Normally – OFF Silicon Carbide Junction Transistor

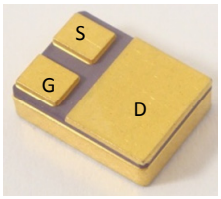
V_{DS}	=	600 V
$R_{DS(ON)}$	=	180 mΩ
$I_{D\ (Tc\ =\ 25°C)}$	=	20 A
$h_{FE\ (Tc\ =\ 25°C)}$	=	110

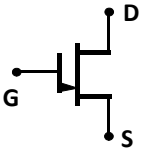
Features

- 225°C maximum operating temperature
- Gate Oxide Free SiC Switch
- Exceptional Safe Operating Area
- Excellent Gain Linearity
- Temperature Independent Switching Performance
- Low Output Capacitance
- Positive Temperature Coefficient of $R_{DS,ON}$
- Suitable for Connecting an Anti-parallel Diode

Package

- RoHS Compliant





SMD0.5 / TO – 276 (Hermetic Package)

Advantages

- Compatible with Si MOSFET/IGBT Gate Drive ICs
- > 20 µs Short-Circuit Withstand Capability
- Lowest-in-class Conduction Losses
- High Circuit Efficiency
- Minimal Input Signal Distortion
- High Amplifier Bandwidth

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

Absolute Maximum Ratings

Parameter	Symbol	Conditions	Values	Unit
Drain – Source Voltage	V_{DS}	V_{GS} = 0 V	600	V
Continuous Drain Current	I_D	T_J = 225°C, T_C = 25°C	20	A
Continuous Gate Current	I_{GM}		1.25	A
Turn-Off Safe Operating Area	RBSOA	T_{VJ} = 225°C, I_G = 1.25 A, Clamped Inductive Load	$I_{D,max}$ = 8 @ $V_{DS} \le V_{DSmax}$	A
Short Circuit Safe Operating Area	SCSOA	T_{VJ} = 225°C, I_G = 1.25 A, V_{DS} = 400 V, Non Repetitive	>20	µs
Reverse Gate – Source Voltage	V_{GS}		30	V
Reverse Drain – Source Voltage	V_{DS}		40	V
Power Dissipation	P_{tot}	T_J = 225°C, T_C = 25°C	200	W
Operating and Storage Temperature	T_j, T_{stg}		-55 to 225	°C

Electrical Characteristics

Parameter	Symbol	Conditions	Values min.	Values typ.	Values max.	Unit
On Characteristics						
Drain – Source On Resistance	$R_{DS(ON)}$	I_D = 8 A, I_G = 250 mA, T_j = 25 °C		180		mΩ
		I_D = 8 A, I_G = 500 mA, T_j = 175 °C		330		
		I_D = 8 A, I_G = 500 mA, T_j = 220 °C		490		
Gate Forward Voltage	$V_{GS(FWD)}$	I_G = 500 mA, T_j = 25 °C		3		V
		I_G = 500 mA, T_j = 220 °C		2.7		
DC Current Gain	h_{FE}	V_{DS} = 5 V, I_D = 10 A, T_j = 25 °C	80	110		
		V_{DS} = 5 V, I_D = 10 A, T_j = 220 °C	50	80		
Off Characteristics						
Drain Leakage Current	I_{DSS}	V_R = 600 V, V_{GS} = 0 V, T_j = 25 °C		10	100	µA
		V_R = 600 V, V_{GS} = 0 V, T_j = 175 °C		40	400	
		V_R = 600 V, V_{GS} = 0 V, T_j = 220 °C		100	600	

