E3M0075120D

Silicon Carbide Power MOSFET

E-Series Automotive

N-Channel Enhancement Mode

Features

- 3rd generation SiC MOSFET technology
- High blocking voltage with low On-resistance
- High speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Qrr)
- Halogen free, RoHS compliant
- Automotive Qualified (AEC-Q101) and PPAP Capable

Benefits

- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency

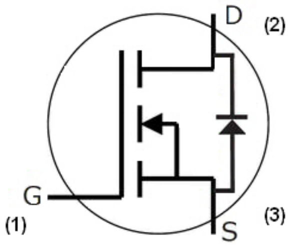
Applications

- EV battery chargers
- High voltage DC/DC converters

Package

Halogen-Free

RoHS



Ordering Part Number	Package	Marking
E3M0075120D	TO 247-3	E3M0075120D

Maximum Ratings (T_C = 25 ˚C unless otherwise specified)
Stress beyond those listed under absolute maximum ratings may cause permanent damage to the device.

Symbol	Parameter		Value	Unit	Note
V_{DSmax}	Drain - Source Voltage		1200	V	
V_{GSmax}	Gate - Source Voltage		-8/+19	V	Note: 1
I_D	Continuous Drain Current, V_{GS} = 15 V	T_C = 25˚C	32	A	Fig. 19, Note: 2
		T_C = 100˚C	23		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_P limited by T_{jmax}		80	A	Fig. 22
P_D	Power Dissipation, T_C=25˚C, T_J = 175 ˚C		145	W	Fig. 20 Note: 2
T_J , T_{stg}	Operating Junction and Storage Temperature		-55 to +175	˚C	
T_L	Solder Temperature, 1.6mm (0.063”) from case for 10s		260	˚C	
M_d	Mounting Torque , M3 or 6-32 screw		1 8.8	Nm lbf-in	

Note (1): Recommended turn off / turn on gate voltage V_{GS} - 4V...0V / +15V
Note (2): Verified by design

Electrical Characteristics (T_C = 25˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	V_{GS} = 0 V, I_D = 100 μA	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.6	3.6	V	V_{DS} = V_{GS}, I_D = 5 mA	Fig. 11
			2.1		V	V_{DS} = V_{GS}, I_D = 5 mA, T_J = 175ºC	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	μA	V_{DS} = 1200 V, V_{GS} = 0 V	
I_{GSS}	Gate-Source Leakage Current		10	250	nA	V_{GS} = 15 V, V_{DS} = 0 V	
$R_{DS(on)}$	Drain-Source On-State Resistance		75	97.5	mΩ	V_{GS} = 15 V, I_D = 17.9 A	Fig. 4, 5, 6
			135			V_{GS} = 15 V, I_D = 17.9 A, T_J = 175ºC	
g_{fs}	Transconductance		11		S	V_{DS}= 20 V, I_{DS}= 17.9 A	Fig. 7
			10.5			V_{DS}= 20 V, I_{DS}= 17.9 A, T_J = 175ºC	
C_{iss}	Input Capacitance		1480		pF	V_{GS} = 0 V, V_{DS} = 1000 V f = 1 MHz V_{AC} = 25 mV	Fig. 17, 18
C_{oss}	Output Capacitance		58				
C_{rss}	Reverse Transfer Capacitance		2.7				
E_{oss}	C_{oss} Stored Energy		32		μJ		Fig. 16
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		67		pF	V_{GS} = 0 V, V_{DS} = 0... 800V	Note (3)
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		96		pF		
E_{ON}	Turn-On Switching Energy (External Diode)		719		μJ	V_{DS} = 800 V, V_{GS} = -4 V/15 V, I_D = 20 A, $R_{G(ext)}$ = 2.5 Ω, L= 135 μH, FWD = External SiC Diode	Fig. 26, 29
E_{OFF}	Turn Off Switching Energy (External Diode)		118				
E_{ON}	Turn-On Switching Energy (Body Diode)		732		μJ	V_{DS} = 800 V, V_{GS} = -4 V/15 V, I_D = 20 A, $R_{G(ext)}$ = 2.5 Ω, L= 135 μH, FWD = Body Diode of MOSFET	Fig. 26, 29
E_{OFF}	Turn Off Switching Energy (Body Diode)		125				
$t_{d(on)}$	Turn-On Delay Time		52		ns	V_{DD} = 800 V, V_{GS} = -4 V/15 V I_D = 20 A, $R_{G(ext)}$ = 2.5 Ω, Timing relative to V_{DS} Inductive load	Fig. 27, 28
t_r	Rise Time		18				
$t_{d(off)}$	Turn-Off Delay Time		31				
t_f	Fall Time		16				
$R_{G(int)}$	Internal Gate Resistance		9.0		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{gs}	Gate to Source Charge		19		nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V I_D = 20 A Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		18				
Q_g	Total Gate Charge		57				

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as Coss while Vds is rising from 0 to 800V
$C_{o(tr)}$, a lumped capacitance that gives same charging time as Coss while Vds is rising from 0 to 800V

Reverse Diode Characteristics (T_C = 25˚C unless otherwise specified)

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage	4.8		V	V_{GS} = -4 V, I_{SD} = 9 A	Fig. 8, 9, 10
		4.2		V	V_{GS} = -4 V, I_{SD} = 9 A, T_J = 175 °C	
I_S	Continuous Diode Forward Current		27	A	V_{GS} = -4 V, T_J = 25 ˚C	
$I_{S, pulse}$	Diode pulse Current		80	A	V_{GS} = -4 V, Pulse width t_P limited by T_{jmax}	
t_{rr}	Reverse Recover time	34		ns	V_{GS} = -4 V, I_{SD} = 20 A, V_R = 800 V dif/dt = 885 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	286		nC		
I_{rrm}	Peak Reverse Recovery Current	13		A		
t_{rr}	Reverse Recover time	40		ns	V_{GS} = -4 V, I_{SD} = 20 A, V_R = 800 V dif/dt = 740 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	256		nC		
I_{rrm}	Peak Reverse Recovery Current	9		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.88	1.03	°C/W		Fig. 21

