

E3M0120090J

Silicon Carbide Power MOSFET

E-Series Automotive

N-Channel Enhancement Mode



Features

- 3rd generation of 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
- Wide creepage (~7mm) between drain and source
- Automotive qualified (AEC-Q101) and PPAP capable

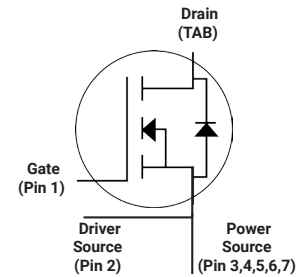
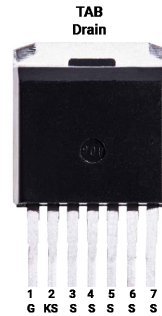
Benefits

- Reduce switching losses and minimize gate ringing
- High system efficiency
- Increased power density
- Increased system switching frequency

Applications

- EV charging
- DC/DC converters
- SMPS
- UPS
- Solar PV inverters

Package



Part Number	Package	Marking
E3M0120090J	TO-263-7	E3M0120090J

Maximum Ratings ($T_c = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain - Source Voltage	900	V	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	
V_{GSmax}	Gate - Source Voltage	-8/+19	V	Absolute maximum values	
V_{GSop}	Gate - Source Voltage	-4/+15	V	Recommended operational values	Note (1)
I_D	Continuous Drain Current	22	A	$V_{GS} = 15\text{ V}, T_C = 25^\circ\text{C}$	Fig. 19
		14		$V_{GS} = 15\text{ V}, T_C = 100^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	50	A	Pulse width t_p limited by T_{Jmax}	Fig. 22
P_D	Power Dissipation	83	W	$T_C = 25^\circ\text{C}, T_J = 150^\circ\text{C}$	Fig. 20
T_J, T_{stg}	Operating Junction and Storage Temperature	-55 to +150	$^\circ\text{C}$		
T_L	Solder Temperature	260	$^\circ\text{C}$	1.6mm (0.063") from case for 10s	

Note (1): MOSFET can also safely operate at 0/+15 V

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	900			V	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.1	3.5	V	$V_{DS} = V_{GS}, I_D = 3\ \text{mA}$	Fig. 11
			1.6		V	$V_{DS} = V_{GS}, I_D = 3\ \text{mA}, T_J = 150^\circ\text{C}$	
I_{DSS}	Zero Gate Voltage Drain Current		1	100	μA	$V_{DS} = 900\ \text{V}, V_{GS} = 0\ \text{V}$	
I_{GSS}	Gate-Source Leakage Current		10	250	nA	$V_{GS} = 15\ \text{V}, V_{DS} = 0\ \text{V}$	
$R_{DS(on)}$	Drain-Source On-State Resistance		120	155	m Ω	$V_{GS} = 15\ \text{V}, I_D = 15\ \text{A}$	Fig. 4, 5, 6
			170			$V_{GS} = 15\ \text{V}, I_D = 15\ \text{A}, T_J = 150^\circ\text{C}$	
g_{fs}	Transconductance		8.9		S	$V_{DS} = 15\ \text{V}, I_{DS} = 15\ \text{A}$	Fig. 7
			7.1			$V_{DS} = 15\ \text{V}, I_{DS} = 15\ \text{A}, T_J = 150^\circ\text{C}$	
C_{iss}	Input Capacitance		414		pF	$V_{GS} = 0\ \text{V}, V_{DS} = 600\ \text{V}$ $f = 1\ \text{MHz}$ $V_{AC} = 25\ \text{mV}$	Fig. 17, 18
C_{oss}	Output Capacitance		48				
C_{rss}	Reverse Transfer Capacitance		3				
E_{oss}	C_{oss} Stored Energy		10.6		μJ		Fig. 16
E_{ON}	Turn-On Switching Energy		32		μJ	$V_{DS} = 400\ \text{V}, V_{GS} = -4\ \text{V}/15\ \text{V}, I_D = 15\ \text{A},$ $R_{G(ext)} = 2.5\ \Omega, L = 99\ \mu\text{H}, T_J = 150^\circ\text{C}$	Fig. 26, 29
E_{OFF}	Turn Off Switching Energy		8				
$t_{d(on)}$	Turn-On Delay Time		5		ns	$V_{DD} = 400\ \text{V}, V_{GS} = -4\ \text{V}/15\ \text{V}$ $I_D = 15\ \text{A}, R_{G(ext)} = 2.5\ \Omega,$ Timing relative to V_{DS} Inductive load	Fig. 27, 29
t_r	Rise Time		8				
$t_{d(off)}$	Turn-Off Delay Time		13				
t_f	Fall Time		4				
$R_{G(int)}$	Internal Gate Resistance		13		Ω	$f = 1\ \text{MHz}, V_{AC} = 25\ \text{mV}$	
Q_{gs}	Gate to Source Charge		6		nC	$V_{DS} = 400\ \text{V}, V_{GS} = -4\ \text{V}/15\ \text{V}$ $I_D = 15\ \text{A}$ Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		5				
Q_g	Total Gate Charge		18				

Reverse Diode Characteristics ($T_c = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage	4.8		V	$V_{GS} = -4\ \text{V}, I_{SD} = 7.5\ \text{A}$	Fig. 8, 9, 10
		4.4		V	$V_{GS} = -4\ \text{V}, I_{SD} = 7.5\ \text{A}, T_J = 150^\circ\text{C}$	
I_S	Continuous Diode Forward Current		15	A	$V_{GS} = -4\ \text{V}$	Note (2)
$I_{S,pulse}$	Diode pulse Current		50	A	$V_{GS} = -4\ \text{V}$, pulse width t_p limited by T_{jmax}	Note (2)
t_{rr}	Reverse Recover time	10		ns	$V_{GS} = -4\ \text{V}, I_{SD} = 15\ \text{A}, V_R = 400\ \text{V}$ $\text{dif}/\text{dt} = 900\ \text{A}/\mu\text{s}, T_J = 150^\circ\text{C}$	Note (2)
Q_{rr}	Reverse Recovery Charge	72		nC		
I_{rrm}	Peak Reverse Recovery Current	12		A		