Electrical Characteristics

Parameter	Symbol	Conditions	Values min.	Values typ.	Values max.	Unit
Capacitance Characteristics						
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_D = 500 V, f = 1 MHz		685		pF
Reverse Transfer/Output Capacitance	C_{rss}/C_{oss}	V_D = 500 V, f = 1 MHz		24		pF
Output Capacitance Stored Energy	E_{OSS}	V_{GS} = 0 V, V_D = 500 V, f = 1 MHz		3.1		µJ
Switching Characteristics						
Turn On Delay Time	$t_{d(on)}$	V_{DD} = 400 V, I_D = 8 A, $R_{G(on)}$ = $R_{G(off)}$ = 32 Ω, C_G = 9 nF Single-Level Gate Drive V_{GS} = -8/15 V ,T_j = 175 ºC Refer to Figure 11 for gate drive current waveforms		10		ns
Rise Time	t_r			30		ns
Turn Off Delay Time	$t_{d(off)}$			75		ns
Fall Time	t_f			40		ns
Turn-On Energy Per Pulse	E_{on}			35		µJ
Turn-Off Energy Per Pulse	E_{off}			65		µJ
Total Switching Energy	E_{ts}			100		µJ
Turn On Delay Time	$t_{d(on)}$	V_{DD} = 400 V, I_D = 8 A, $R_{G(on)}$ = $R_{G(off)}$ = 32 Ω, C_G = 9 nF Single-Level Gate Drive V_{GS} = -8/15 V ,T_j = 250 ºC Refer to Figure 11 for gate drive current waveforms		10		ns
Rise Time	t_r			30		ns
Turn Off Delay Time	$t_{d(off)}$			75		ns
Fall Time	t_f			60		ns
Turn-On Energy Per Pulse	E_{on}			45		µJ
Turn-Off Energy Per Pulse	E_{off}			80		µJ
Total Switching Energy	E_{ts}			125		µJ
Thermal Characteristics						
Thermal resistance, junction - case	R_{thJC}			1		°C/W

