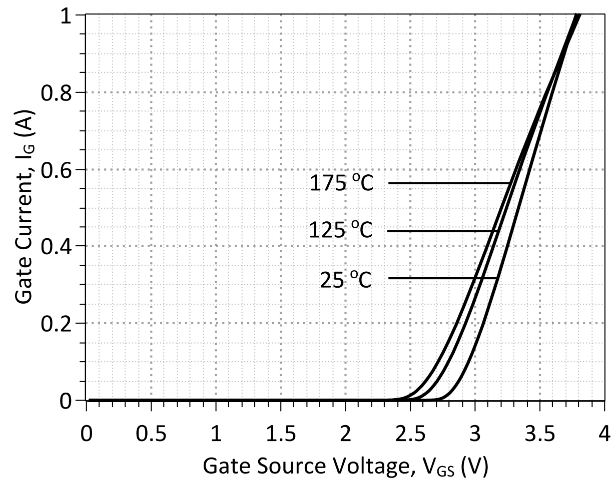



Figure 4: Typical Gate Source I-V Characteristics vs. Temperature

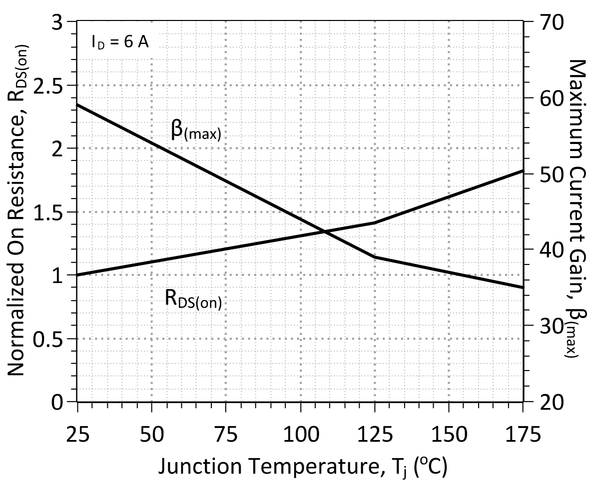



Figure 5: Normalized On-Resistance and Current Gain vs. Temperature

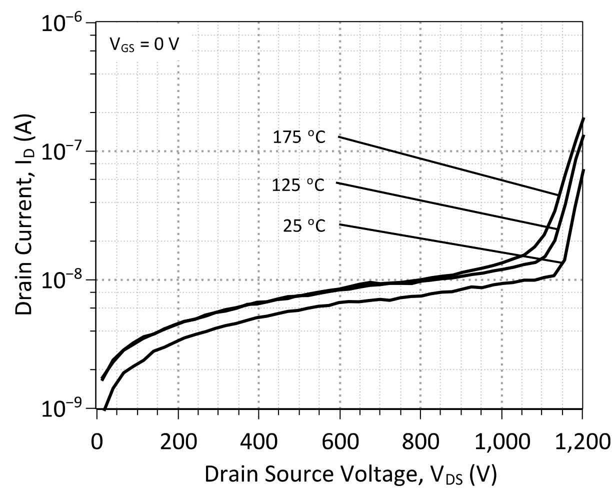



Figure 6: Typical Blocking Characteristics

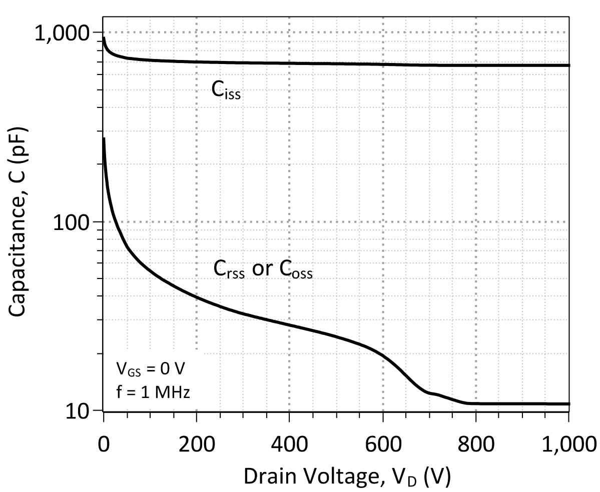