Typical Performance

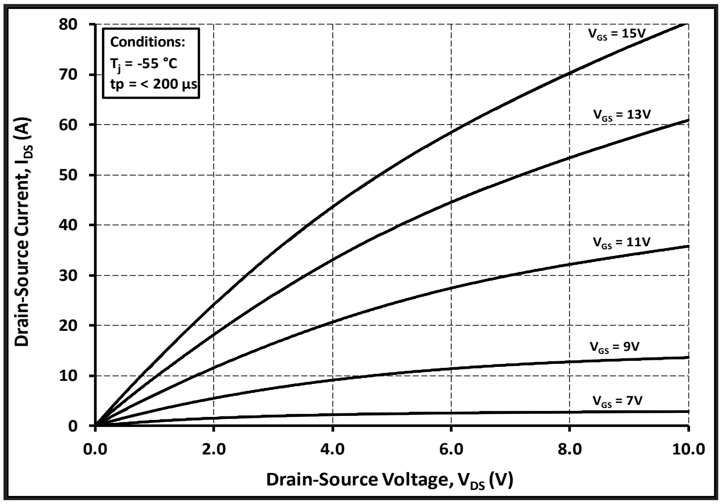


Figure 1. Output Characteristics T_J = -55 °C

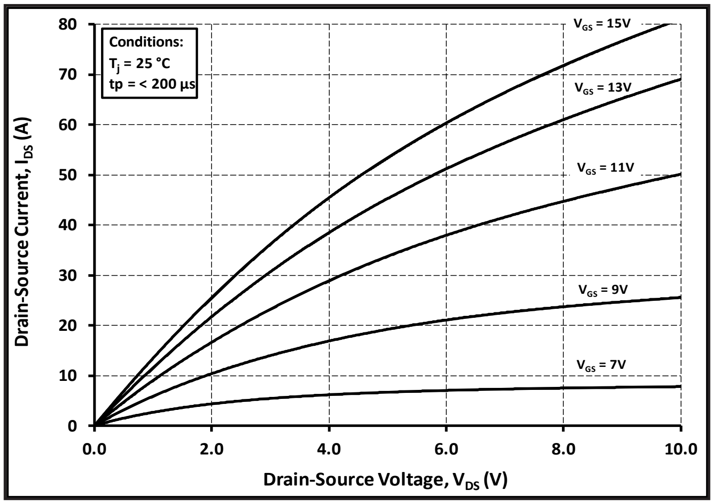


Figure 2. Output Characteristics T_J = 25 °C

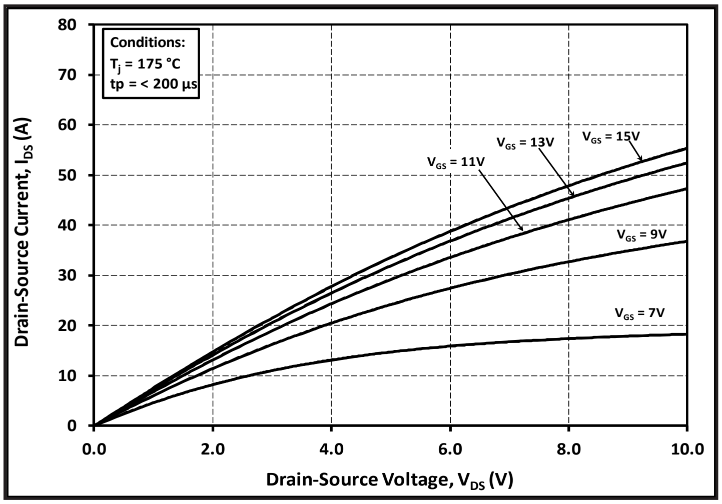


Figure 3. Output Characteristics T_J = 175 °C

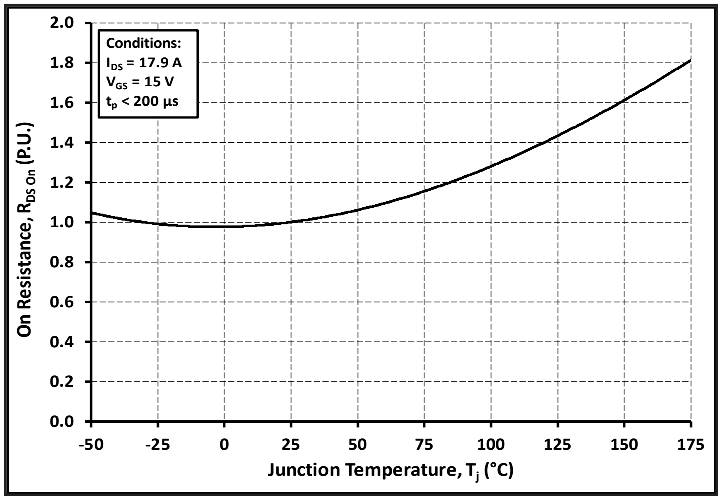


Figure 4. Normalized On-Resistance vs. Temperature

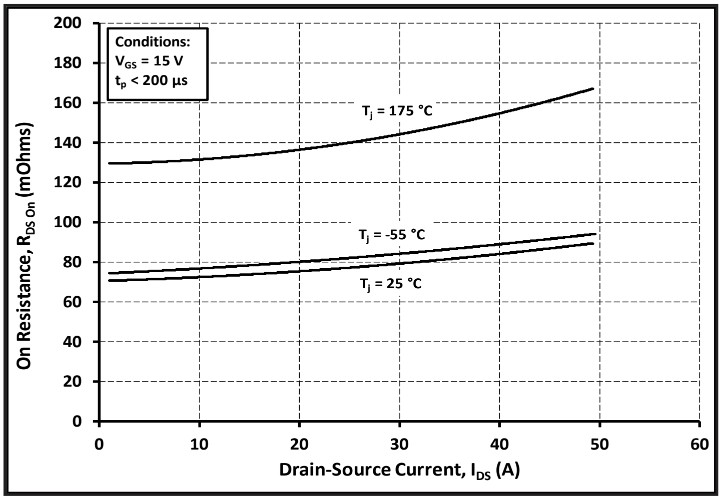


