E3M0120090D

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

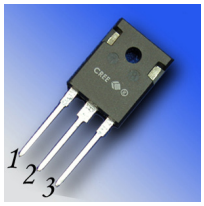
Benefits

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

Applications

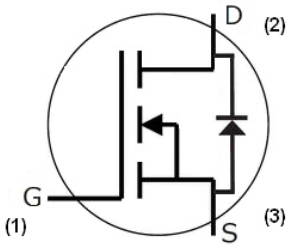
- Automotive EV battery chargers
- Renewable energy
- High voltage DC/DC converters

Package



Halogen-Free

RoHS



Part Number	Package	Marking
E3M0120090D	TO-247-3	E3M0120090

Maximum Ratings (T_C = 25 ˚C unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain - Source Voltage	900	V	V_{GS} = 0 V, I_D = 100 µA	
V_{GSmax}	Gate - Source Voltage	-8/+18	V		Note: 1
V_{GSop}	Gate - Source Voltage (Recommended operating values)	-4/+15	V		Note: 2
I_D	Continuous Drain Current	23	A	V_{GS} = 15 V, T_C = 25˚C	Fig. 19
		15		V_{GS} = 15 V, T_C = 100˚C	
$I_{D(pulse)}$	Pulsed Drain Current	50	A	Pulse width t_P limited by T_{jmax}	Fig. 22
P_D	Power Dissipation	97	W	T_C=25˚C, T_J = 150 ˚C	Fig. 20
T_J , T_{stg}	Operating Junction and Storage Temperature	-55 to +150	˚C		
T_L	Solder Temperature	260	˚C	1.6mm (0.063”) from case for 10s	
M_d	Mounting Torque	1 8.8	Nm lbf-in	M3 or 6-32 screw	

Note (1): When using MOSFET Body Diode V_{GSmax} = -4V/+18V
Note (2): MOSFET can also safely operate at 0/+15 V

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	900			V	V_{GS} = 0 V, I_D = 100 µA	
$V_{GS(th)}$	Gate Threshold Voltage	1.7	2.1	3.5	V	V_{DS} = V_{GS}, I_D = 3 mA	Fig. 11
			1.6		V	V_{DS} = V_{GS}, I_D = 3 mA, T_J = 150ºC	
I_{DSS}	Zero Gate Voltage Drain Current		1	100	µA	V_{DS} = 900 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		120	155	mΩ	V_{GS} = 15 V, I_D = 15 A	Fig. 4, 5, 6
			170			V_{GS} = 15 V, I_D = 15 A, T_J = 150ºC	
g_{fs}	Transconductance		7.7		S	V_{DS}= 20 V, I_{DS}= 15 A	Fig. 7
			6.7			V_{DS}= 20 V, I_{DS}= 15 A, T_J = 150ºC	
C_{iss}	Input Capacitance		350		pF	V_{GS} = 0 V, V_{DS} = 600 V f = 1 MHz V_{AC} = 25 mV	Fig. 17, 18
C_{oss}	Output Capacitance		40				
C_{rss}	Reverse Transfer Capacitance		3				
E_{oss}	C_{oss} Stored Energy		9		µJ		Fig. 16
E_{ON}	Turn-On Switching Energy (Body Diode FWD)		170		µJ	V_{DS} = 400 V, V_{GS} = -4 V/15 V, I_D = 15 A, $R_{G(ext)}$ = 2.5Ω, L= 142 µH, T_J = 150ºC	Fig. 26, 29
E_{OFF}	Turn Off Switching Energy (Body Diode FWD)		25				
$t_{d(on)}$	Turn-On Delay Time		27		ns	V_{DD} = 400 V, V_{GS} = -4 V/15 V I_D = 15 A, $R_{G(ext)}$ = 2.5 Ω, Timing relative to V_{DS} Inductive load	Fig. 27, 29
t_r	Rise Time		10				
$t_{d(off)}$	Turn-Off Delay Time		25				
t_f	Fall Time		8				
$R_{G(int)}$	Internal Gate Resistance		16		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{gs}	Gate to Source Charge		4.8		nC	V_{DS} = 400 V, V_{GS} = -4 V/15 V I_D = 15 A Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		5.0				
Q_g	Total Gate Charge		17.3				

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} = 7.5 A	Fig. 8, 9, 10
		4.4		V	V_{GS} = -4 V, I_{SD} = 7.5 A, T_J = 150 °C	
I_S	Continuous Diode Forward Current		21	A	V_{GS} = -4 V, T_C = 25˚C	Note 1
$I_{S, pulse}$	Diode pulse Current		50	A	V_{GS} = -4 V, pulse width t_P limited by T_{jmax}	Note 1
t_{rr}	Reverse Recover time	24		ns	V_{GS} = -4 V, I_{SD} = 7.5 A, V_R = 400 V dif/dt = 900 A/µs, T_J = 150 °C	Note 1
Q_{rr}	Reverse Recovery Charge	115		nC		
I_{rrm}	Peak Reverse Recovery Current	6.2		A		

Thermal Characteristics

Symbol	Parameter	Max.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	1.3	°C/W		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			

Note (3): Turn-off and Turn-on switching energy and timing values measured using SiC MOSFET Body Diode