Figure 7: Capacitance Characteristics

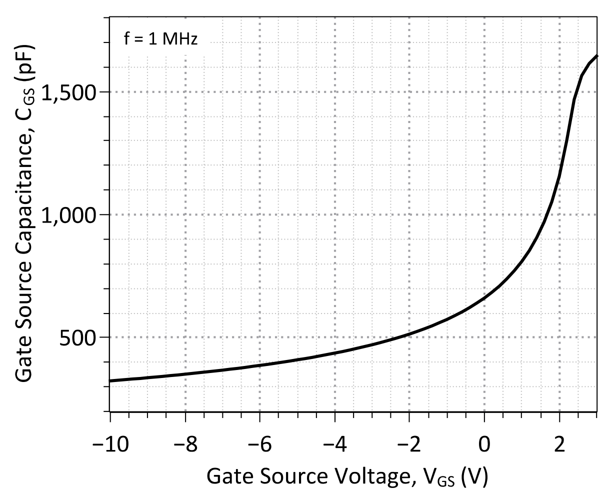



Figure 8: Capacitance Characteristics

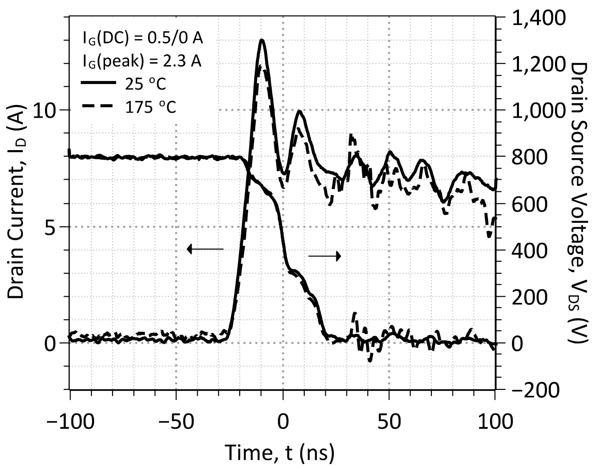



**Figure 9: Typical Hard-switched Turn On Waveforms**

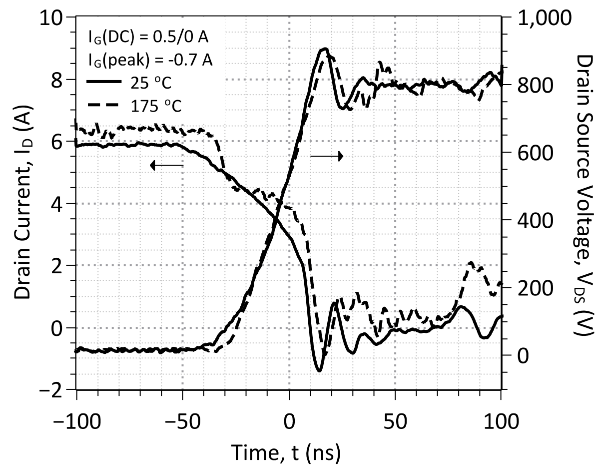



**Figure 10: Typical Hard-switched Turn Off Waveforms**

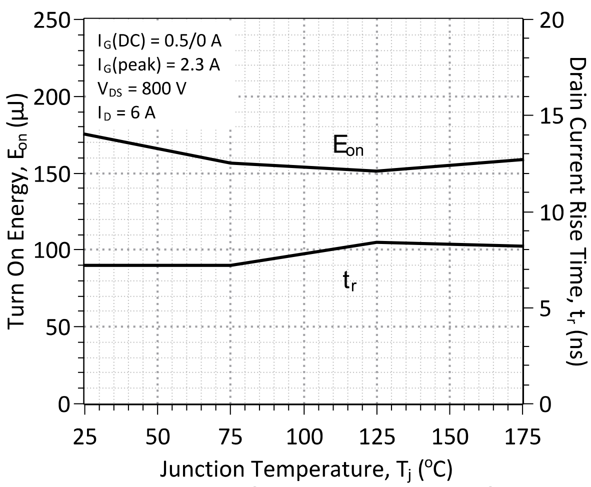