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

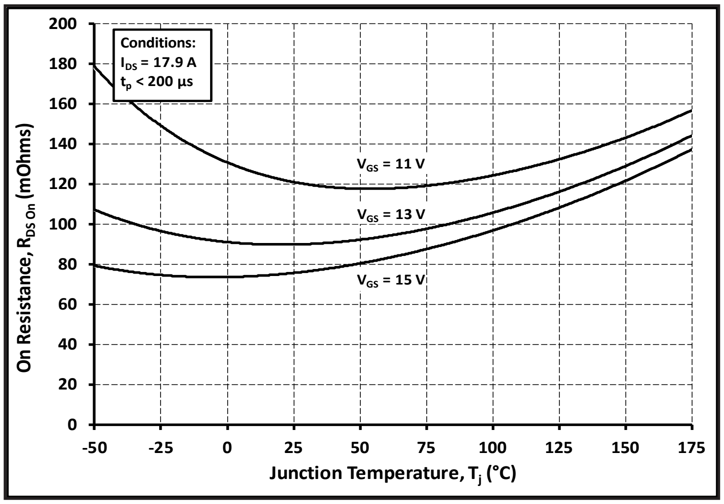


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

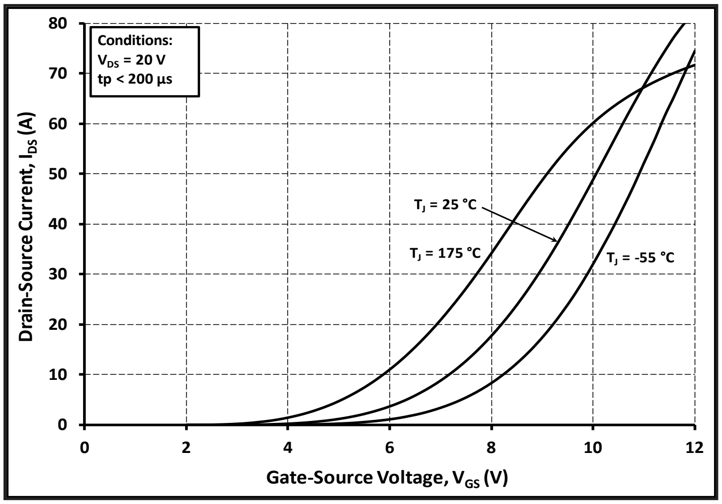


Figure 7. Transfer Characteristic for Various Junction Temperatures

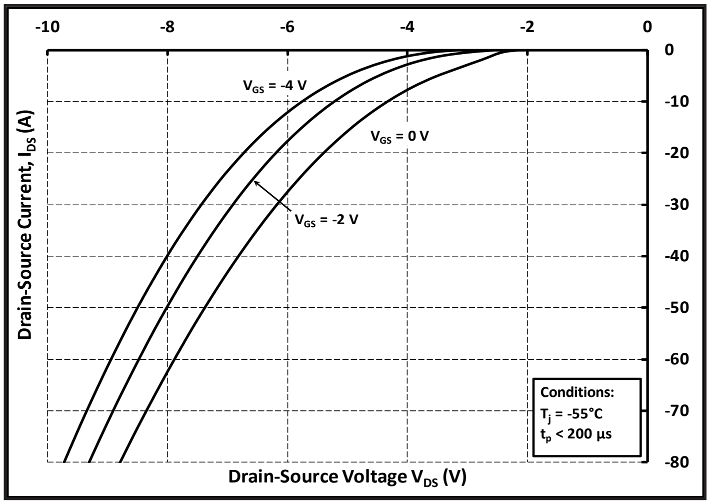


Figure 8. Body Diode Characteristic at -55 °C

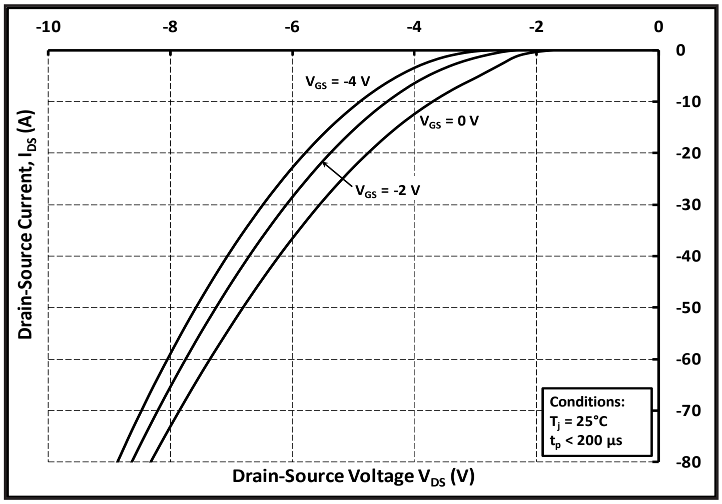


Figure 9. Body Diode Characteristic at 25 °C