Typical Performance

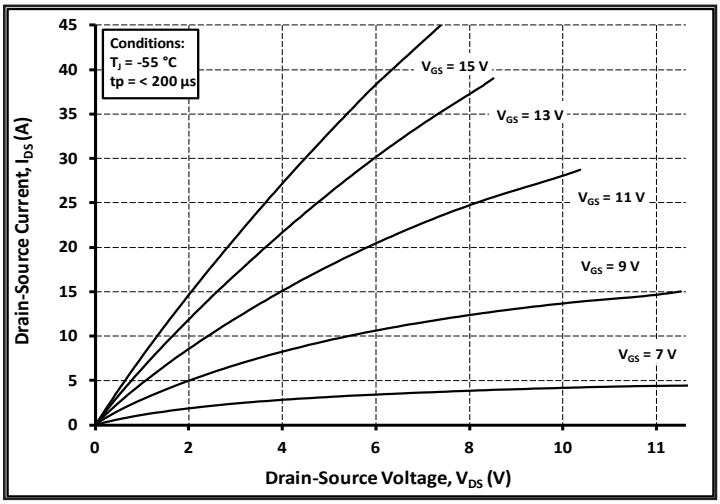


Figure 1. Output Characteristics T_J = -55 ºC

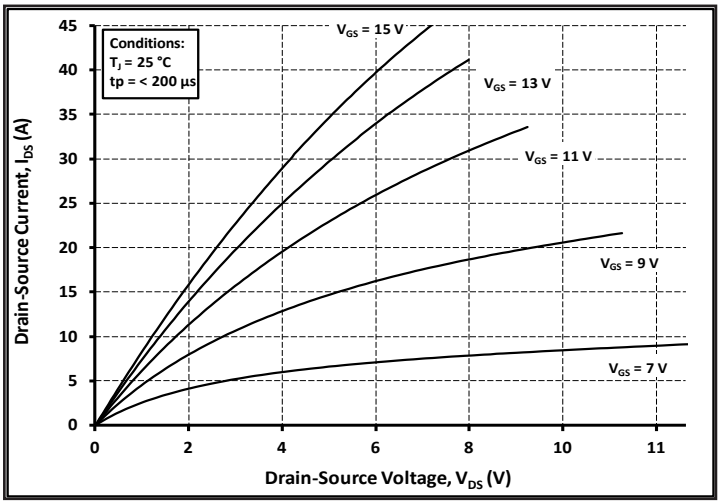


Figure 2. Output Characteristics T_J = 25 ºC

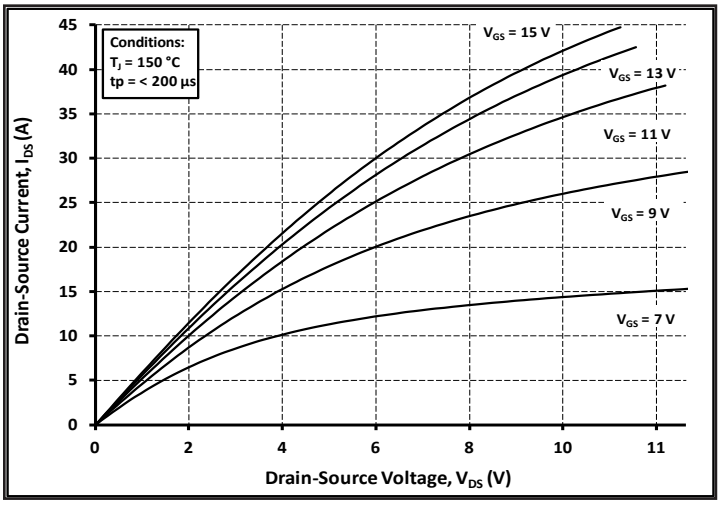


Figure 3. Output Characteristics T_J = 150 ºC

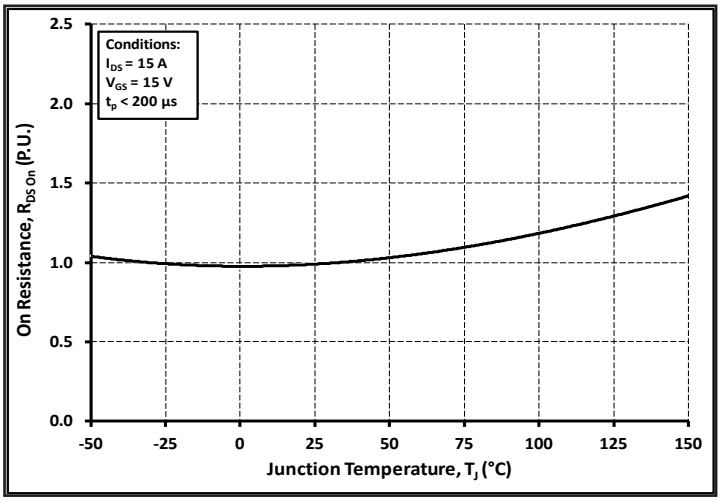


Figure 4. Normalized On-Resistance vs. Temperature

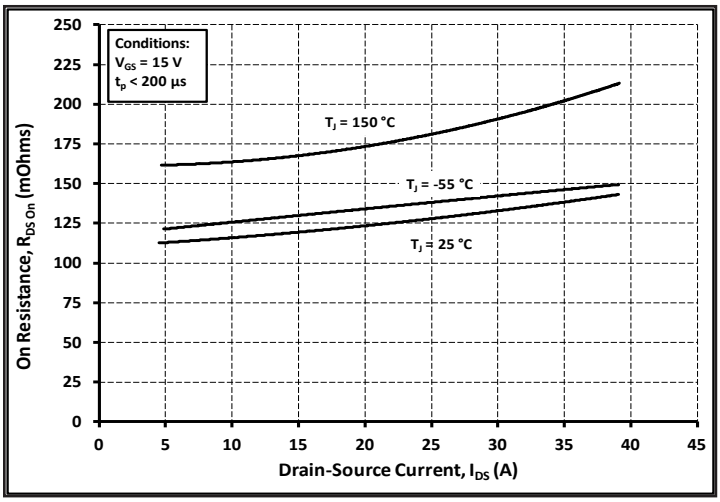