 Note (2): When using SiC Body Diode the maximum recommended $V_{GS} = -4\text{V}$
Thermal Characteristics

Symbol	Parameter	Max.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	1.5	$^\circ\text{C}/\text{W}$		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			

Typical Performance

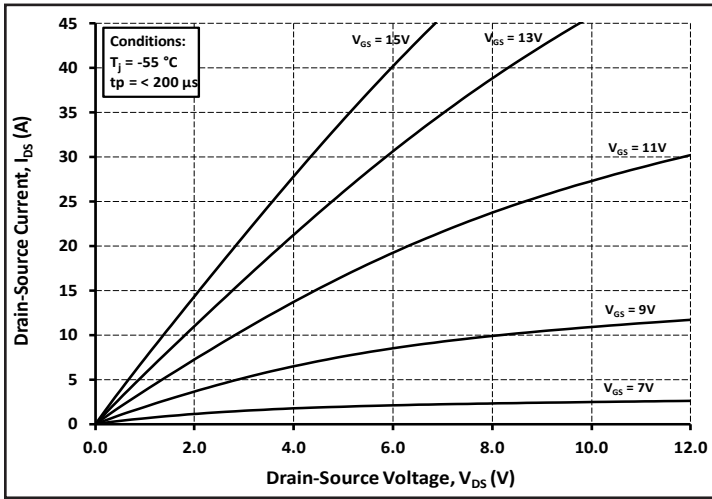


Figure 1. Output Characteristics $T_J = -55\text{ }^\circ\text{C}$

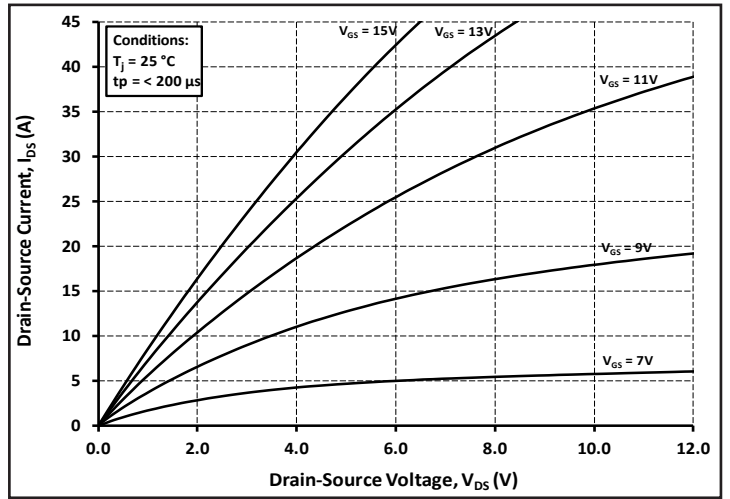


Figure 2. Output Characteristics $T_J = 25\text{ }^\circ\text{C}$

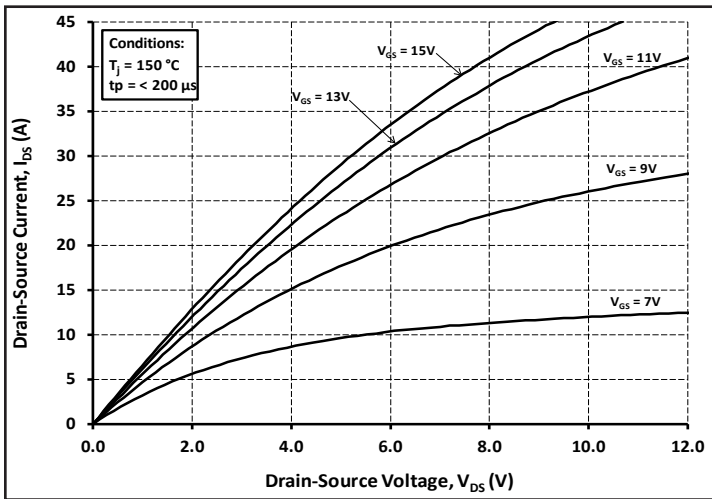