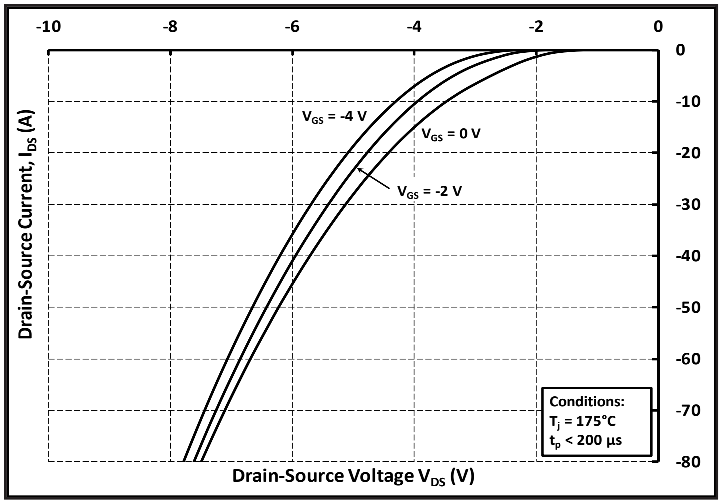


Figure 10. Body Diode Characteristic at 175 °C

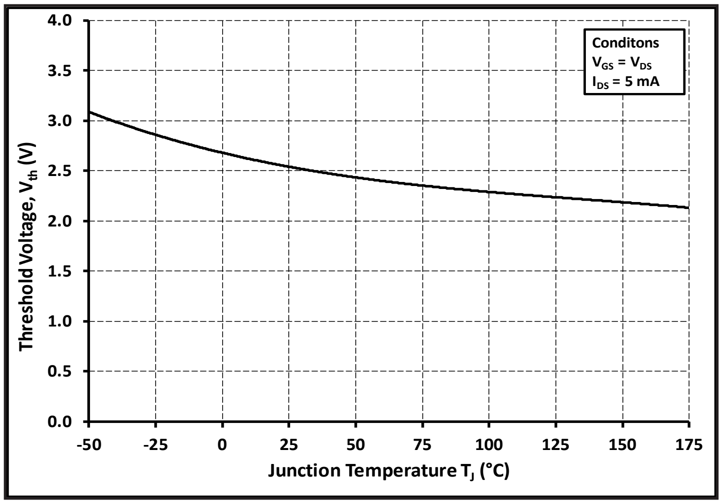


Figure 11. Threshold Voltage vs. Temperature

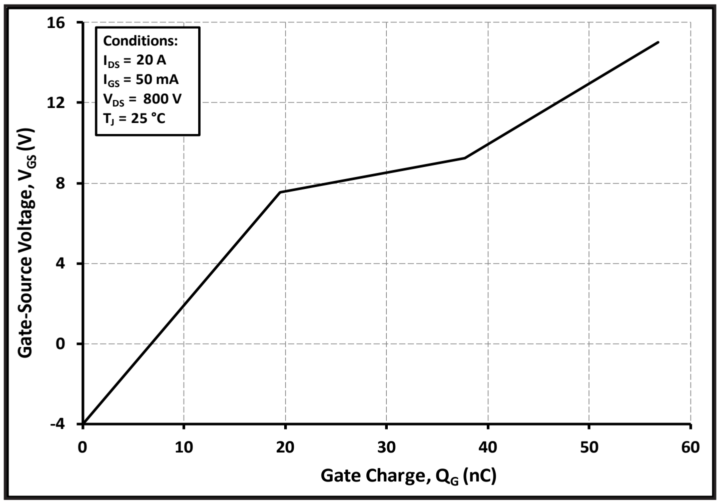


Figure 12. Gate Charge Characteristics

Typical Performance

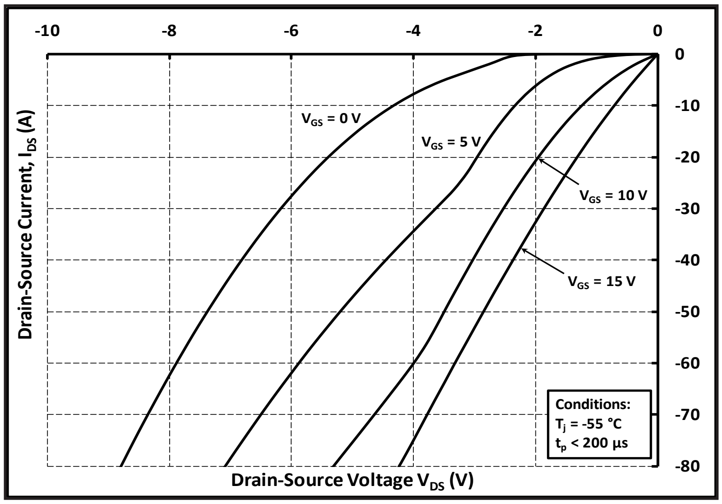


Figure 13. 3rd Quadrant Characteristic at -55 °C

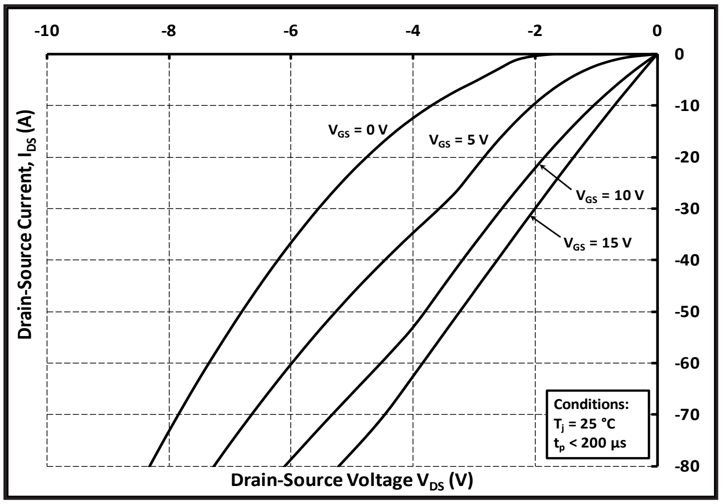