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

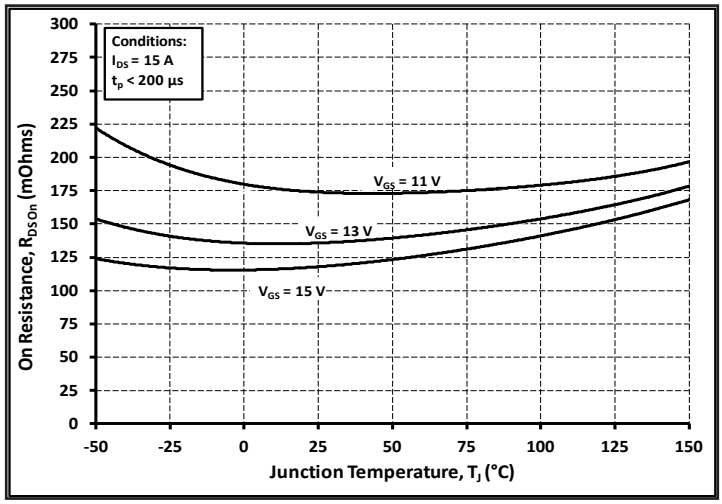


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

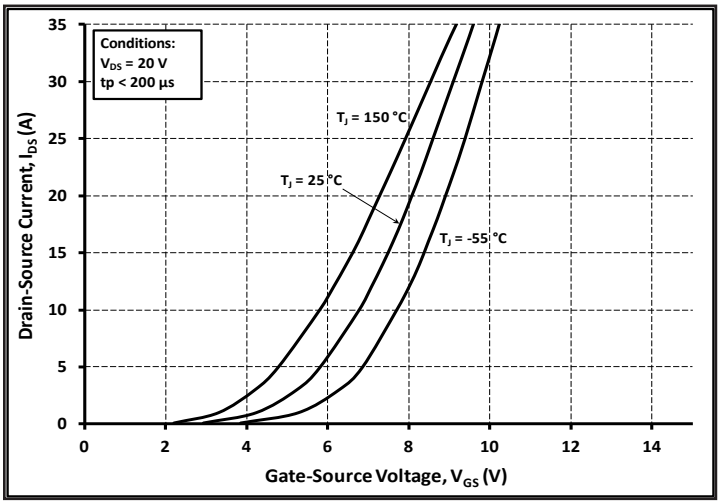


Figure 7. Transfer Characteristic for Various Junction Temperatures

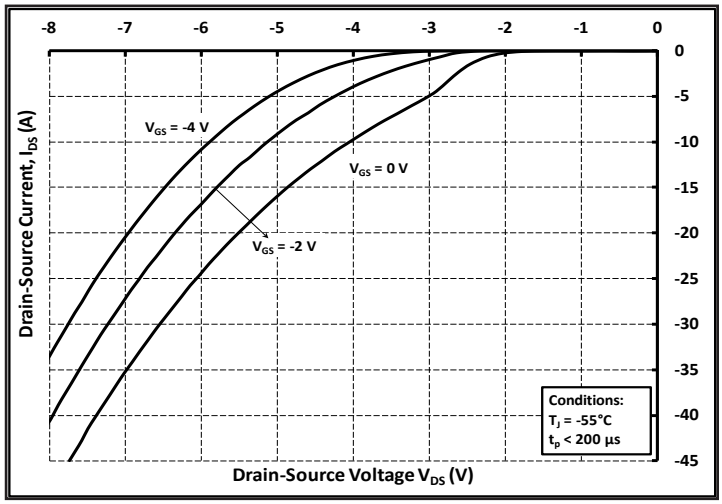


Figure 8. Body Diode Characteristic at -55 ºC

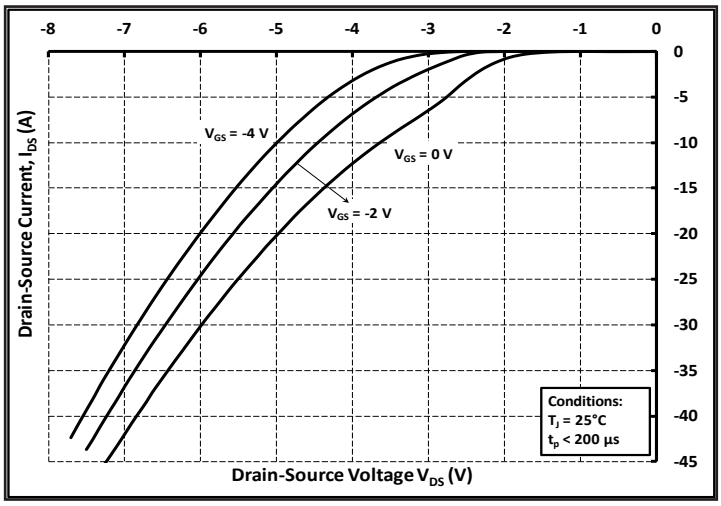


Figure 9. Body Diode Characteristic at 25 ºC

