GeneSiC
S E M I C O N D U C T O R

# Silicon Carbide Junction Transistor/Schottky Diode Co-pack

V_{DS}	=	1200 V
$V_{DS(ON)}$	=	1.4 V
I_D	=	20 A
$R_{DS(ON)}$	=	70 mΩ

Features

- 175 °C maximum operating temperature
- Temperature independent switching performance
- Gate oxide free SiC switch
- Integrated SiC Schottky Rectifier
- Positive temperature coefficient for easy paralleling
- Low intrinsic device capacitance
- Low gate charge

Package

- RoHS Compliant
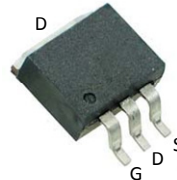
TO-263
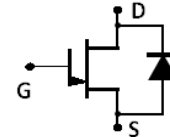
Advantages

- Low switching losses
- High circuit efficiency
- High temperature operation
- High short circuit withstand capability
- Reduced cooling requirements
- Reduced system size

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 at T_j = 175 °C, unless otherwise specified

Parameter	Symbol	Conditions	Values	Unit
SiC Junction Transistor				
Drain – Source Voltage	V_{DS}	V_{GS} = 0 V	1200	V
Continuous Drain Current	I_D	$T_{C,MAX}$ = 95 °C	20	A
Gate Peak Current	I_{GM}		10	A
Turn-Off Safe Operating Area	RBSOA	T_{VJ} = 175 °C, I_G = 1 A, Clamped Inductive Load	$I_{D,max}$ = 20 @ $V_{DS} \leq V_{DSmax}$	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}		25	V
Power Dissipation	P_{tot}	T_C = 95 °C	157	W
Storage Temperature	T_{stg}		-55 to 175	°C
Free-wheeling Silicon Carbide diode				
DC-Forward Current	I_F	$T_C \leq$ 150 °C	20	A
Non Repetitive Peak Forward Current	I_{FM}	T_C = 25 °C, t_P = 10 µs	280	A
Surge Non Repetitive Forward Current	$I_{F,SM}$	t_P = 10 ms, half sine, T_C = 25 °C	65	A

Thermal Characteristics

Parameter	Symbol	Conditions	Values	Unit
Thermal resistance, junction - case	R_{thJC}	SiC Junction Transistor	0.51	°C/W
Thermal resistance, junction - case	R_{thJC}	SiC Diode	0.82	°C/W

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

Parameter	Symbol	Conditions	Values min.	Values typ.	Values max.	Unit

SJT On-State Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Drain – Source On Voltage	$V_{DS(ON)}$	I_D = 20 A, I_G = 400 mA, T_j = 25 °C		1.4		V
		I_D = 20 A, I_G = 800 mA, T_j = 125 °C		1.6		
		I_D = 20 A, I_G = 1600 mA, T_j = 175 °C		2.2		
Drain – Source On Resistance	$R_{DS(ON)}$	I_D = 20 A, I_G = 400 mA, T_j = 25 °C		70		mΩ
		I_D = 20 A, I_G = 800 mA, T_j = 125 °C		80		
		I_D = 20 A, I_G = 1600 mA, T_j = 175 °C		110		
Gate Forward Voltage	$V_{GS(FWD)}$	I_G = 500 mA, T_j = 25 °C		3.3		V
		I_G = 500 mA, T_j = 175 °C		3.1		
DC Current Gain	β	V_{DS} = 5 V, I_D = 20 A, T_j = 25 °C		TBD		
		V_{DS} = 5 V, I_D = 20 A, T_j = 175 °C		TBD		

SJT Off-State Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Drain Leakage Current	I_{DSS}	V_R = 1200 V, V_{GS} = 0 V, T_j = 25 °C		1.1		µA
		V_R = 1200 V, V_{GS} = 0 V, T_j = 125 °C		1.6		
		V_R = 1200 V, V_{GS} = 0 V, T_j = 175 °C		2.1		
Gate Leakage Current	I_{SG}	V_{SG} = 20 V, T_j = 25 °C		20		nA