Figures

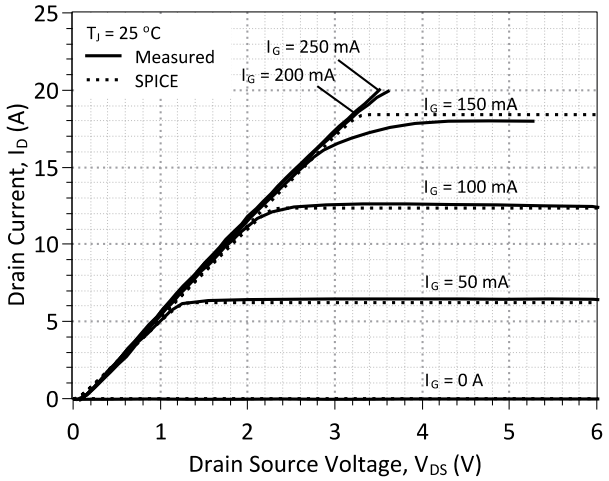


Figure 1: Typical Output Characteristics at 25 °C

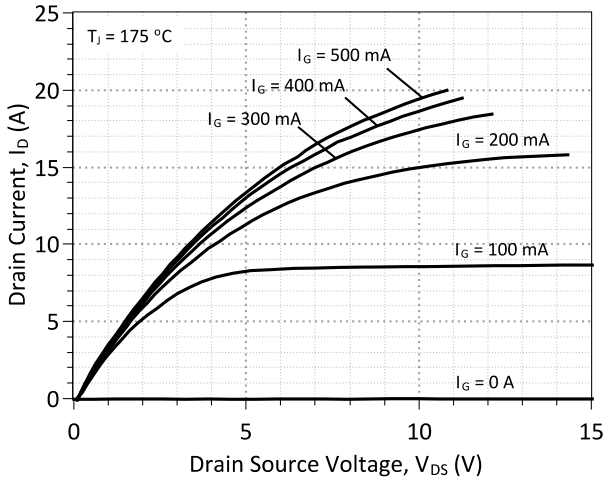


Figure 2: Typical Output Characteristics at 175 °C

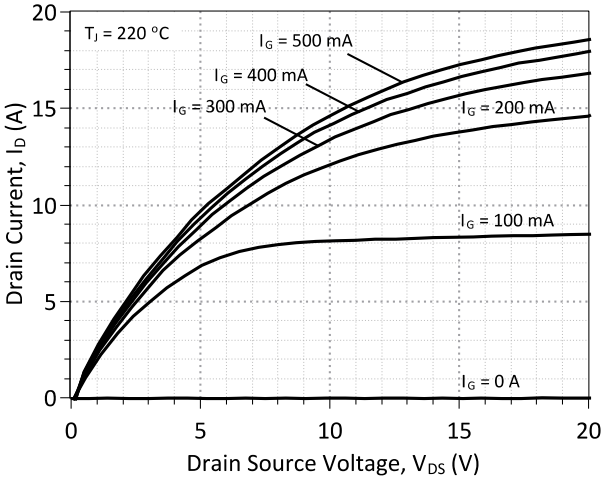


Figure 3: Typical Output Characteristics at 220 °C

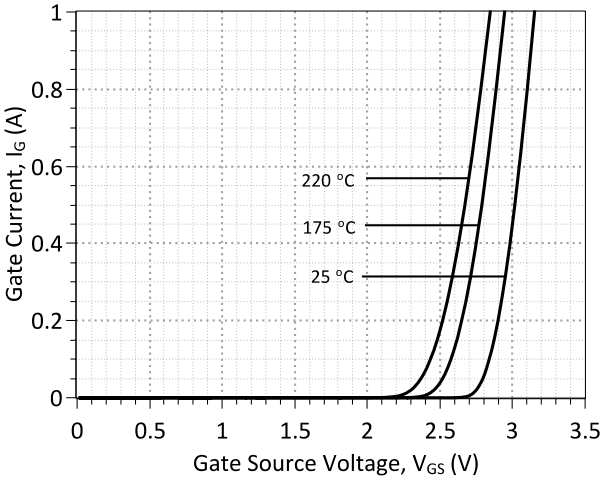


Figure 4: Typical Gate Source I-V Characteristics vs. Temperature

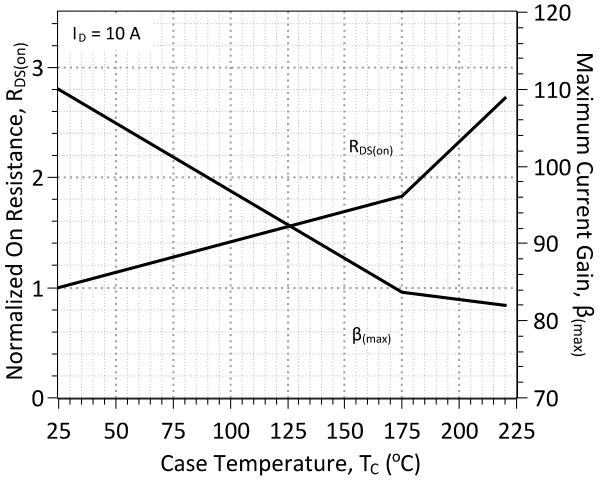


Figure 5: Normalized On-Resistance and Current Gain vs. Temperature

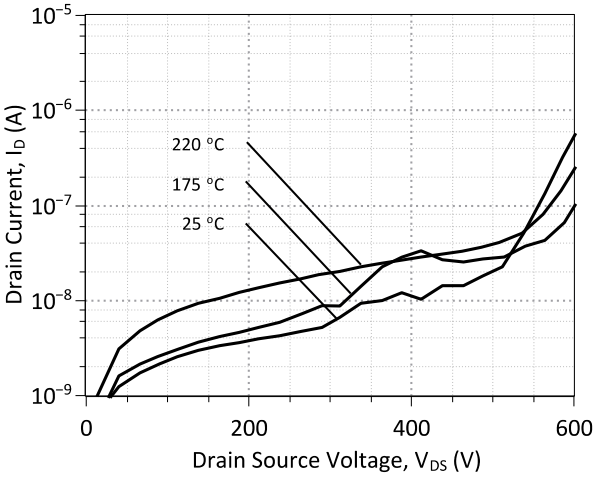


Figure 6: Typical Blocking Characteristics

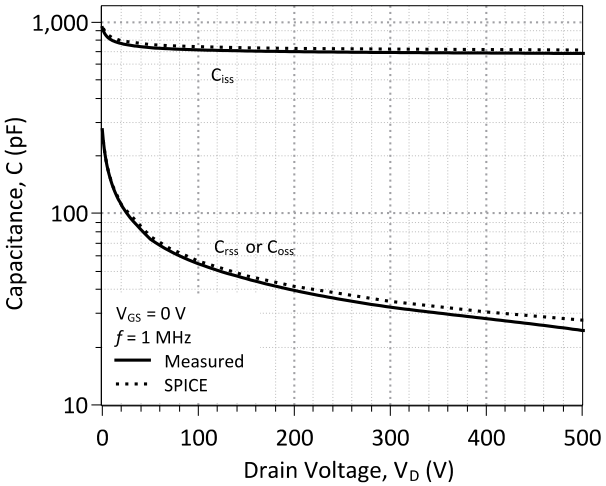


Figure 7: Capacitance Characteristics

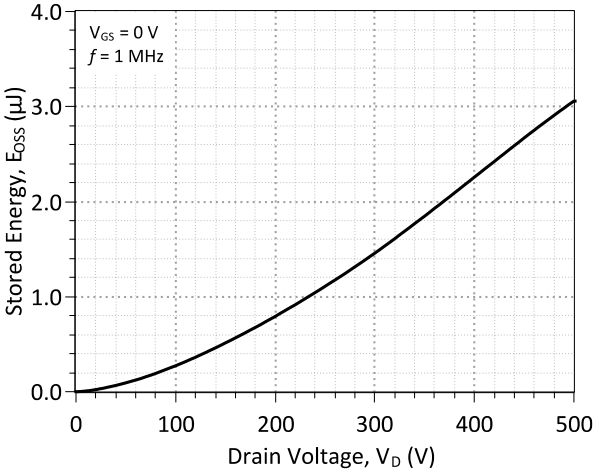


Figure 8: Output Capacitance Stored Energy

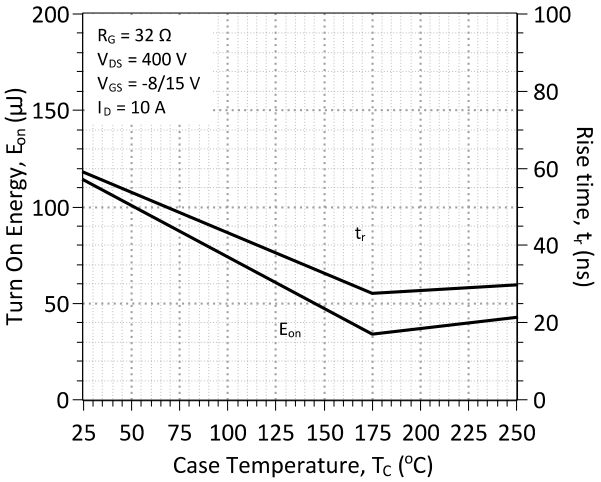


Figure 9: Typical Turn On Energy Losses and Switching Times vs. Temperature

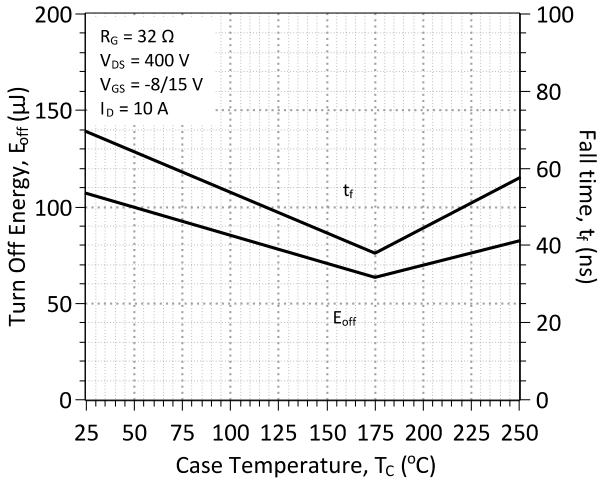