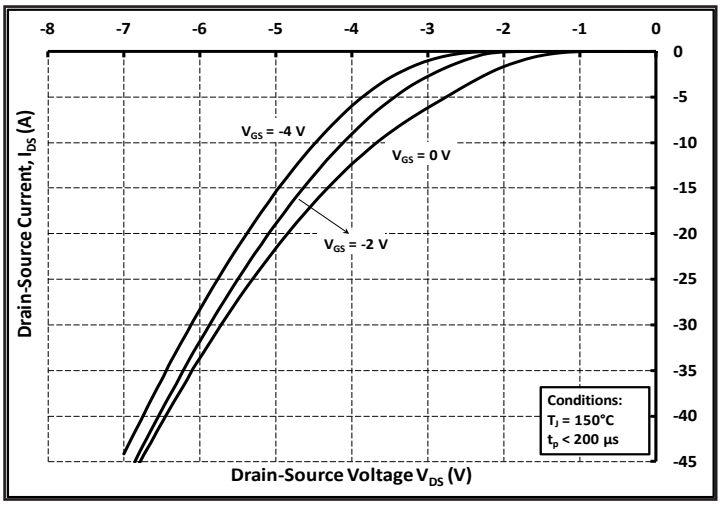


Figure 10. Body Diode Characteristic at 150 ºC

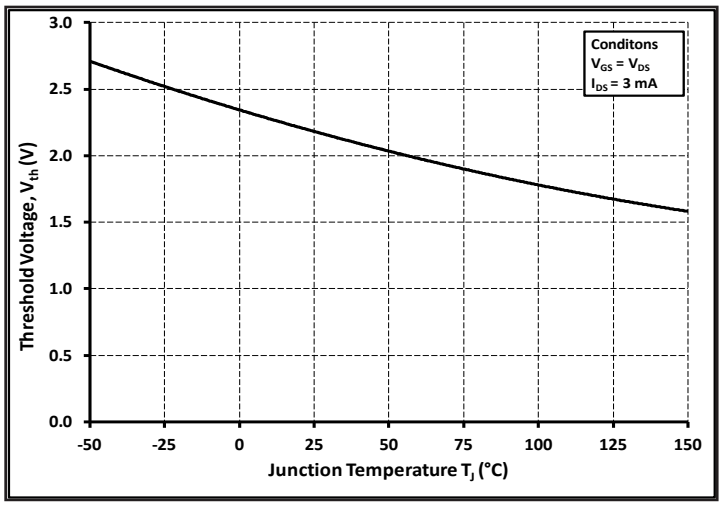


Figure 11. Threshold Voltage vs. Temperature

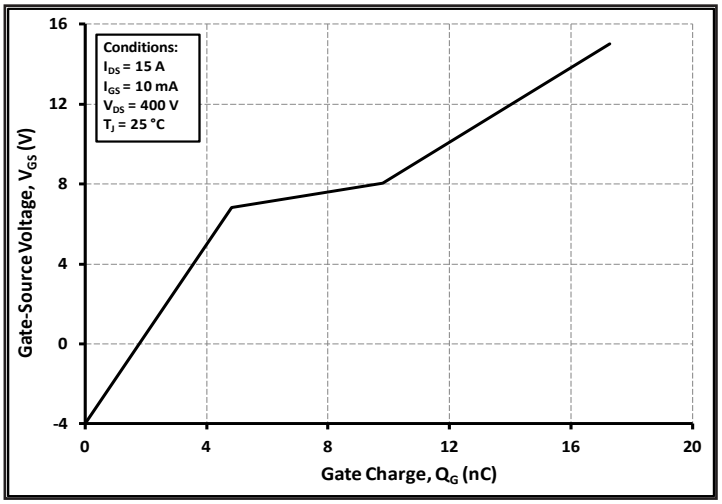


Figure 12. Gate Charge Characteristics

Typical Performance

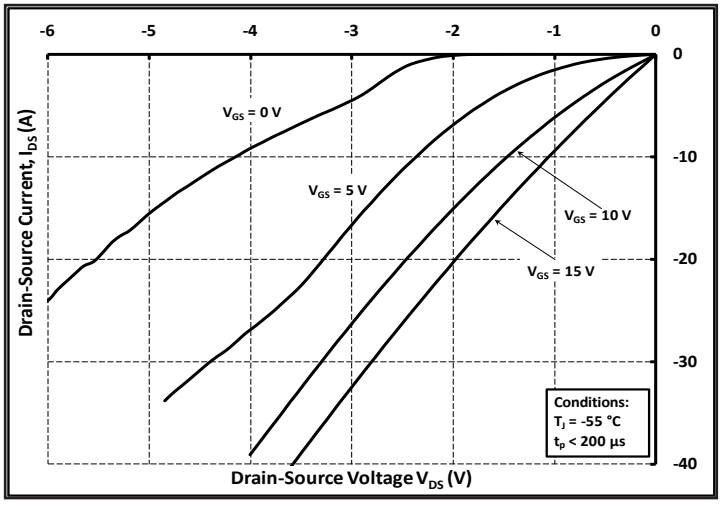


Figure 13. 3rd Quadrant Characteristic at -55 ºC

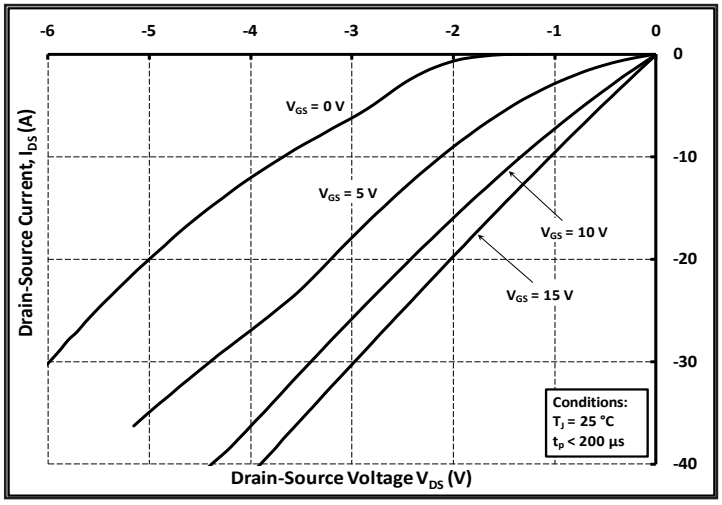