Figure 3. Output Characteristics $T_J = 150\text{ }^\circ\text{C}$

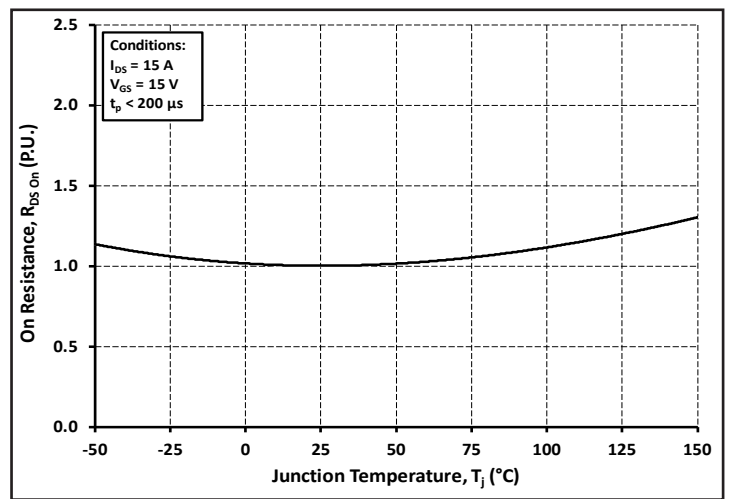


Figure 4. Normalized On-Resistance vs. Temperature

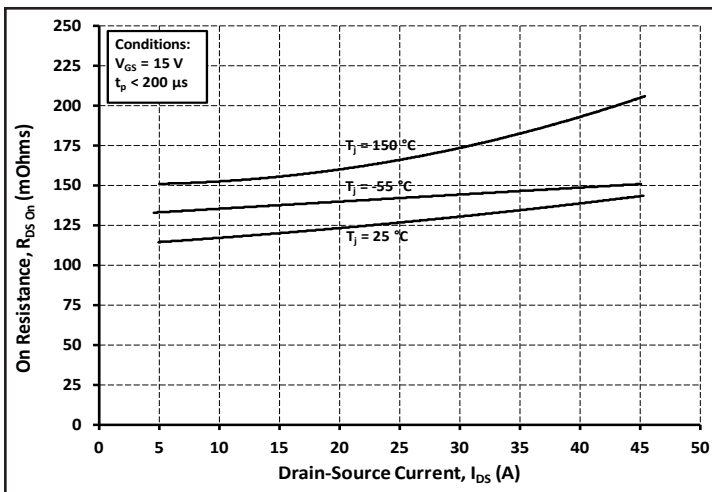


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

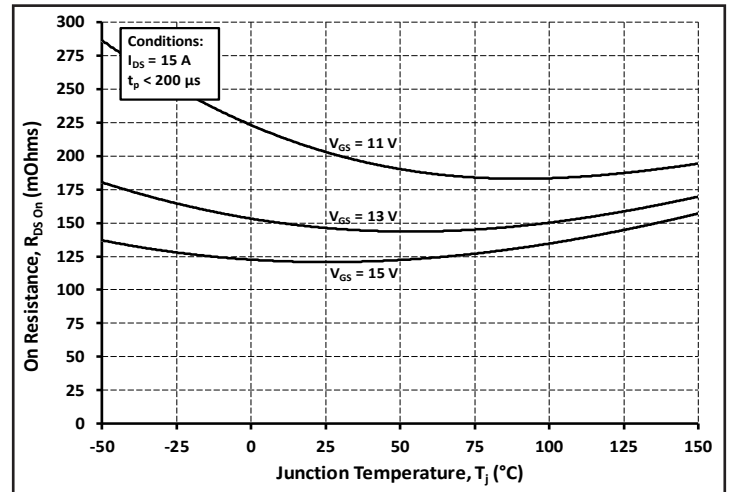


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage

Typical Performance

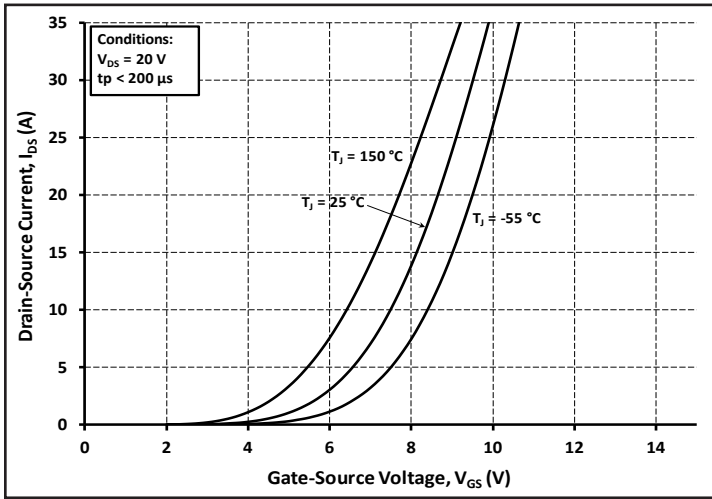


Figure 7. Transfer Characteristic for Various Junction Temperatures