Figure 14. 3rd Quadrant Characteristic at 25 °C

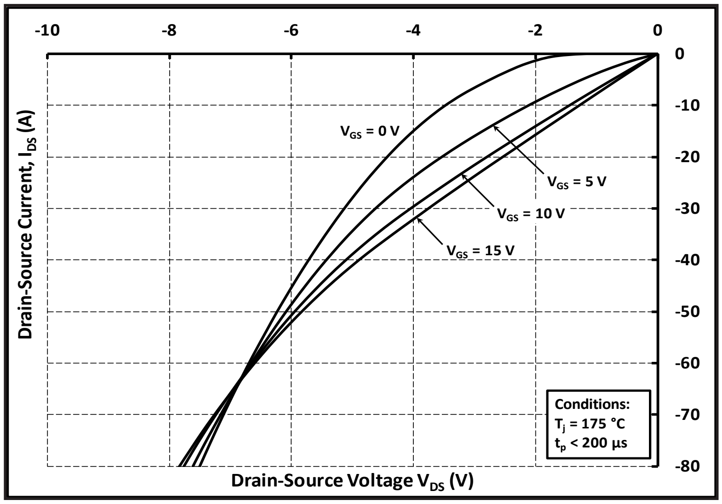


Figure 15. 3rd Quadrant Characteristic at 175 °C

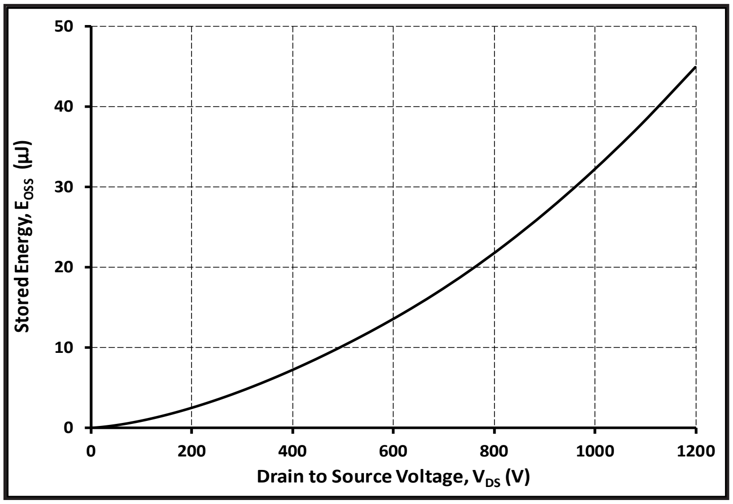


Figure 16. Output Capacitor Stored Energy

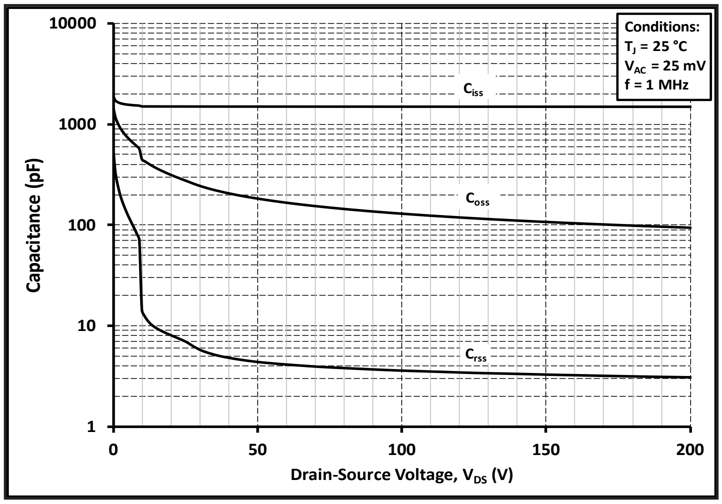


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

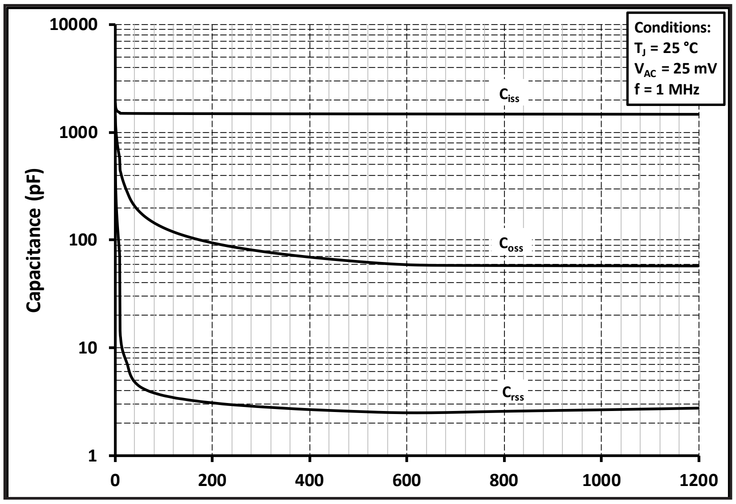


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1000V)

