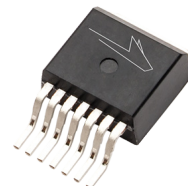
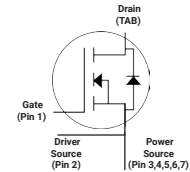


E3M0120090J

Silicon Carbide Power MOSFET
E-Series Automotive
N-Channel Enhancement Mode



TO-263-7



Package Types: TO-263-7

PN's: E3M0120090J

Wolfspeed, Inc. is in the process of rebranding its products and related materials pursuant to the entity name change from Cree, Inc. to Wolfspeed, Inc. During this transition period, products received may be marked with either the Cree name and/or logo or the Wolfspeed name and/or logo.

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 (Q_{rr})
- Halogen free, RoHS compliant
- Wide creepage (~7 mm) between drain and source
- Automotive qualified (AEC-Q101) and PPAP capable

Applications

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

Benefits

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

Maximum Ratings ($T_c = 25^\circ\text{C}$ Unless Otherwise Specified)

Parameter	Symbol	Value	Unit	Test Conditions	Note
Drain-Source Voltage	V_{DSmax}	900	V	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	
Gate-Source Voltage	V_{GSmx}	-8/+19		Absolute Maximum Values	
Gate-Source Voltage	V_{GSop}	-4/+15		Recommended Operational Values	Note: 1
Continuous Drain Current	I_D	22	A	$V_{GS} = 15\text{ V}, T_c = 25^\circ\text{C}$	Fig. 19
		14		$V_{GS} = 15\text{ V}, T_c = 100^\circ\text{C}$	
Pulsed Drain Current	$I_D(\text{pulse})$	50		Pulse Width t_p Limited by T_{jmax}	Fig. 22
Power Dissipation	P_D	83	W	$T_c = 25^\circ\text{C}, T_J = 150^\circ\text{C}$	Fig. 20
Operating Junction and Storage Temperature	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$		
Solder Temperature	T_L	260		According to JEDEC J-STD-020	

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


Electrical Characteristics ($T_C = 25^\circ\text{C}$ Unless Otherwise Specified)

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



Reverse Diode Characteristics ($T_c = 25\text{ }^\circ\text{C}$ Unless Otherwise Specified)

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

Note (2): When using SiC body diode the maximum recommended $V_{GS} = -4\text{ V}$