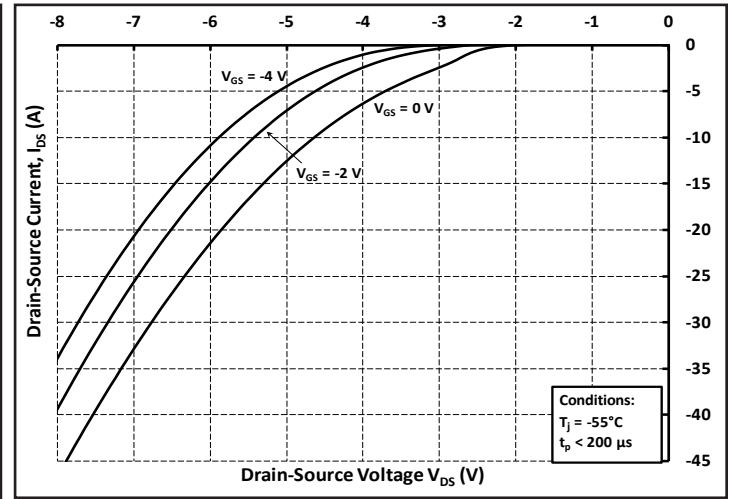


Figure 8. Body Diode Characteristic at -55 °C

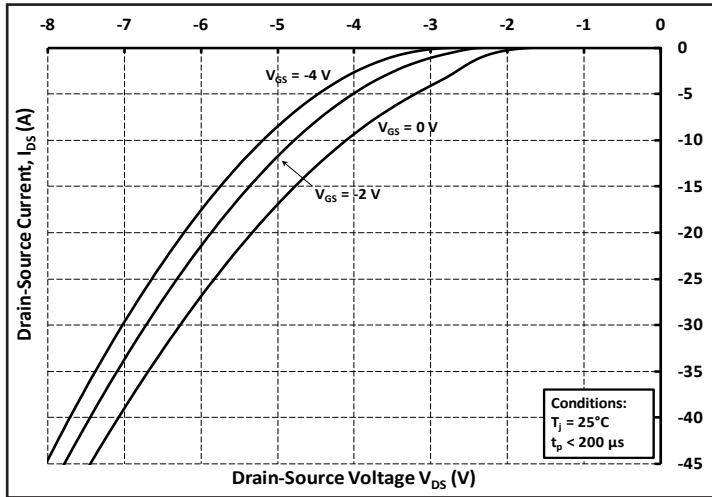


Figure 9. Body Diode Characteristic at 25 °C

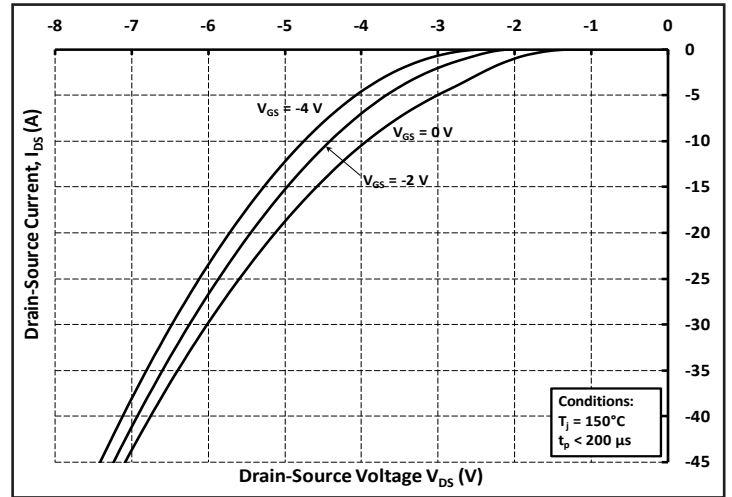


Figure 10. Body Diode Characteristic at 150 °C

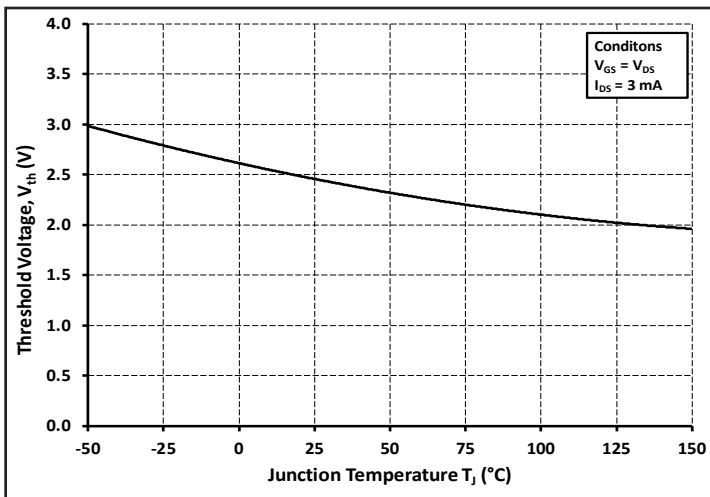


Figure 11. Threshold Voltage vs. Temperature

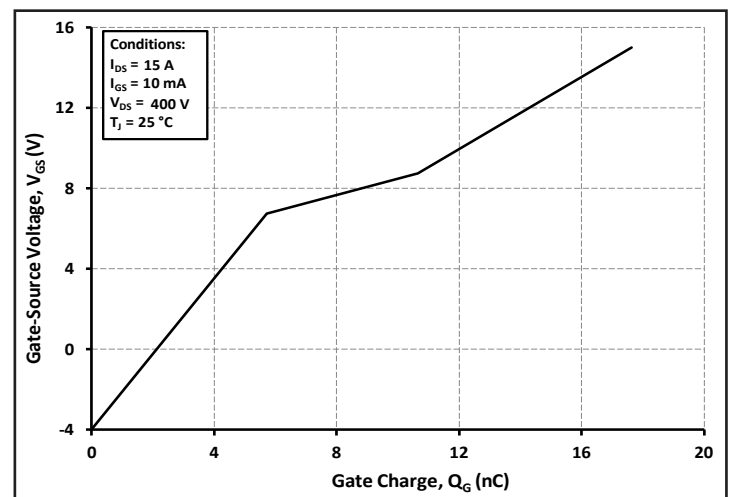


Figure 12. Gate Charge Characteristics

Typical Performance

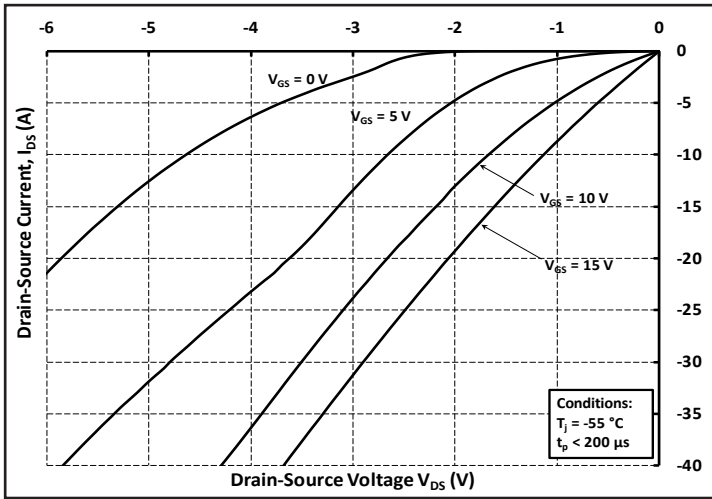


Figure 13. 3rd Quadrant Characteristic at $-55\text{ }^\circ\text{C}$