Typical Performance

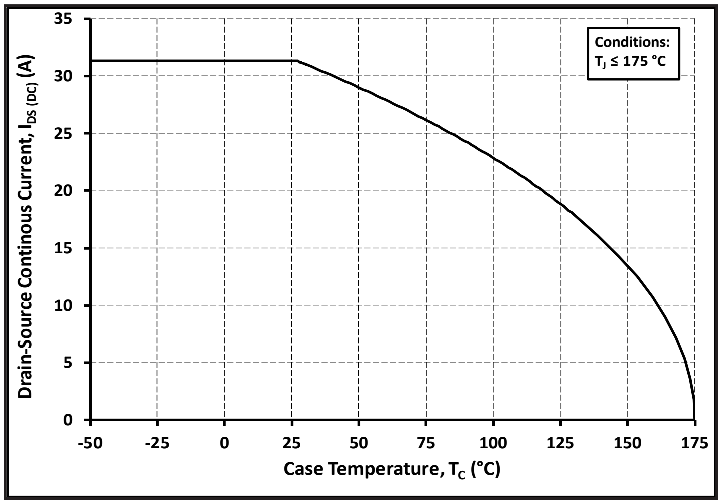


Figure 19. Continuous Drain Current Derating vs. Case Temperature

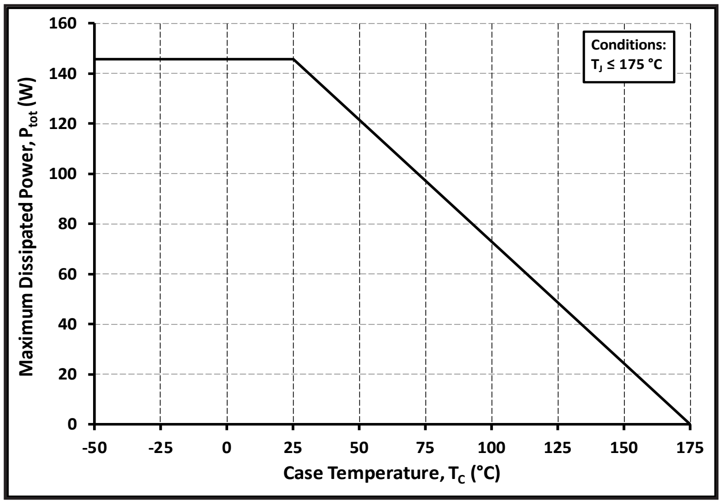


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

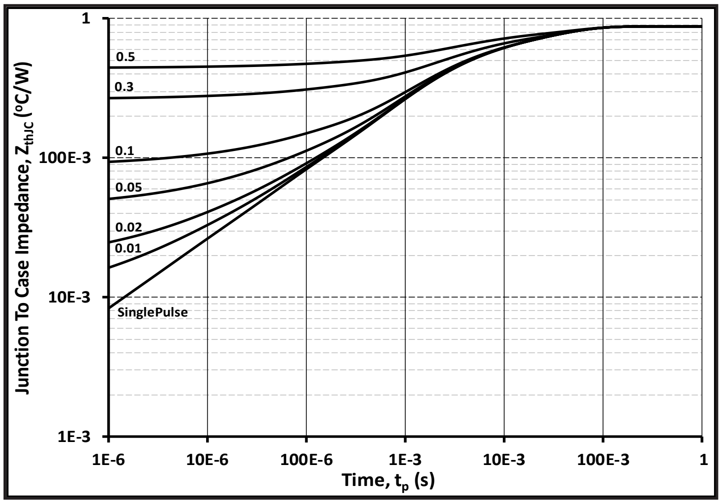


Figure 21. Transient Thermal Impedance (Junction - Case)

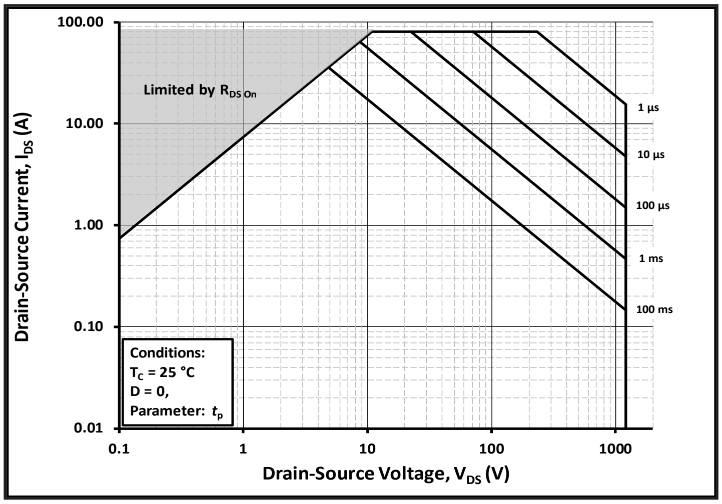


Figure 22. Safe Operating Area

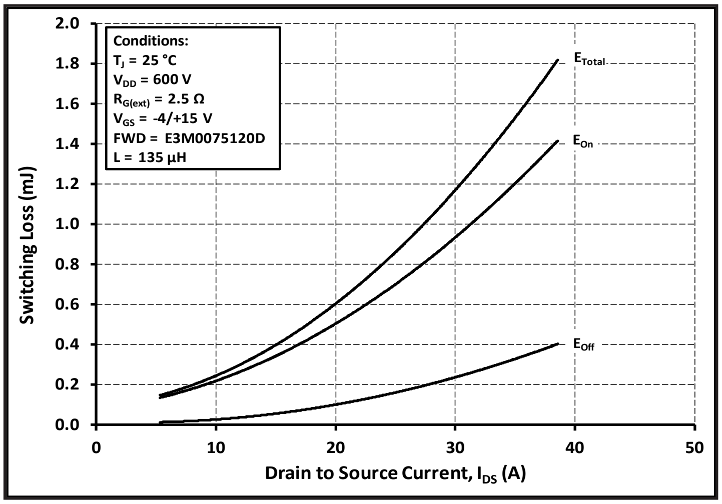


Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 600V)

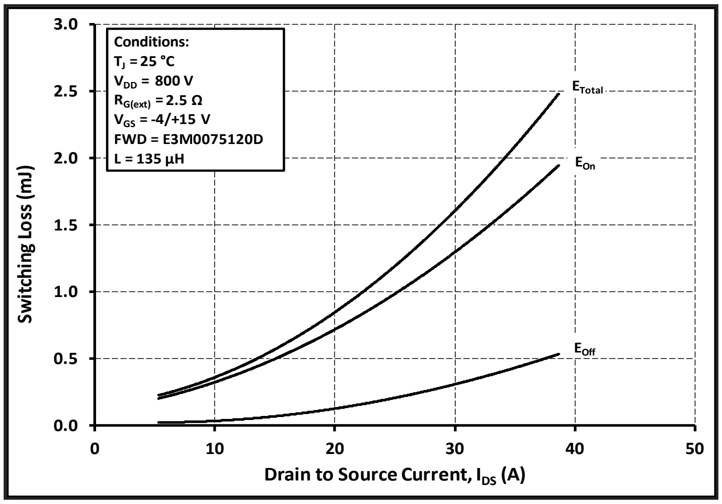


Figure 24. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 800V)