Figure 14. 3rd Quadrant Characteristic at 25 ºC

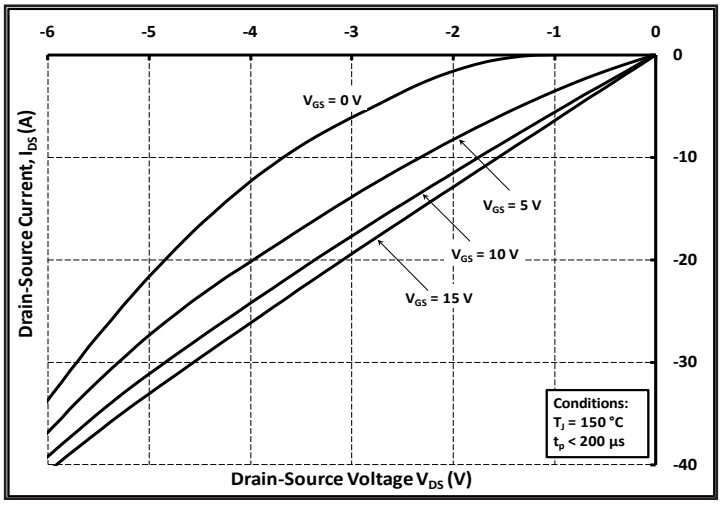


Figure 15. 3rd Quadrant Characteristic at 150 ºC

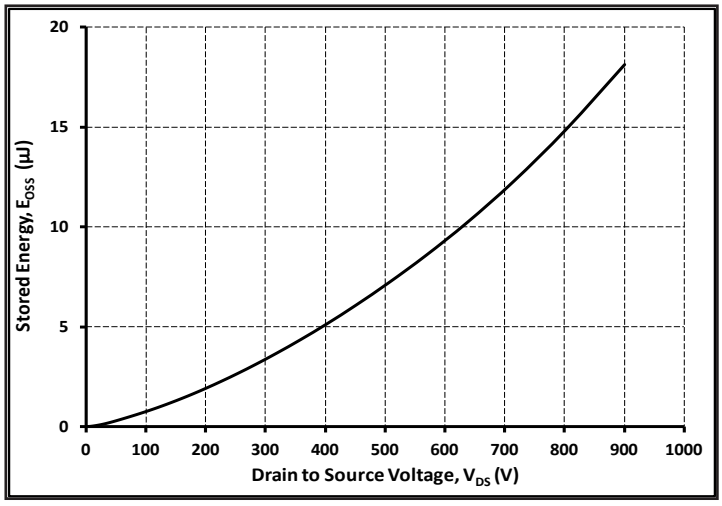


Figure 16. Output Capacitor Stored Energy

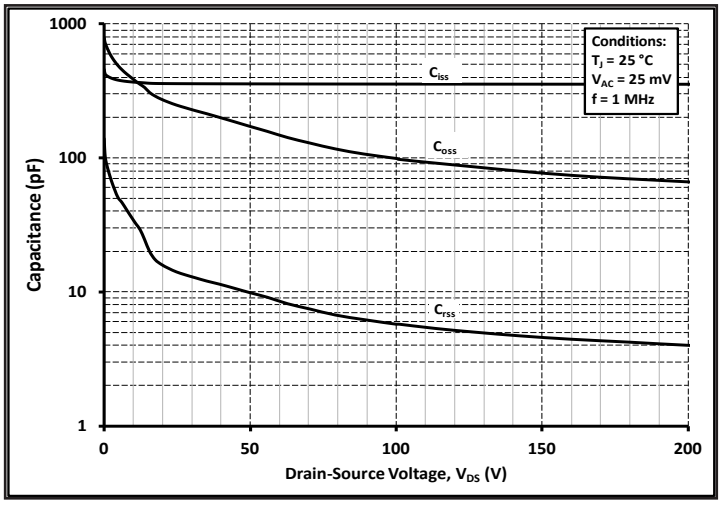


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

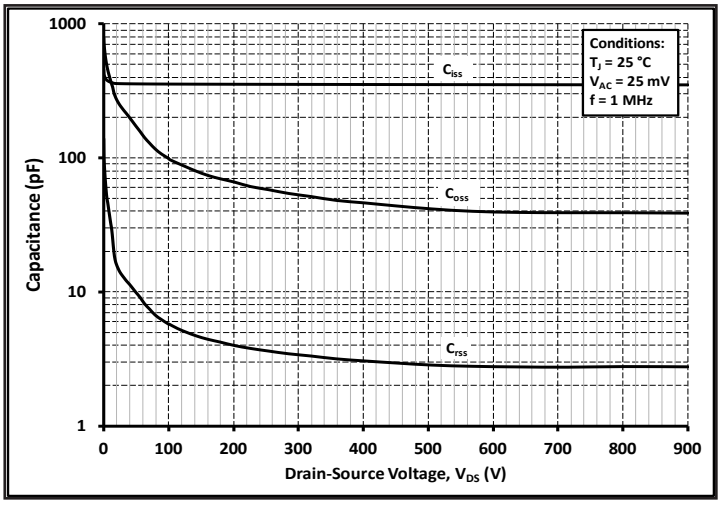


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 900V)