Thermal Characteristics

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

Typical Performance

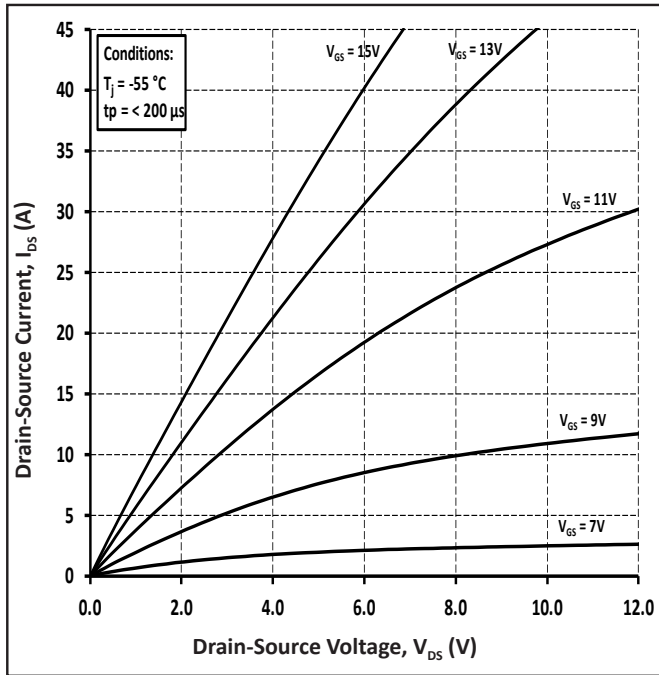
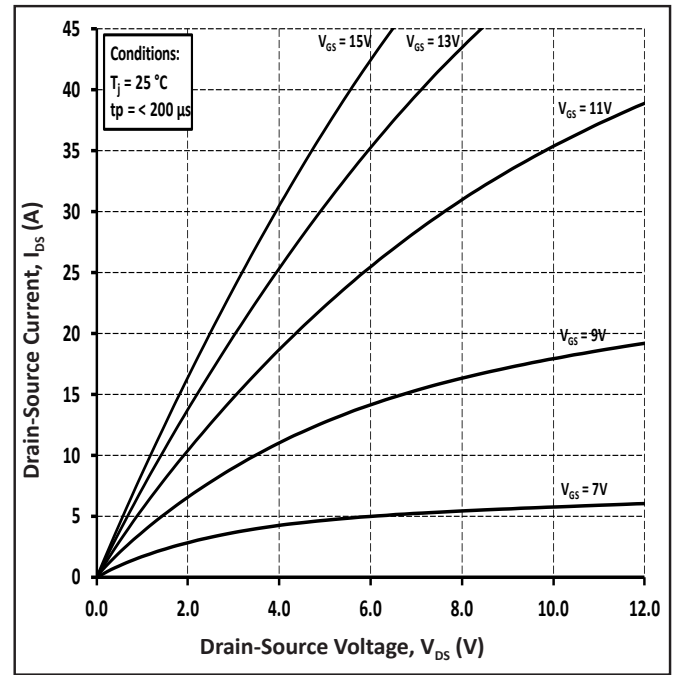
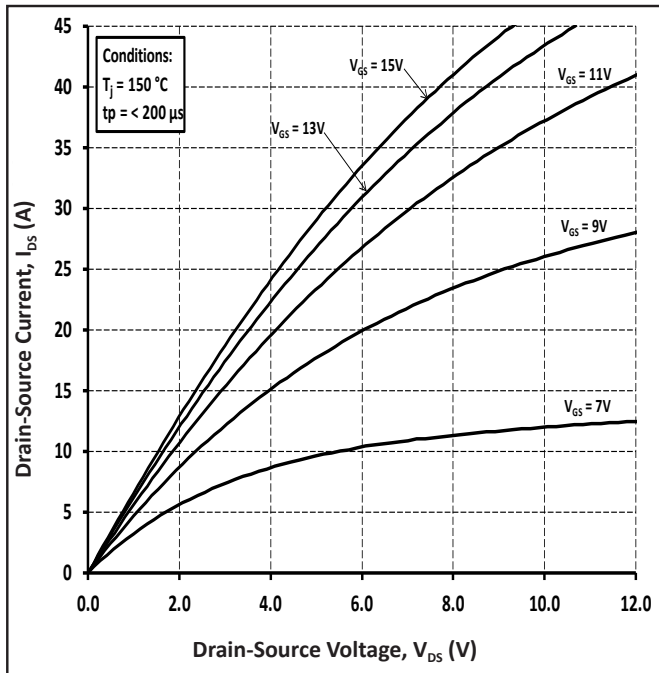
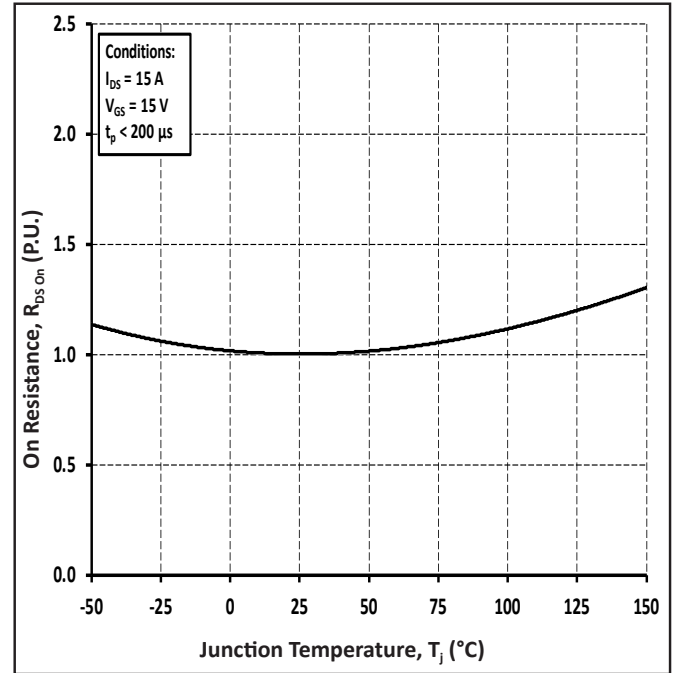
Figure 1. Output Characteristics $T_j = -55^\circ\text{C}$ Figure 2. Output Characteristics $T_j = 25^\circ\text{C}$ Figure 3. Output Characteristics $T_j = 150^\circ\text{C}$ 