Typical Performance

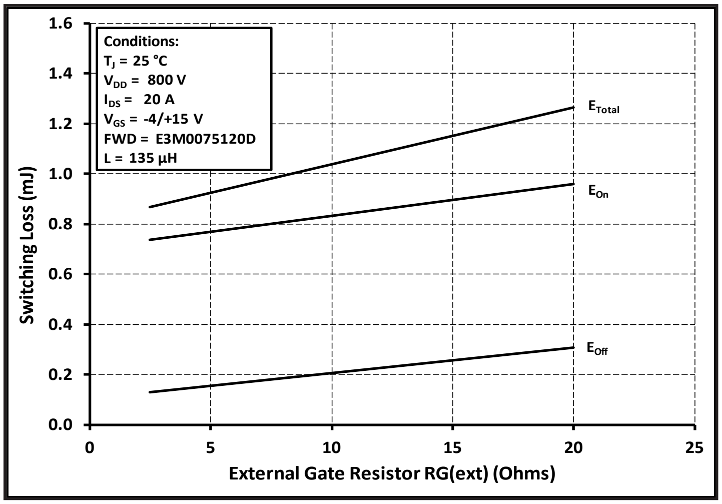


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

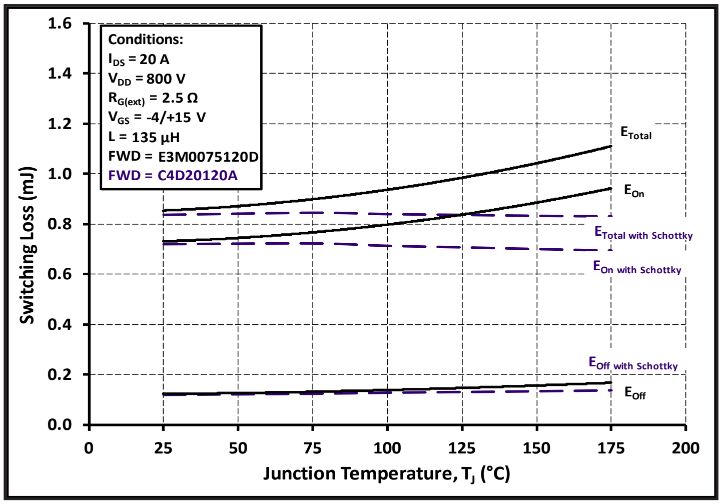


Figure 26. Clamped Inductive Switching Energy vs. Temperature

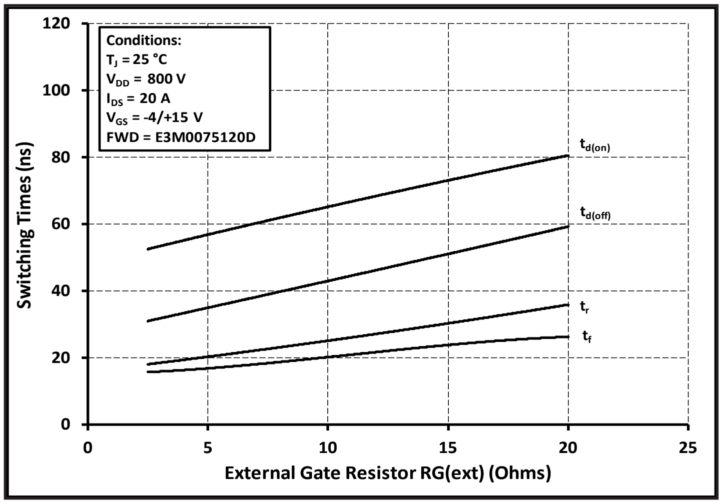


Figure 27. Switching Times vs. $R_{G(ext)}$

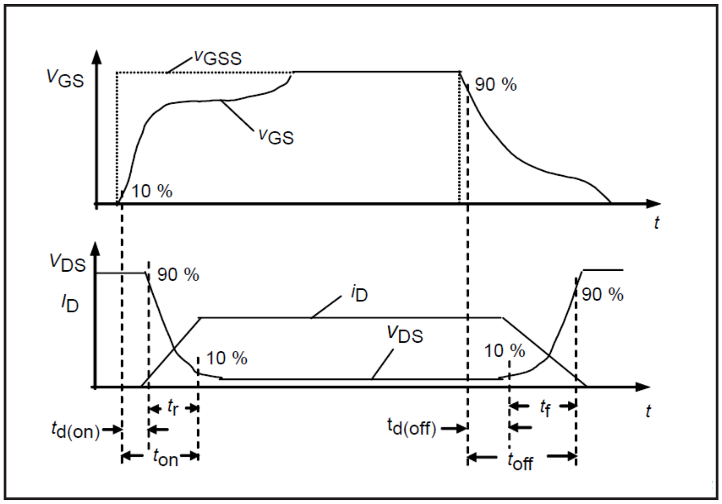


Figure 28. Switching Times Definition

Test Circuit Schematic

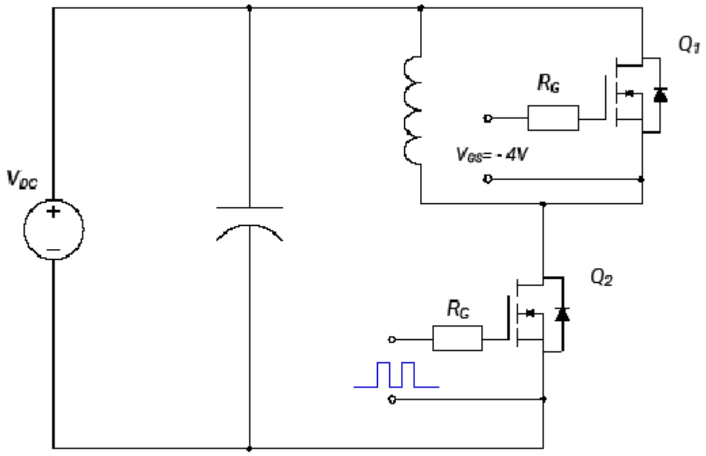
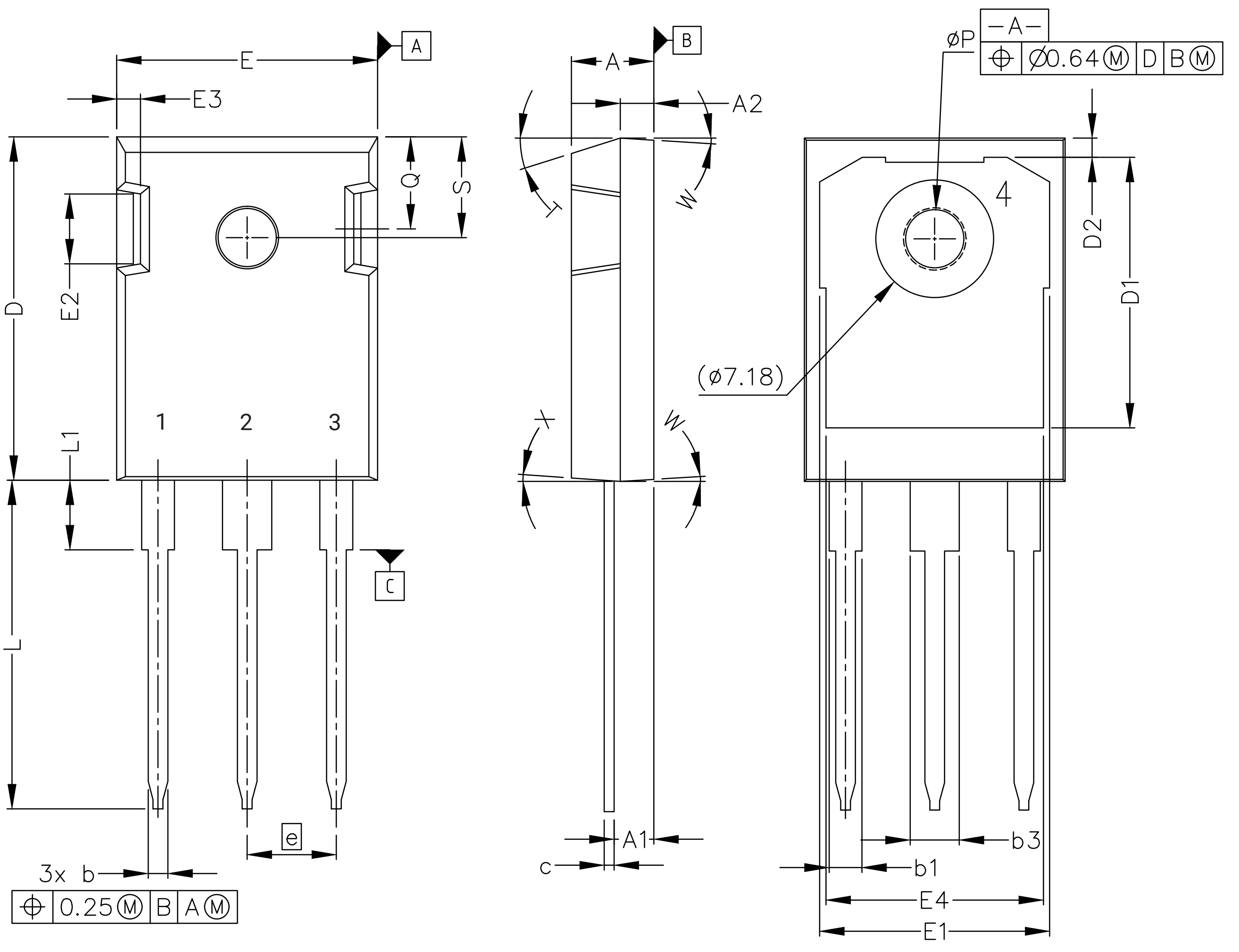


Figure 29. Clamped Inductive Switching Waveform Test Circuit

Package Dimensions

Package TO-247-3



NOTE ;
1. ALL METAL SURFACES: TIN PLATED,EXCEPT AREA OF CUT
2. DIMENSIONING & TOLERANCEING CONFIRM TO
ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS.
ANGLES ARE IN DEGREES.
4. THIS DRAWING WILL MEET ALL DIMENSIONS REQUIREMENT
OF JEDEC outlines TO-247 AD.
5. DIMENSION DO NOT INCLUDE BURR OR MOLD FLASH.

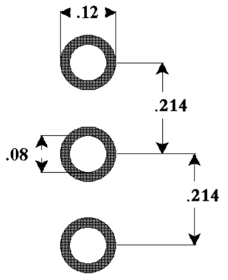
1 - GATE
2 - DRAIN (COLLECTOR)
3 - SOURCE (EMITTER)
4 - DRAIN (COLLECTOR)

Package Dimensions

Package TO-247-3

SYM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	.190	.205
A1	2.29	2.54	.090	.100
A2	1.91	2.16	.075	.085
b	1.07	1.33	.042	.052
b1	1.91	2.41	.075	.095
b3	2.87	3.38	.113	.133
c	0.55	0.68	.022	.027
D	20.80	21.10	.819	.831
D1	16.25	17.65	.640	.695
D2	0.95	1.25	.037	.049
E	15.75	16.13	.620	.635
E1	13.10	14.15	.516	.557
E2	3.68	5.10	.145	.201
E3	1.00	1.90	.039	.075
E4	12.38	13.43	.487	.529