**Figure 11: Typical Turn On Energy Losses and Switching Times vs. Temperature**

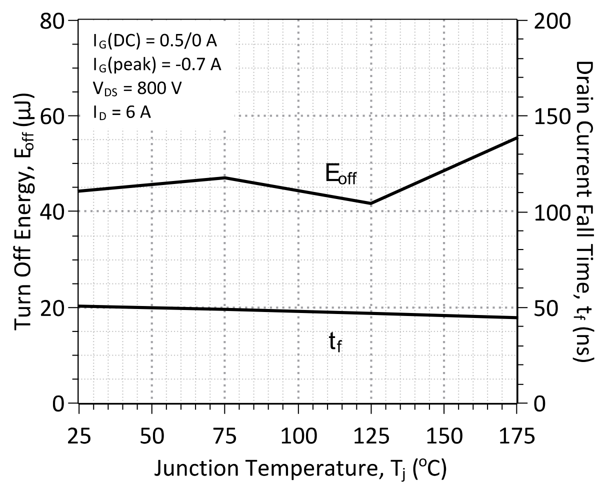



**Figure 12: Typical Turn Off Energy Losses and Switching Times vs. Temperature**

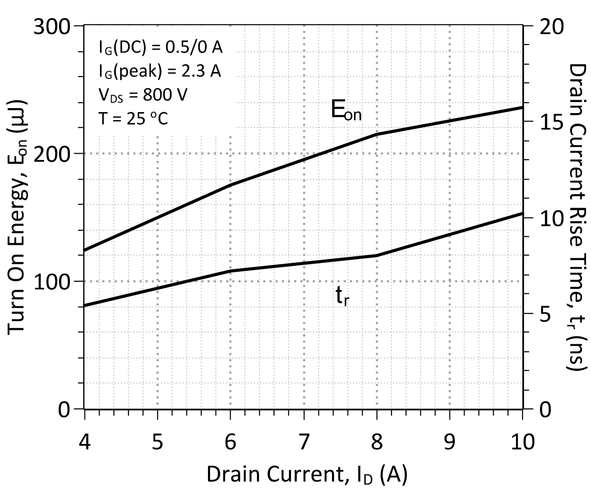