Typical Performance

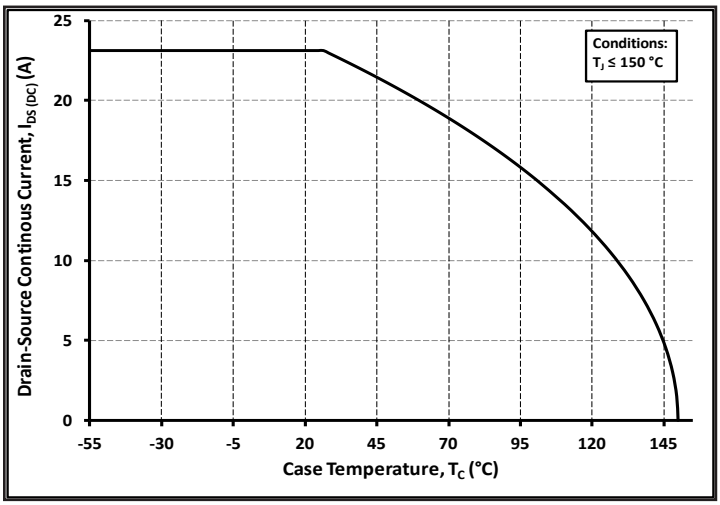


Figure 19. Continuous Drain Current Derating vs. Case Temperature

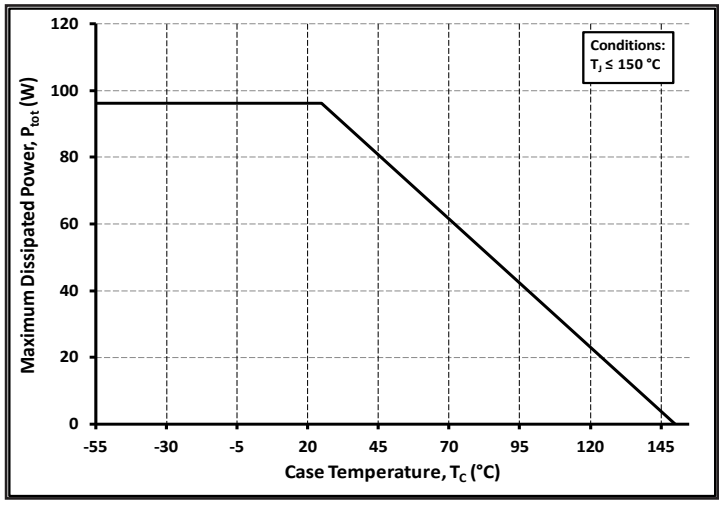


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

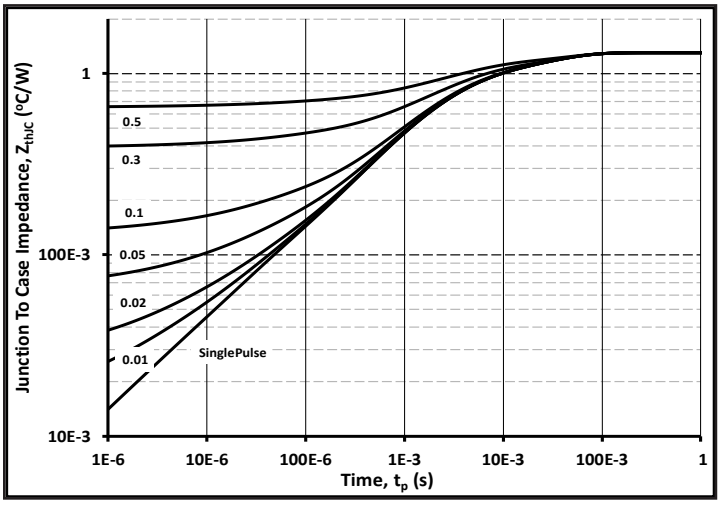


Figure 21. Transient Thermal Impedance (Junction - Case)

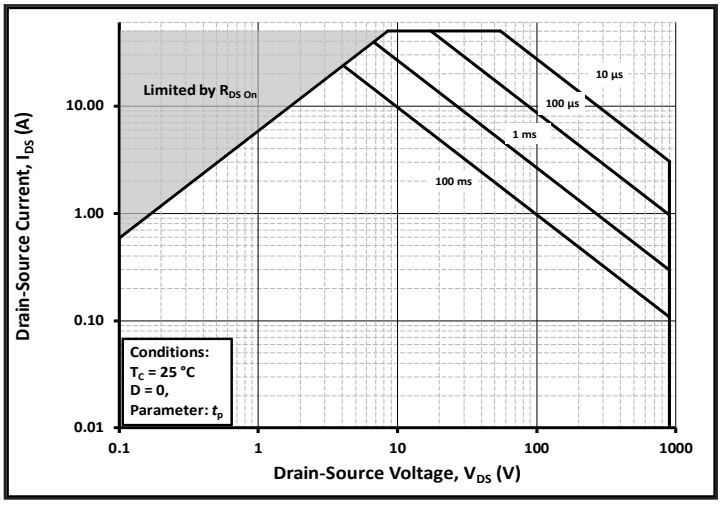


Figure 22. Safe Operating Area

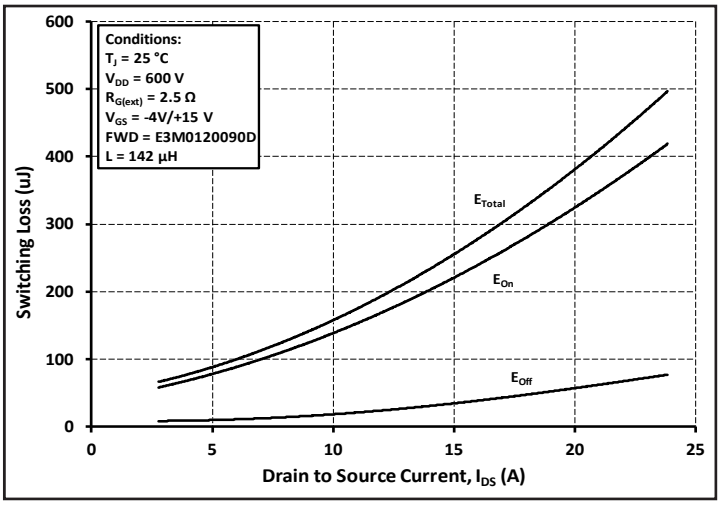


Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 600V)