Figure 10: Typical Turn Off Energy Losses and Switching Times vs. Temperature

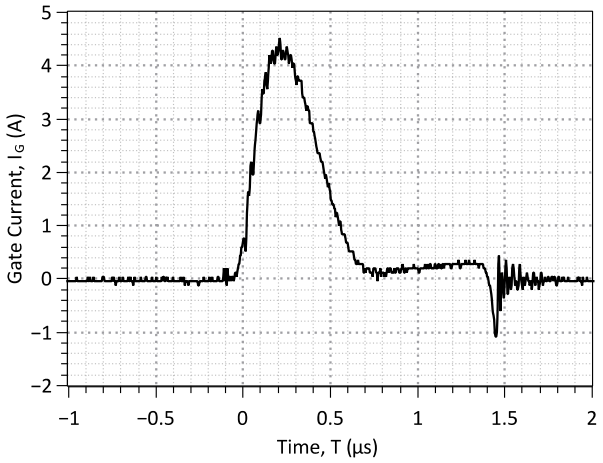


Figure 11: Typical Gate Current Waveform

Gate Drive Theory of Operation

The SJT transistor is a current controlled transistor which requires a positive gate current for turn-on as well as to remain in on-state. An ideal gate current waveform for ultra-fast switching of the SJT, while maintaining low gate drive losses, is shown in Figure 12.

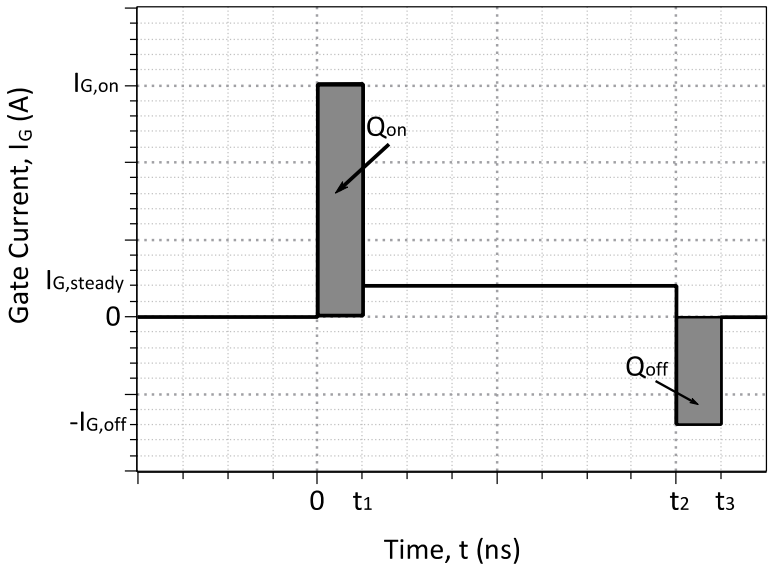


Figure 12: Idealized Gate Current Waveform

Gate Currents, $I_{G,pk}$/$-I_{G,pk}$ and Voltages during Turn-On and Turn-Off

An SJT is rapidly switched from its blocking state to on-state, when the necessary gate charge, Q_G, for turn-on is supplied by a burst of high gate current, $I_{G,on}$, until the gate-source capacitance, C_{GS}, and gate-drain capacitance, C_{GD}, are fully charged.

$$I_{G,on} * t_1 \geq Q_{gs} + Q_{gd}$$

The $I_{G,pon}$ pulse should ideally terminate, when the drain voltage falls to its on-state value, in order to avoid unnecessary drive losses during the steady on-state. In practice, the rise time of the $I_{G,on}$ pulse is affected by the parasitic inductances, L_{par} in the package and drive circuit. A voltage developed across the parasitic inductance in the source path, L_s, can de-bias the gate-source junction, when high drain currents begin to flow through the device. The applied gate voltage should be maintained high enough, above the $V_{GS,ON}$ level to counter these effects.

A high negative peak current, $-I_{G,off}$ is recommended at the start of the turn-off transition, in order to rapidly sweep out the injected carriers from the gate, and achieve rapid turn-off. While satisfactory turn off can be achieved with V_{GS} = 0 V, a negative gate voltage V_{GS} may be used in order to speed up the turn-off transition.