**Figure 13: Typical Turn On Energy Losses vs. Drain Current**

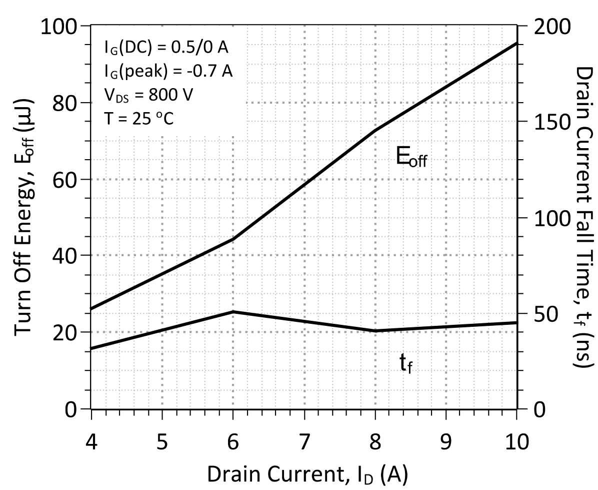



**Figure 14: Typical Turn Off Energy Losses vs. Drain Current**

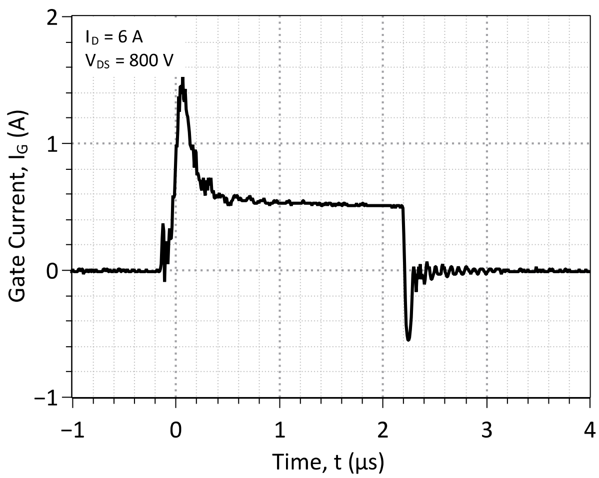



Figure 15: Typical Gate Current Waveform

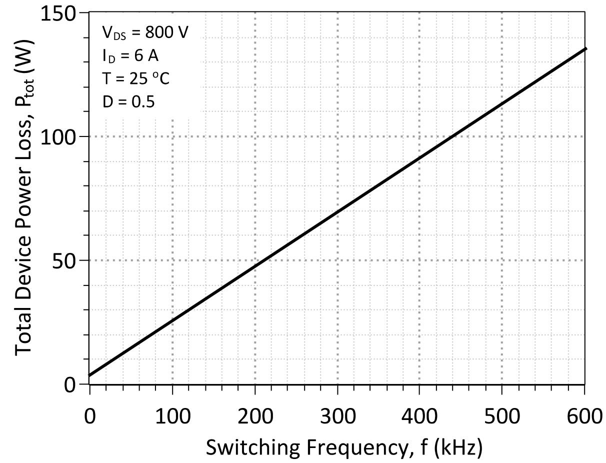



Figure 16: Typical Hard Switched Device Power Loss vs. Switching Frequency [1]