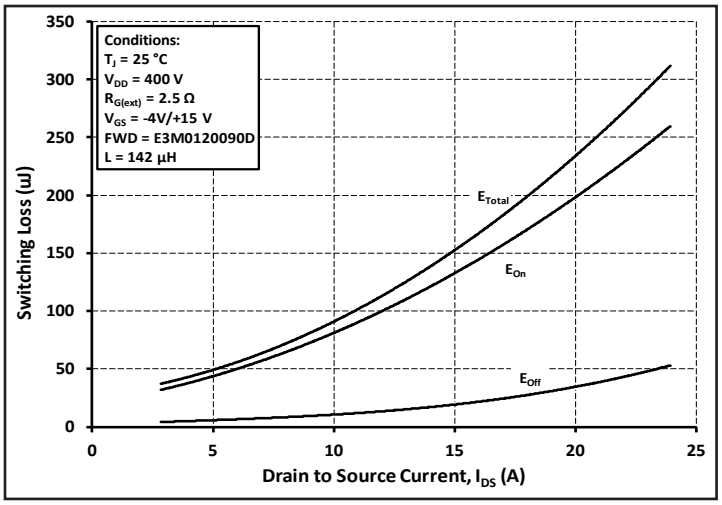


Figure 24. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 400V)

Typical Performance

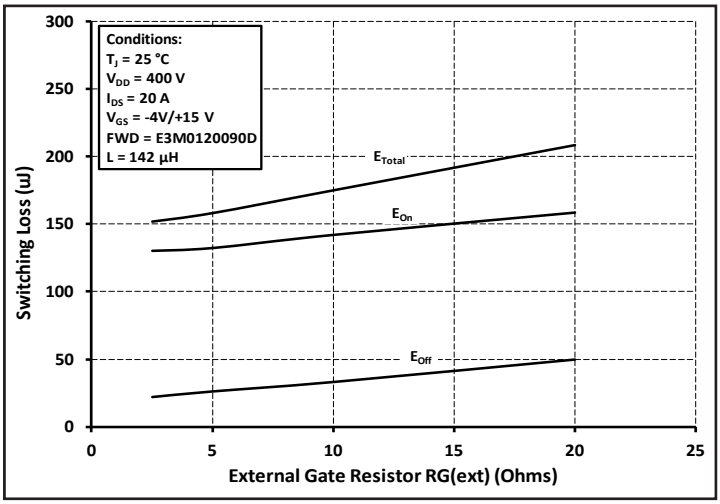


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

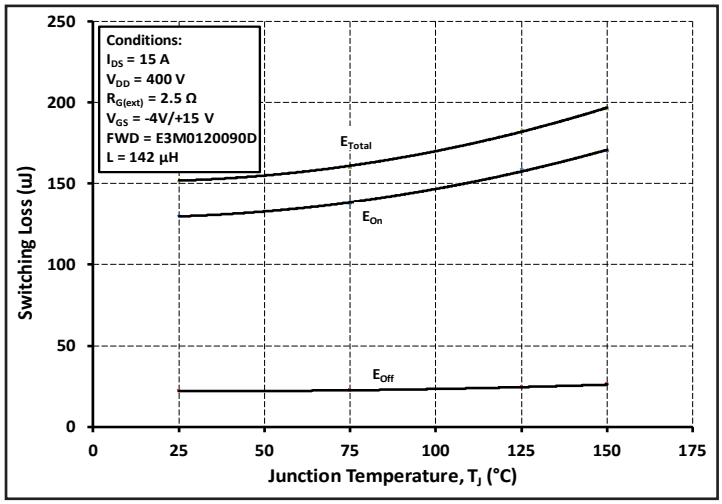


Figure 26. Clamped Inductive Switching Energy vs. Temperature

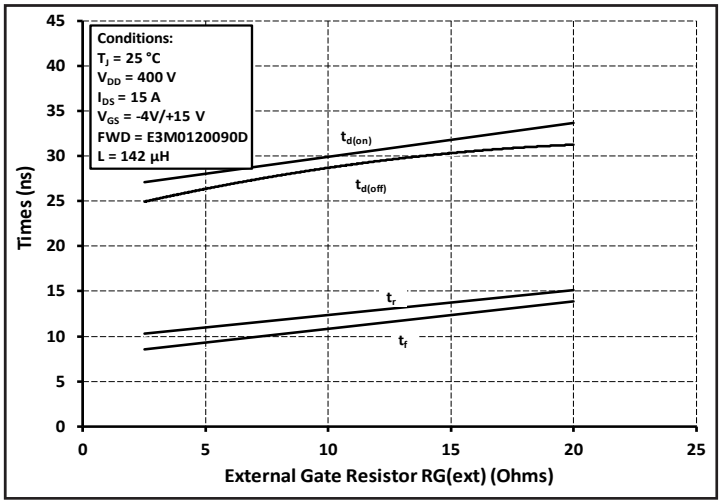


Figure 27. Switching Times vs. $R_{G(ext)}$

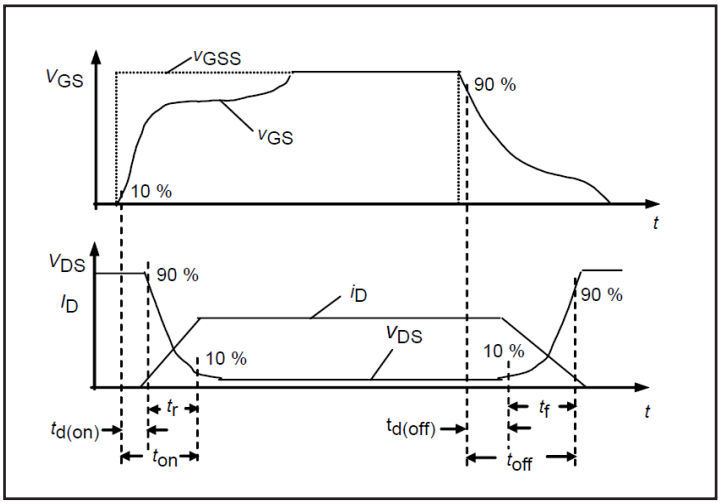


Figure 28. Switching Times Definition

Test Circuit Schematic

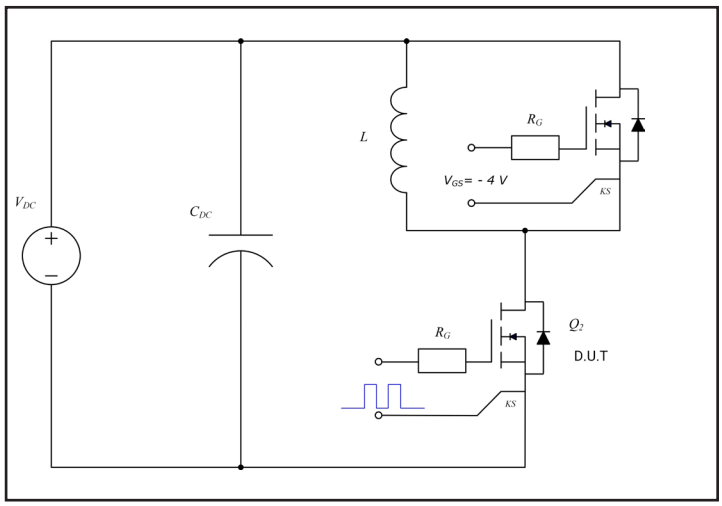
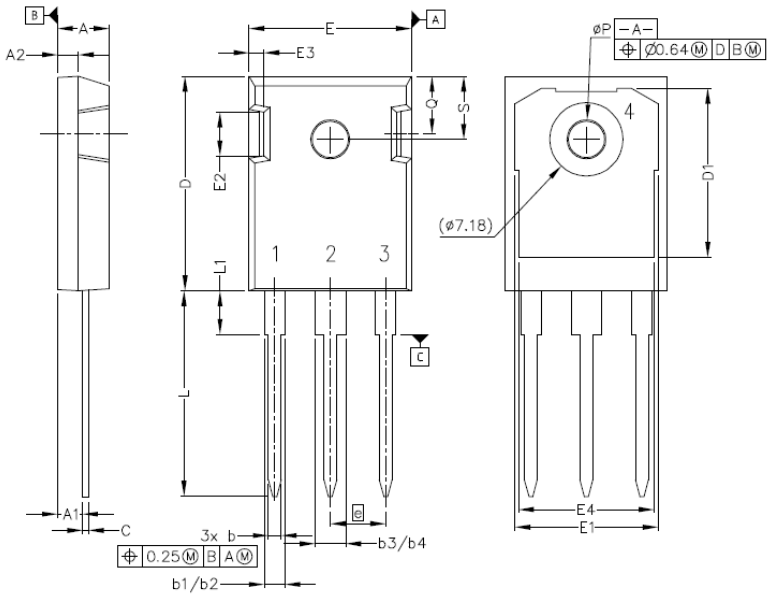


Figure 29. Clamped Inductive Switching Test Circuit

Note (3): Turn-off and Turn-on switching energy and timing values measured using SiC MOSFET Body Diode as shown above.

Package Dimensions

Package TO-247-3



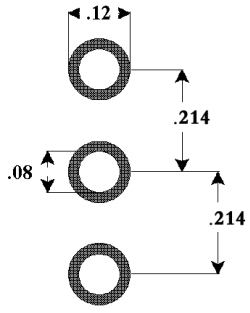