SJT Capacitance Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Gate-Source Capacitance	C_{gs}	V_{GS} = 0 V, f = 1 MHz		tbd		pF
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_D = 1 V, f = 1 MHz		tbd		pF
Reverse Transfer/Output Capacitance	C_{rss}/C_{oss}	V_D = 1 V, f = 1 MHz		tbd		pF

SJT Switching Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Turn On Delay Time	$t_{d(on)}$	V_{DD} = 800 V, I_D = 20 A, $R_{G(on)}$ = $R_{G(off)}$ = tbd Ω, FWD = GB20SLT12, T_j = 25 ºC Refer to Figure 15 for gate current waveform		tbd		ns
Rise Time	t_r			tbd		ns
Turn Off Delay Time	$t_{d(off)}$			tbd		ns
Fall Time	t_f			tbd		ns
Turn-On Energy Per Pulse	E_{on}			tbd		µJ
Turn-Off Energy Per Pulse	E_{off}			tbd		µJ
Total Switching Energy	E_{ts}			tbd		µJ
Turn On Delay Time	$t_{d(on)}$	V_{DD} = 800 V, I_D = 20 A, $R_{G(on)}$ = $R_{G(off)}$ = tbd Ω, FWD = GB20SLT12, T_j = 175 ºC Refer to Figure 15 for gate current waveform		tbd		
Rise Time	t_r			tbd		ns
Turn Off Delay Time	$t_{d(off)}$			tbd		ns
Fall Time	t_f			tbd		ns
Turn-On Energy Per Pulse	E_{on}			tbd		µJ
Turn-Off Energy Per Pulse	E_{off}			tbd		µJ
Total Switching Energy	E_{ts}			tbd		µJ

Free-wheeling Silicon Carbide Schottky Diode

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Forward Voltage	V_F	I_F = 20 A, V_{GE} = 0 V, T_j = 25 ºC (175 ºC)		2.4		V
Diode Knee Voltage	$V_{D(knee)}$	T_j = 25 ºC, I_F = 1 mA		0.8		V
Peak Reverse Recovery Current	I_{rrm}	I_F = 20 A, V_{GE} = 0 V, V_R = 800 V, -dI_F/dt = 625 A/µs, T_j = 175 ºC		tbd		A
Reverse Recovery Time	t_{rr}			tbd		ns
Rise Time	t_r	V_{DD}= 800 V, I_D = 20 A, R_{gon} = R_{goff} = tbd Ω, , T_j= 25 ºC		tbd		ns
Fall Time	t_f			tbd		ns
Turn-On Energy Loss Per Pulse	E_{on}			tbd		µJ
Turn-Off Energy Loss Per Pulse	E_{off}			tbd		µJ
Reverse Recovery Charge	Q_{rr}			tbd		nC
Rise Time	t_r	V_{DD}= 800 V, I_D = 20 A, R_{gon} = R_{goff} = tbd Ω, T_j= 175 ºC		tbd		ns
Fall Time	t_f			tbd		ns
Turn-On Energy Loss Per Pulse	E_{on}			tbd		µJ
Turn-Off Energy Loss Per Pulse	E_{off}			tbd		µJ
Reverse Recovery Charge	Q_{rr}			tbd		nC

Figures

TBD

TBD

Figure 1: Typical Output Characteristics at 25 °C

Figure 2: Typical Output Characteristics at 125 °C

TBD

TBD

Figure 3: Typical Output Characteristics at 175 °C

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

TBD

TBD

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

Figure 6: Typical Blocking Characteristics

TBD

TBD

Figure 7: Capacitance Characteristics

Figure 8: Capacitance Characteristics

TBD

TBD

Figure 9: Typical Hard-switched Turn On Waveforms

Figure 10: Typical Hard-switched Turn Off Waveforms

TBD

TBD

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

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

TBD

TBD

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

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

TBD

TBD

Figure 15: Typical Gate Current Waveform

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

TBD

TBD

Figure 17: Power Derating Curve

Figure 18: Forward Bias Safe Operating Area

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

TBD

TBD

Figure 19: Turn-Off Safe Operating Area

Figure 20: Transient Thermal Impedance

25 ℃
75 ℃
125 ℃
175 ℃

Drain Current, I_D (A)