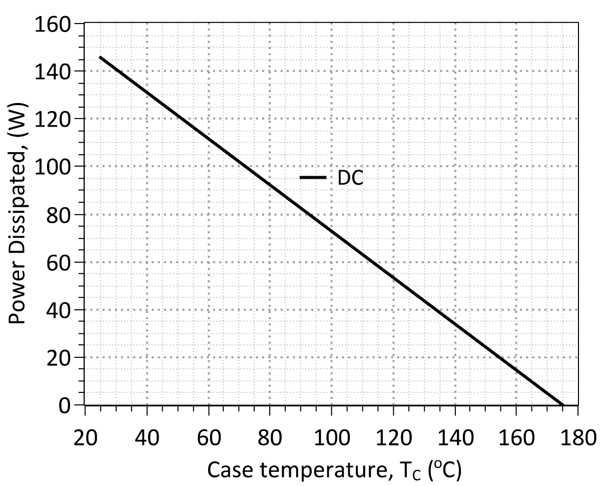



Figure 17: Power Derating Curve

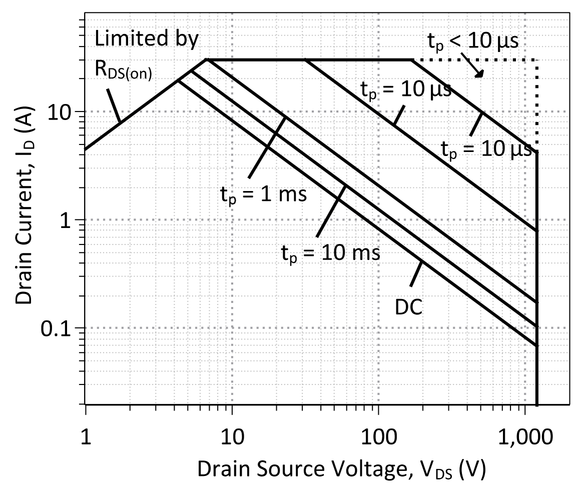



Figure 18: Forward Bias Safe Operating Area

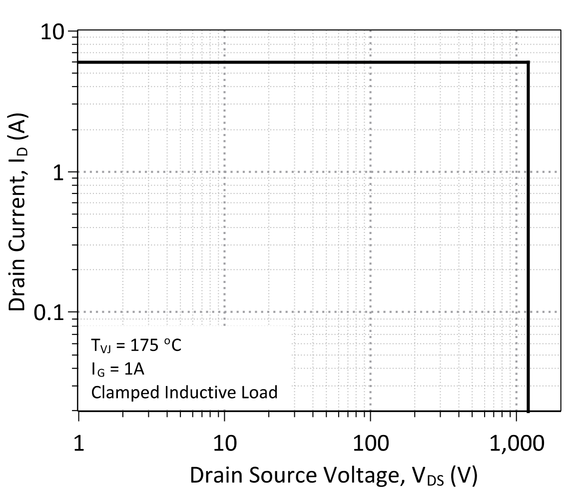



Figure 19: Turn-Off Safe Operating Area

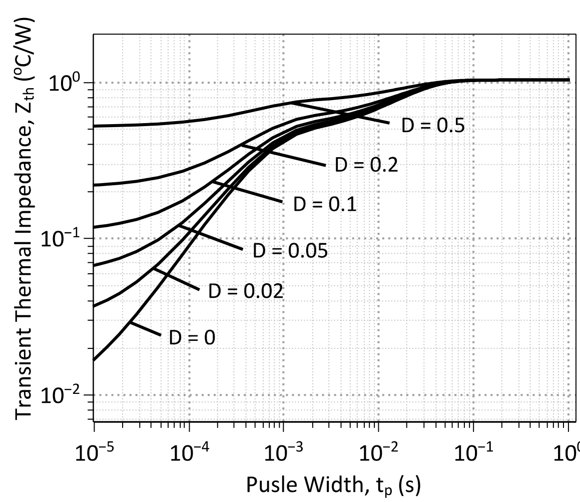



Figure 20: Transient Thermal Impedance

[1] – Representative values based on device switching energy loss. Actual losses will depend on gate drive conditions, device load, and circuit topology.

## Gate Drive Technique (Option #1)

To drive the GA06JT12-247 with the lowest gate drive losses, please refer to the dual voltage source gate drive configuration described in Application Note AN-10B (http://www.genesicsemi.com/index.php/references/notes).

## Gate Drive Technique (Option #2)

The GA06JT12-247 can be effectively driven using the IXYS IXDN614 / IXDD614 non-inverting gate driver IC or a comparable product. A typical gate driver configuration along with component values using this driver is offered below. Additional information is available in GeneSiC Application Note AN-10A and from the manufacturer at www.ixys.com.