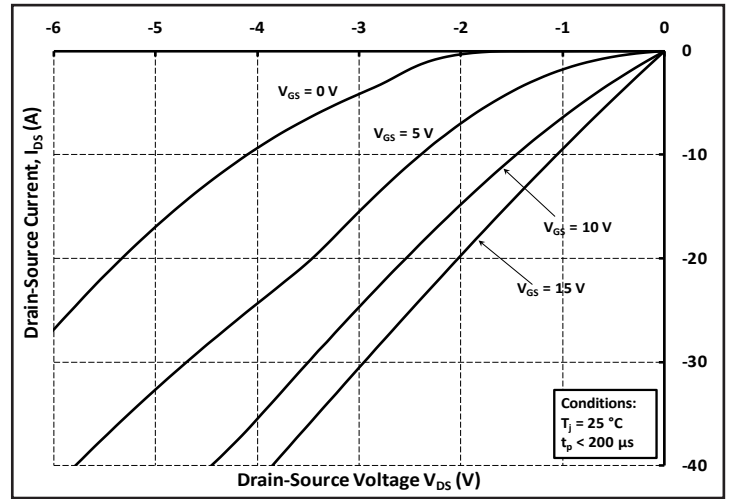


Figure 14. 3rd Quadrant Characteristic at $25\text{ }^\circ\text{C}$

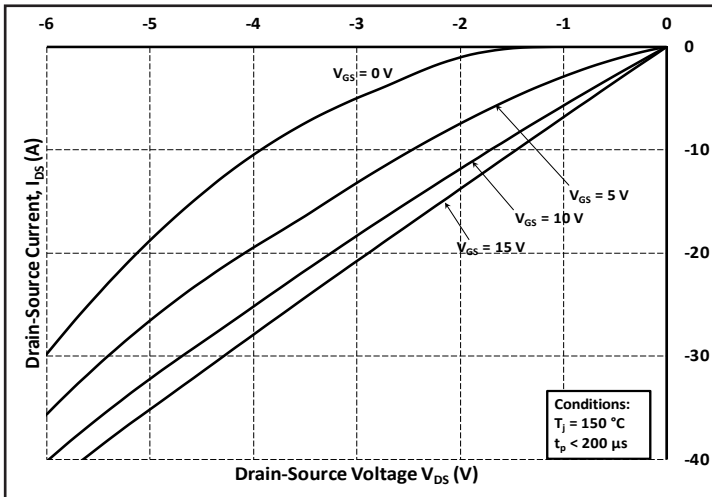


Figure 15. 3rd Quadrant Characteristic at $150\text{ }^\circ\text{C}$

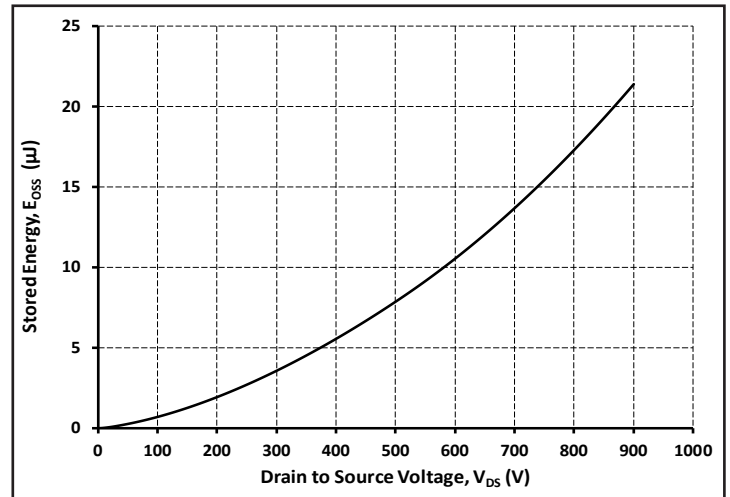


Figure 16. Output Capacitor Stored Energy

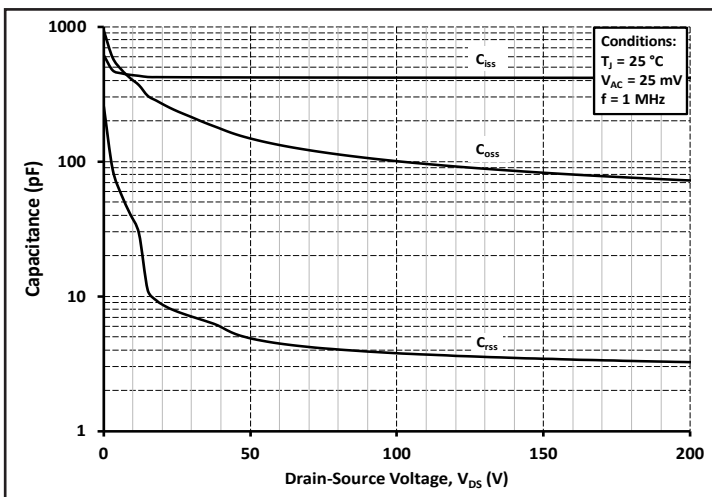


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

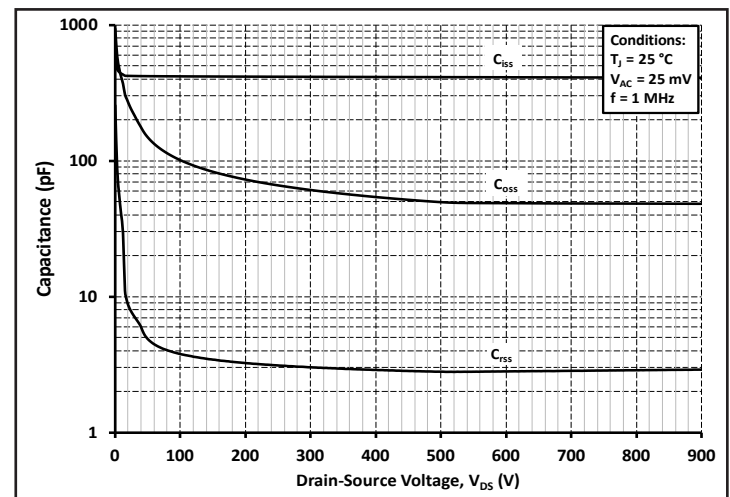


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 900V)