Steady On-State

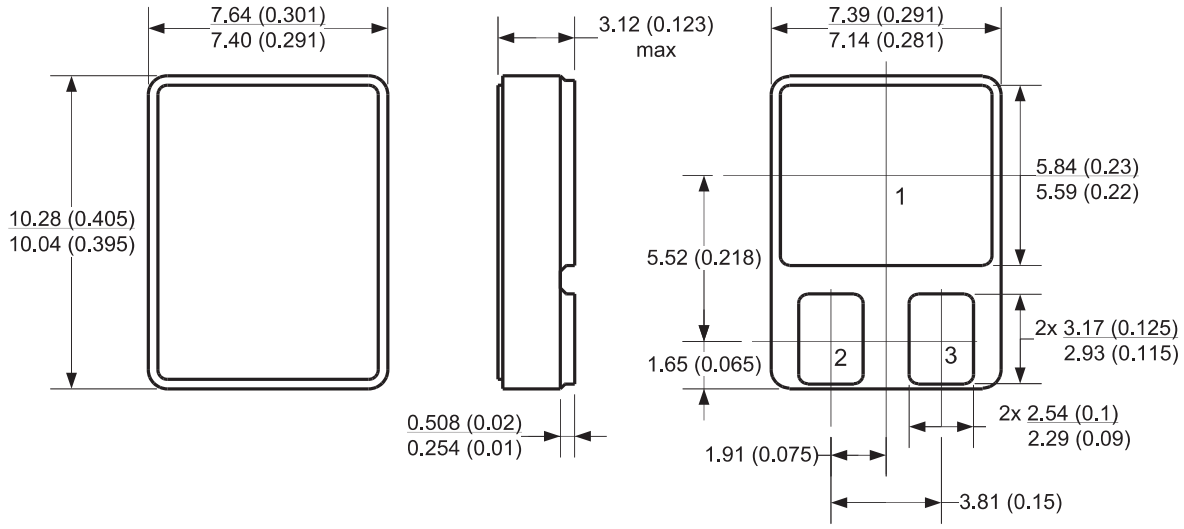
After the device is turned on, I_G may be advantageously lowered to $I_{G,steady}$ for reducing unnecessary gate drive losses. The $I_{G,steady}$ is determined by noting the DC current gain, h_{FE}, of the device.

The desired $I_{G,steady}$ is determined by the peak device junction temperature T_J during operation, drain current I_D, DC current gain h_{FE}, and a 50 % safety margin to ensure operating the device in the saturation region with low on-state voltage drop by the equation:

$$I_{G,steady} \approx \frac{I_D}{h_{FE}(T, I_D)} * 1.5$$

Package Dimensions:

SMD-0.5/TO-276 **PACKAGE OUTLINE**



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

Revision History			
Date	Revision	Comments	Supersedes
2014/08/23	5	Updated Electrical Characteristics	
2014/03/19	4	Updated Gate Drive Section	
2014/02/12	3	Updated Electrical Characteristics	
2013/12/19	2	Updated Gate Drive Section	
2013/11/18	1	Updated Electrical Characteristics	
2012/08/24	0	Initial release	

Published by
GeneSiC Semiconductor, Inc.
43670 Trade Center Place Suite 155
Dulles, VA 20166

SPICE Model Parameters

This is a secure document. Please copy this code from the SPICE model PDF file on our website (http://www.genesicsemi.com/images/hit_sic/sjt/2N7638-GA_SPICE.pdf) into LTSPICE (version 4) software for simulation of the 2N7638-GA.

```
*     MODEL OF GeneSiC Semiconductor Inc.
*
*     $Revision:   1.2           $
*     $Date:   23-JUN-2014       $
*
*     GeneSiC Semiconductor Inc.
*     43670 Trade Center Place Ste. 155
*     Dulles, VA 20166
*
*     COPYRIGHT (C) 2014 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 2N7638 NPN
+ IS       5.08E-47
+ ISE      1.26E-28
+ EG       3.23
+ BF       125
+ BR       0.55
+ IKF      900
+ NF       1
+ NE       2.021
+ RB       7.0
+ 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      -0.35
+ TRC1     1.90E-2
+ VCEO     600
+ ICRATING 20
+ MFG      GeneSiC_Semiconductor
*
* End of 2N7638-GA SPICE Model
```