Drain Voltage, V_{DS} (V)
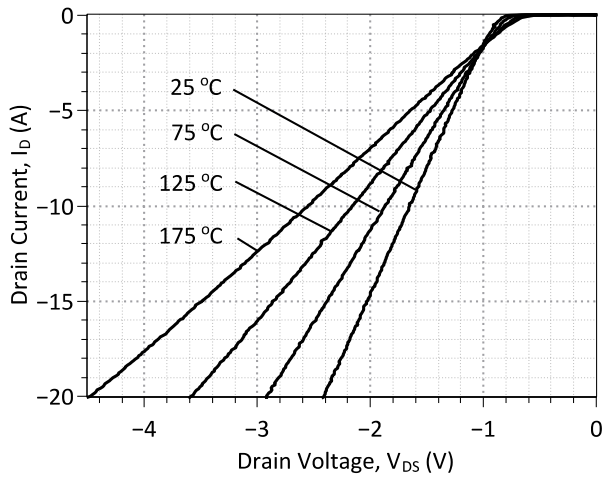
Figure 21: Typical FWD Forward Characteristics

Gate Drive Technique (Option #1)

To drive the GA20SICP12-263 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 GA20SICP12-263 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.
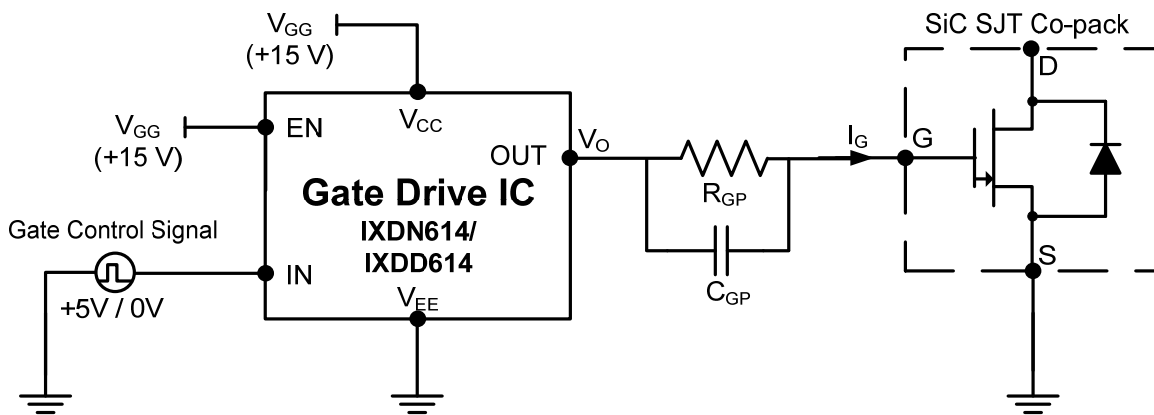

**Figure 21: Recommended Gate Diver Configuration (Option #2)**

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Option #2 Gate Drive Conditions (IXDD614/IXDN614)						
Supply Voltage	V_{CC}		-0.3	15	40	V
Gate Control Input Signal, Low	IN		-5.0	0	0.8	V
Gate Control Input Signal, High	IN		3.0	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		tbd	14	A
Output Current, Continuous	I_{OUT}			tbd	4.0	A
Passive Gate Components						
Gate Resistance	R_{GP}	$I_G \approx 0.5$ A	5	tbd		Ω
Gate Capacitance	C_{GP}	$I_G \approx 0.5$ A		tbd		nF