Typical Performance

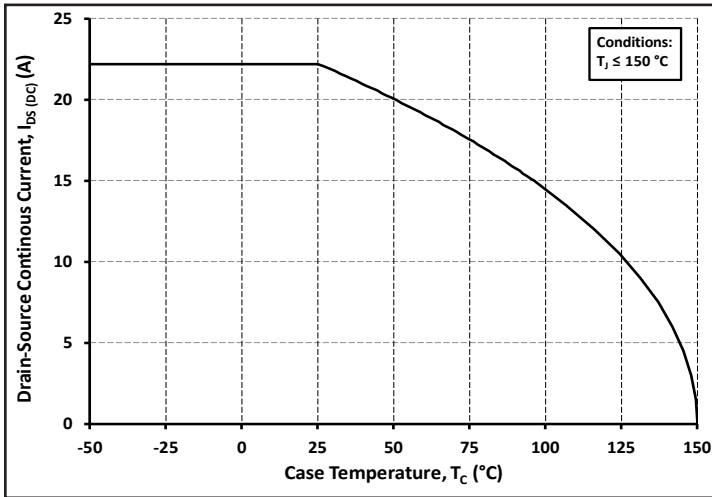


Figure 19. Continuous Drain Current Derating vs. Case Temperature

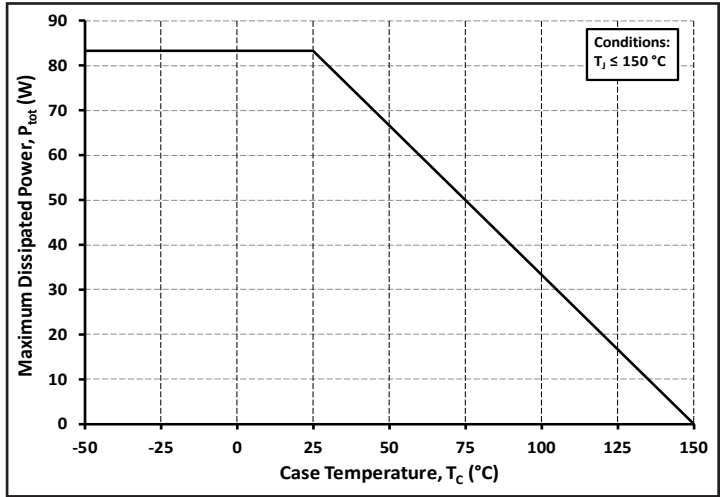


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

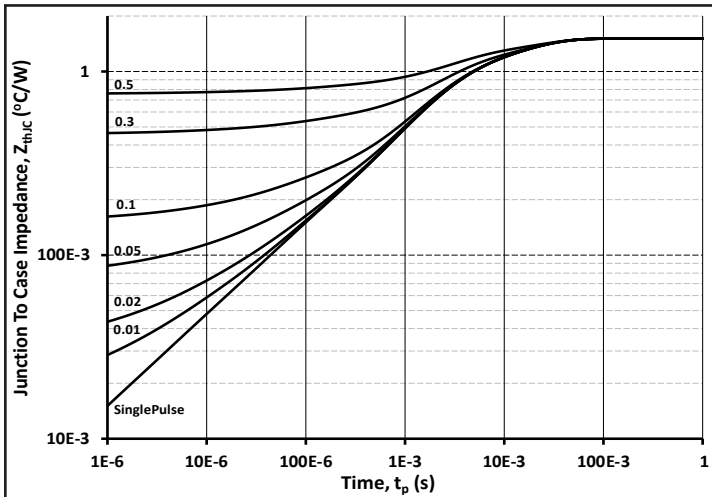


Figure 21. Transient Thermal Impedance (Junction - Case)