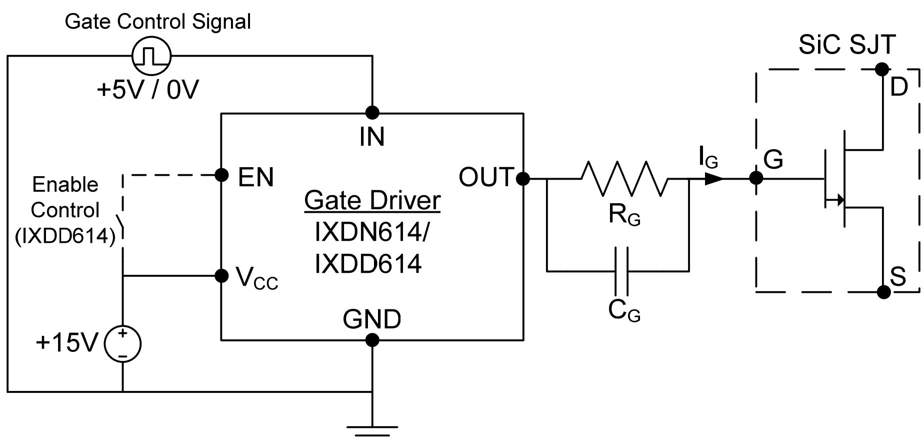
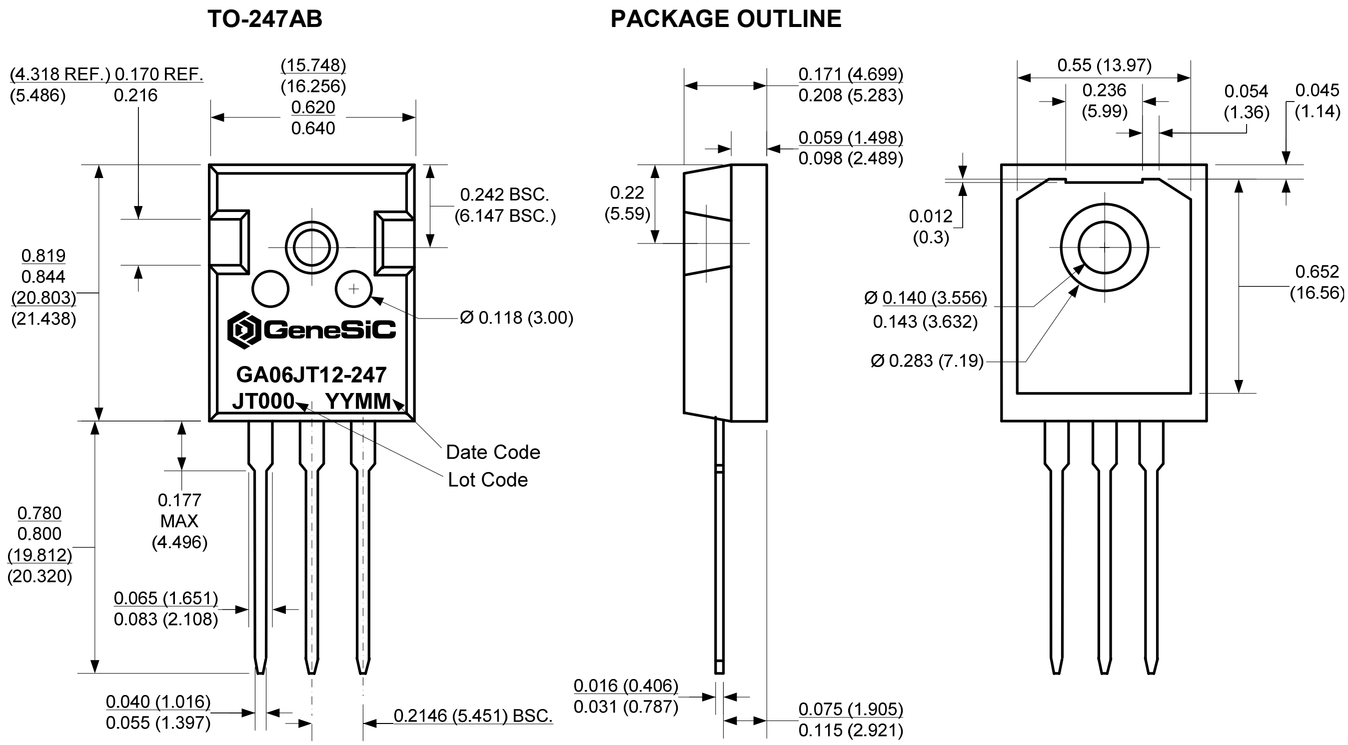