Package Dimensions:
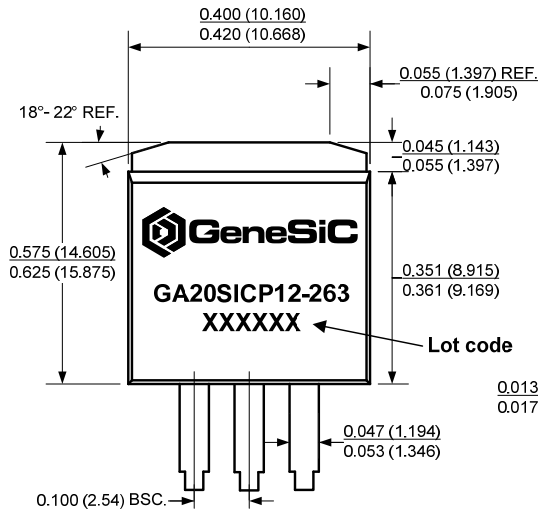
TO-263   PACKAGE OUTLINE
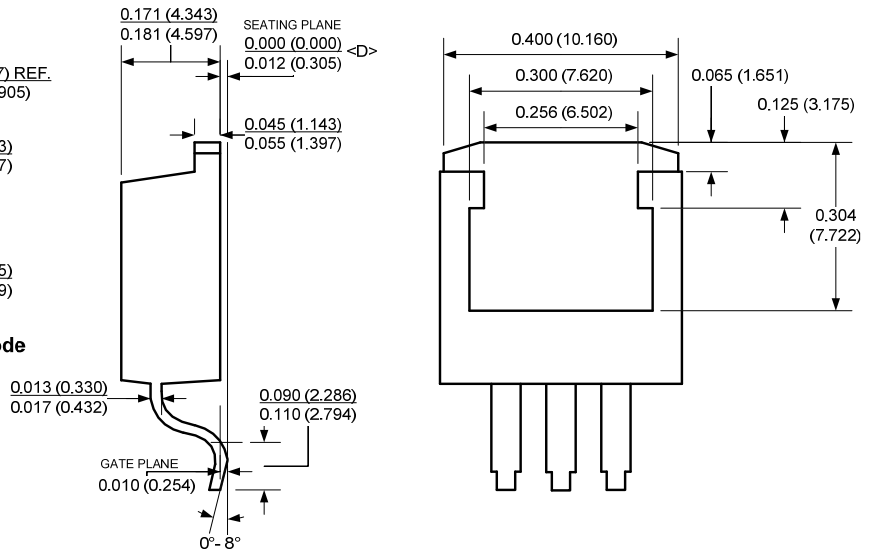
NOTE
1. CONTROLLED DIMENSION IS INCH. DIMENSION IN BRACKET IS MILLIMETER.
2. DIMENSIONS DO NOT INCLUDE END FLASH, MOLD FLASH, MATERIAL PROTRUSIONS

Revision History			
Date	Revision	Comments	Supersedes
2013/09/12	0	Initial release	

SPICE Model Parameters

Copy the following code into a SPICE software program for simulation of the GA20SICP12-263 device.

```
*       MODEL OF GeneSiC Semiconductor Inc.
*
*       $Revision:   1.0              $
*       $Date:    20-SEP-2013         $
*
*       GeneSiC Semiconductor Inc.
*       43670 Trade Center Place Ste. 155
*       Dulles, VA 20166
*       http://www.genesicsemi.com/index.php/sic-products/copack
*
*       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.
*
* Start of GA20SICP12-263 SPICE Model
*
.SUBCKT GA20SIPC12 DRAIN GATE SOURCE
Q1 DRAIN GATE SOURCE GA20SIPC12_Q
D1 SOURCE DRAIN GA20SIPC12_D1
D2 SOURCE DRAIN GA20SIPC12_D2
.model GA20SIPC12_Q NPN
+ IS      5.00E-47       ISE       1.26E-28       EG        3.2
+ BF      100            BR        0.55           IKF       700
+ NF      1              NE        2              RB        0.26
+ RC      0.055          CJC       6.98E-10       VJC       3
+ MJC     0.5            CJE       2.22E-09       VJE       3
+ MJE     0.5            XTI       3              XTB       -1.2
+ TRC1    7.00E-03       MFG       GeneSiC_Semi
.MODEL GA20SIPC12_D1 D
+ IS      4.55E-15       RS        0.0736         N         1
+ IKF     1000           EG        1.2            XTI       -2
+ TRS1    0.005434       TRS2      2.71739E-05    CJO       6.40E-10
+ VJ      0.469          M         1.508          FC        0.5
+ TT      1.00E-10
.MODEL GA20SIPC12_D2 D
+ IS      1.54E-22       RS        0.19           TRS1      -0.004
+ N       3.941          EG        3.23           IKF       19
+ XTI     0              FC        0.5            TT    0
.ENDS
*
* End of GA20SICP12-263 SPICE Model
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