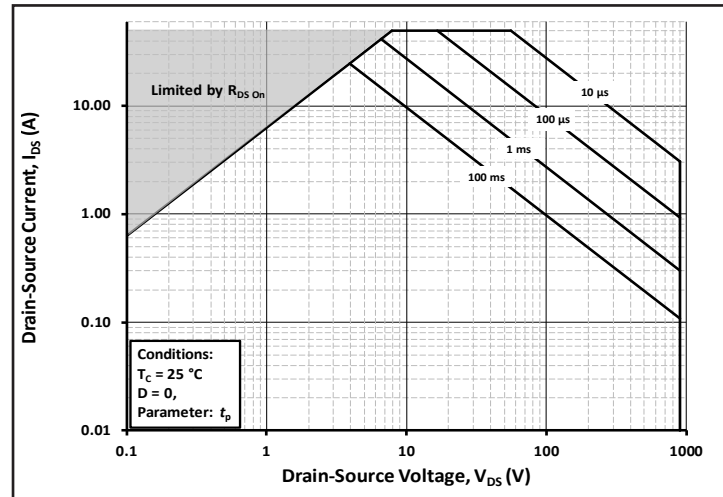


Figure 22. Safe Operating Area

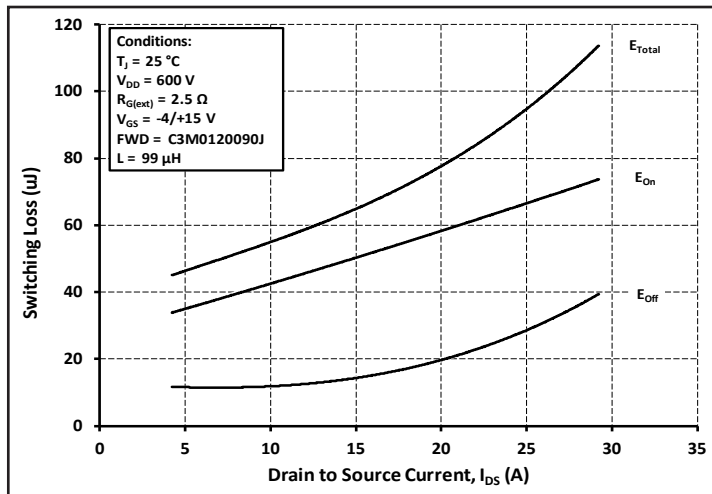


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 600V$)

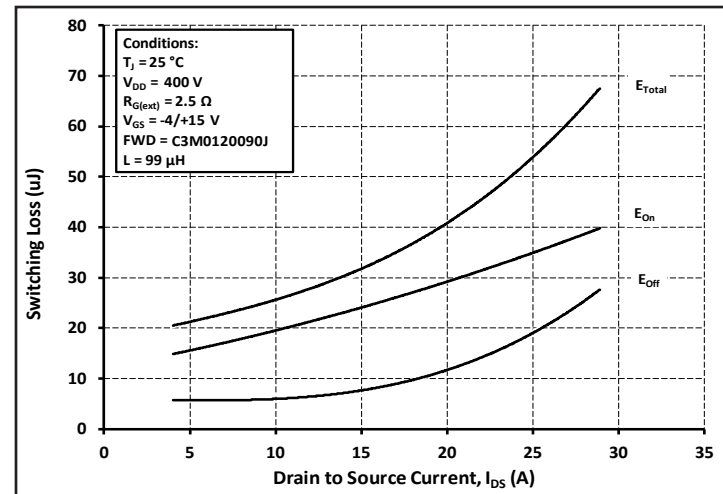


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 400V$)