**Figure 21: Gate Diver Configuration (Option #2)**

| Parameter | Symbol | Conditions | Values min. | Values typ. | Values max. | Unit |
|---|---|---|---|---|---|---|
| **Option #1 Gate Drive Conditions (IXDD614/IXDN614)** | | | | | | |
| Supply Voltage, High Side Driver | $V_{CC}$ | $V_{GH}$ | 15 | 20 | 30 | V |
| Supply Voltage, Low Side Driver | $V_{CC}$ | $V_{GL}$ | 5 | 6 | | V |
| Off State Voltage, Both Drivers | GND | $V_{EE}$ | | -5 | 0 | V |
| Gate Control Input Signal, Low | IN | | -5.0 | 0 | 0.8 | V |
| Gate Control Input Signal, High | IN | | 4 | 5.0 | $V_{CC}$+0.3 | V |
| Enable, Low | EN | IXDD614 Only | | | 1/3*$V_{CC}$ | V |
| Enable, High | EN | IXDD614 Only | 2/3*$V_{CC}$ | | | V |
| Output Voltage, Low | $V_{OUT}$ | | | | 0.025 | V |
| Output Voltage, High | $V_{OUT}$ | | $V_{CC}$-0.025 | | | V |
| Output Current, Peak | $I_{OUT}$ | Package Limited | | | 14 | A |
| Output Current, Continuous | $I_{OUT}$ | | | 0.5 | 4.0 | A |
| **Passive Gate Components** | | | | | | |
| Gate Resistance | $R_G$ | $V_{GL}$ = 6.0 V, $I_G \approx$ 0.5 A | | 1.6 | 5 | Ω |
| Gate Capacitance | $C_G$ | $V_{GH}$ = 20 V, $I_{G,pk} \approx$ 2.0 A | 5 | 9 | | nF |

## Package Dimensions:




**NOTE**
1. CONTROLLED DIMENSION IS INCH. DIMENSION IN BRACKET IS MILLIMETER.
2. DIMENSIONS DO NOT INCLUDE END FLASH, MOLD FLASH, MATERIAL PROTRUSIONS

**Revision History**

| Date | Revision | Comments | Supersedes |
|---|---|---|---|
| 2013/11/13 | 4 | Updated Electrical Characteristics | |
| 2013/08/23 | 3 | Updated Switching Characteristics | |
| 2013/06/24 | 2 | Updated Electrical Characteristics | |
| 2013/02/21 | 1 | Revised Electrical Characteristics | |
| 2012/11/30 | 0 | Initial Release | |

Published by
GeneSiC Semiconductor, Inc.
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Dulles, VA 20166

## SPICE Model Parameters

Copy the following code into a SPICE software program for simulation of the GA06JT12 SJT device.

```
*     MODEL OF GeneSiC Semiconductor Inc.
*
*     $Revision:   1.0           $
*     $Date:   26-AUG-2013       $
*
*     GeneSiC Semiconductor Inc.
*     43670 Trade Center Place Ste. 155
*     Dulles, VA 20166
*     http://www.genesicsemi.com/index.php/sic-products/sjt
*
*     COPYRIGHT (C) 2013 GeneSiC Semiconductor Inc.
*     ALL RIGHTS RESERVED
*
* These models are provided "AS IS, WHERE IS, AND WITH NO WARRANTY
* OF ANY KIND EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED
* TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A
* PARTICULAR PURPOSE."
* Models accurate up to 2 times rated drain current.
*
.model GA06JT12 NPN
+ IS       5.08E-47
+ ISE      1.26E-28
+ EG       3.2
+ BF       58.31
+ BR       0.55
+ IKF      200
+ NF       1
+ NE       1.892
+ RB       0.26
+ RE       0.1039
+ RC       0.06188
+ CJC      2.73E-10
+ VJC      3.04
+ MJC      0.448
+ CJE      6.86E-10
+ VJE      2.89
+ MJE      0.466
+ XTI      3
+ XTB      -1.33
+ TRC1     1.90E-2
+ VCEO     1200
+ ICRATING 6
+ MFG      GeneSiC_Semiconductor
*
* End of GA06JT12 SPICE Model
```