e	5.44 BSC		.214 BSC	
N	3		3	
L	19.81	20.32	.780	.800
L1	4.10	4.40	.161	.173
∅P	3.51	3.65	.138	.144
Q	5.49	6.00	.216	.236
S	6.04	6.30	.238	.248
T	17.5° REF.			
W	3.5° REF.			
X	4° REF.			

Recommended Solder Pad Layout



TO-247-3

Notes

- **RoHS Compliance**
  The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/EC (RoHS2), as implemented January 2, 2013. RoHS Declarations for this product can be obtained from your Cree representative or from the Product Documentation sections of www.cree.com.

- **REACh Compliance**
  REACh substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future,please contact a Cree representative to insure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

- This product has not been designed or tested for use in, and is not intended for use in, applications implanted into the human body nor in applications in which failure of the product could lead to death, personal injury or property damage, including but not limited to equipment used in the operation of nuclear facilities, life-support machines, cardiac defibrillators or similar emergency medical equipment, aircraft navigation or communication or control systems, air traffic control systems.

Related Links

- **SPICE Models: http://wolfspeed.com/power/tools-and-support**
- **SiC MOSFET Isolated Gate Driver reference design: http://wolfspeed.com/power/tools-and-support**
- **SiC MOSFET Evaluation Board: http://wolfspeed.com/power/tools-and-support**