Pinout Information:

- Pin 1 = Gate
- Pin 2, 4 = Drain
- Pin 3 = Source

POS	Inches		Millimeters	
	Min	Max	Min	Max
A	.190	.205	4.83	5.21
A1	.090	.100	2.29	2.54
A2	.075	.085	1.91	2.16
b	.042	.052	1.07	1.33
b1	.075	.095	1.91	2.41
b2	.075	.085	1.91	2.16
b3	.113	.133	2.87	3.38
b4	.113	.123	2.87	3.13
c	.022	.027	0.55	0.68
D	.819	.831	20.80	21.10
D1	.640	.695	16.25	17.65
D2	.037	.049	0.95	1.25
E	.620	.635	15.75	16.13
E1	.516	.557	13.10	14.15
E2	.145	.201	3.68	5.10
E3	.039	.075	1.00	1.90
E4	.487	.529	12.38	13.43
e	.214 BSC		5.44 BSC	
N	3		3	
L	.780	.800	19.81	20.32
L1	.161	.173	4.10	4.40
ØP	.138	.144	3.51	3.65
Q	.216	.236	5.49	6.00
S	.238	.248	6.04	6.30
T	9°	11°	9°	11°
U	9°	11°	9°	11°
V	2°	8°	2°	8°
W	2°	8°	2°	8°

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

- **LTSPICE 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**

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