Typical Performance

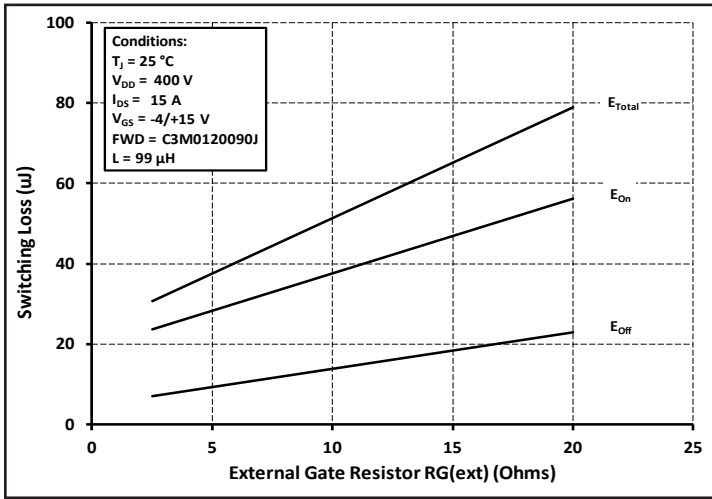


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

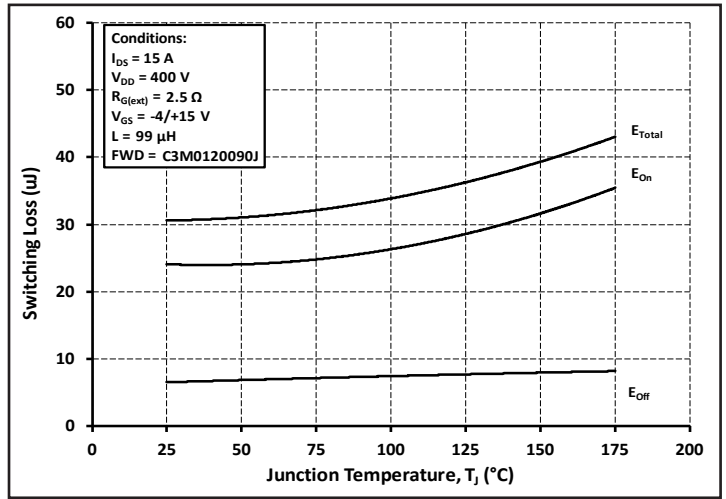


Figure 26. Clamped Inductive Switching Energy vs. Temperature

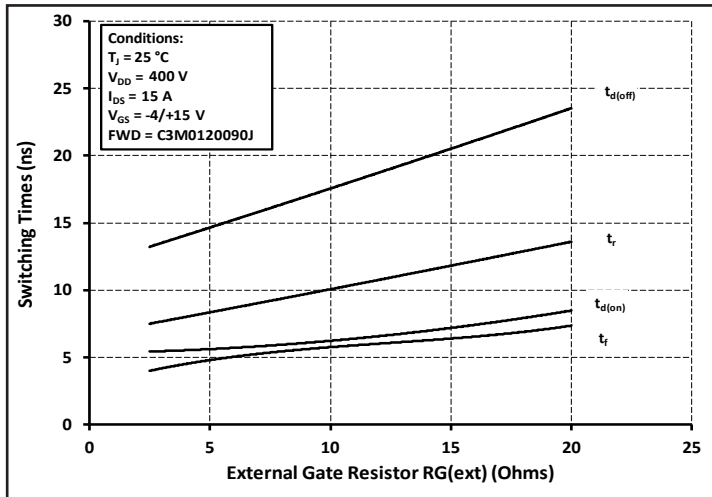


Figure 27. Switching Times vs. $R_{G(ext)}$

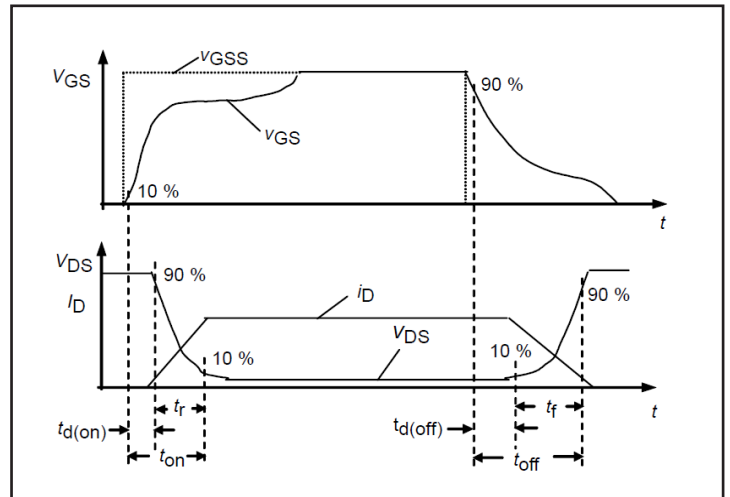


Figure 28. Switching Times Definition

Test Circuit Schematic

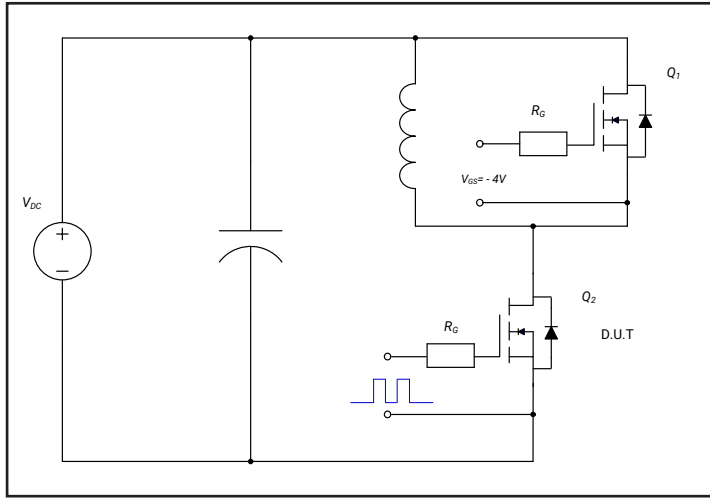
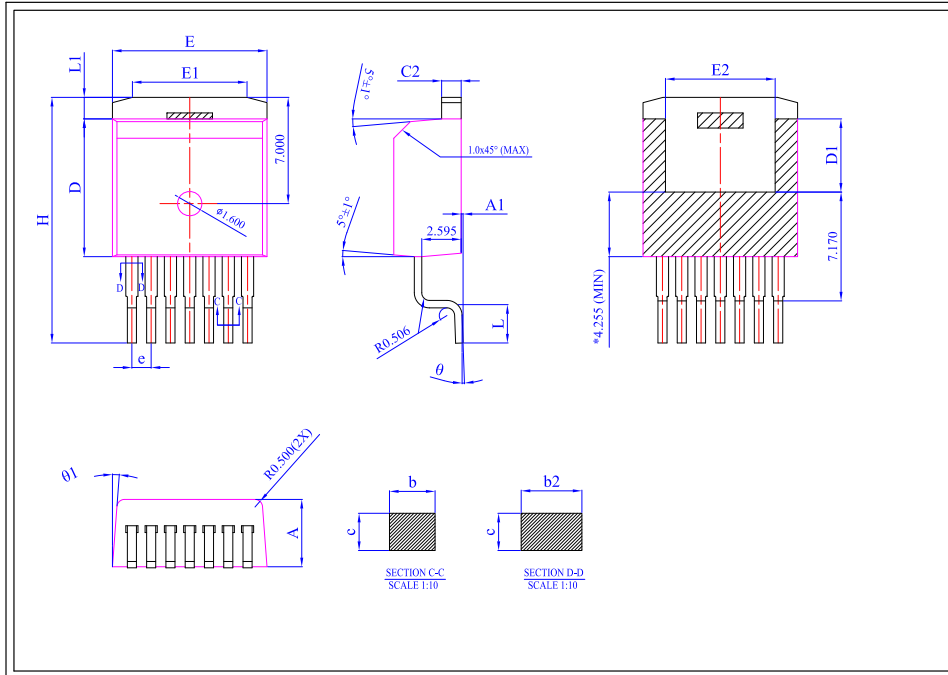


Figure 29. Clamped Inductive Switching Test Circuit

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

Package Dimensions

TO-263-7



Dim	All Dimensions in Millimeters		
	Min	typ	Max
A	4.300	4.435	4.570
A1	0.00	0.125	0.25
b	0.500	0.600	0.700
b2	0.600	0.800	1.000
c	0.330	0.490	0.650
C2	1.170	1.285	1.400
D	9.025	9.075	9.125
D1	4.700	4.800	4.900
E	10.130	10.180	10.230
E1	6.500	7.550	8.600
E2	6.778	7.223	7.665
e	1.27		
H	15.043	16.178	17.313
L	2.324	2.512	2.700
L1	0.968	1.418	1.868
ϕ	0°	4°	8°
$\phi 1$	4.5°	5°	5.5°