Figure 4. Normalized On-Resistance vs Temperature

Typical Performance

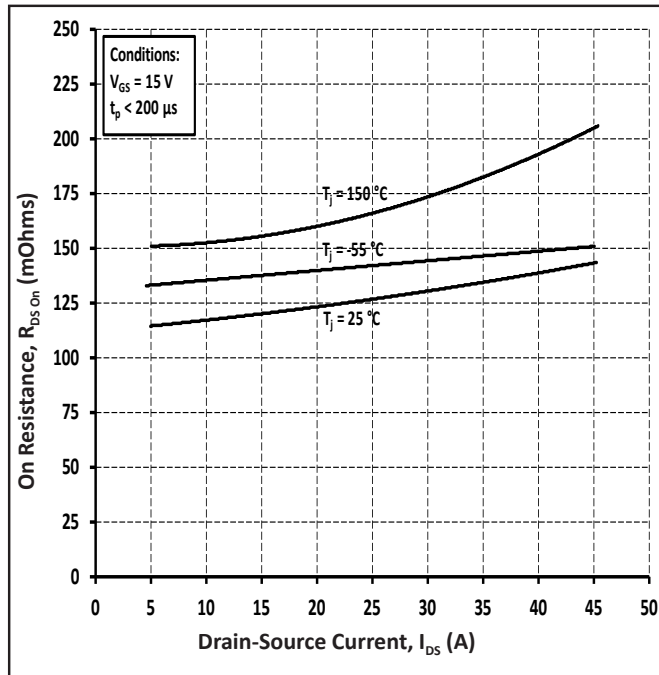


Figure 5. On-Resistance vs Drain Current for Various Temperatures

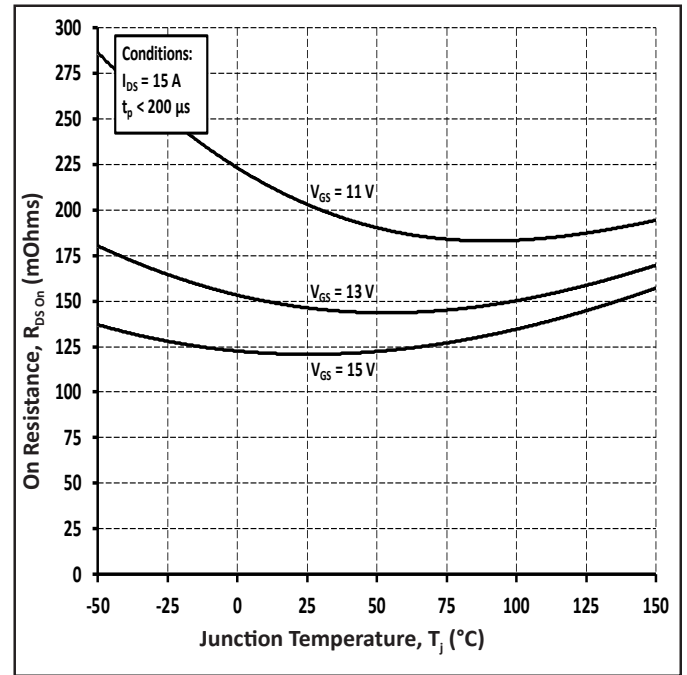


Figure 6. On-Resistance vs Temperature for Various Gate Voltage

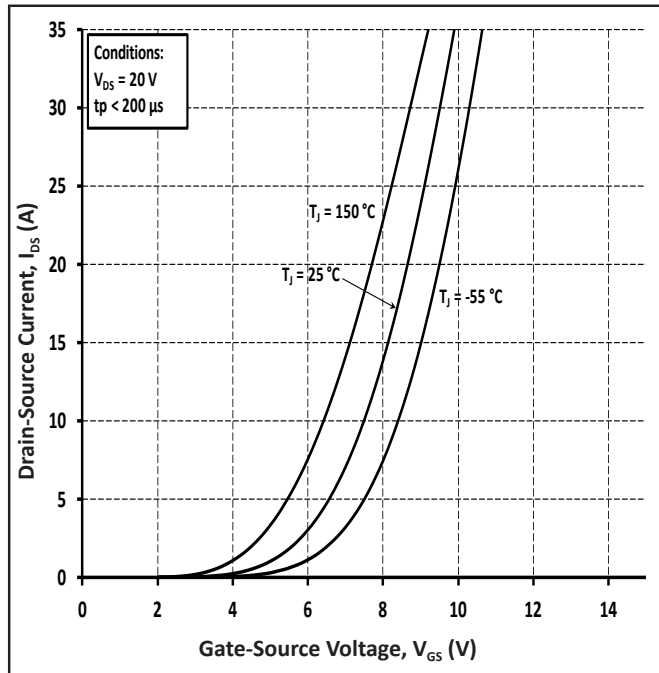


Figure 7. Transfer Characteristic for Various Junction Temperatures

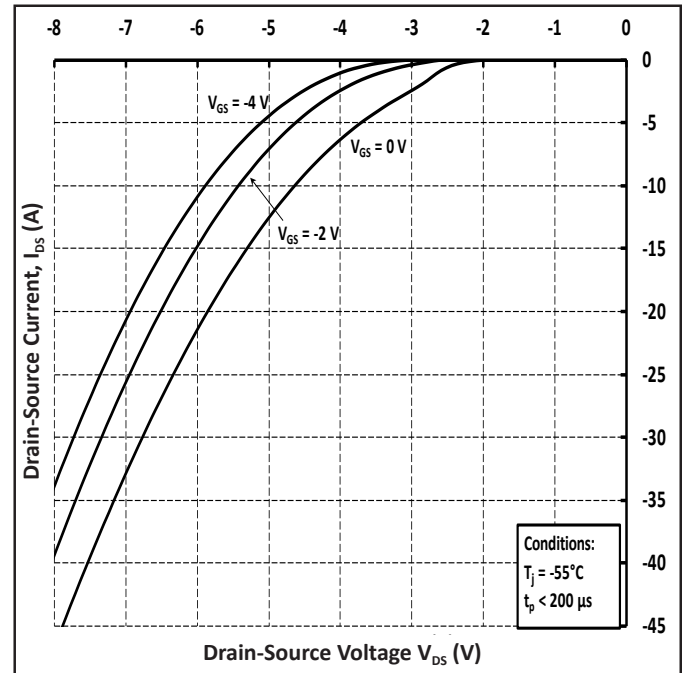


Figure 8. Body Diode Characteristic at -55°C

Typical Performance

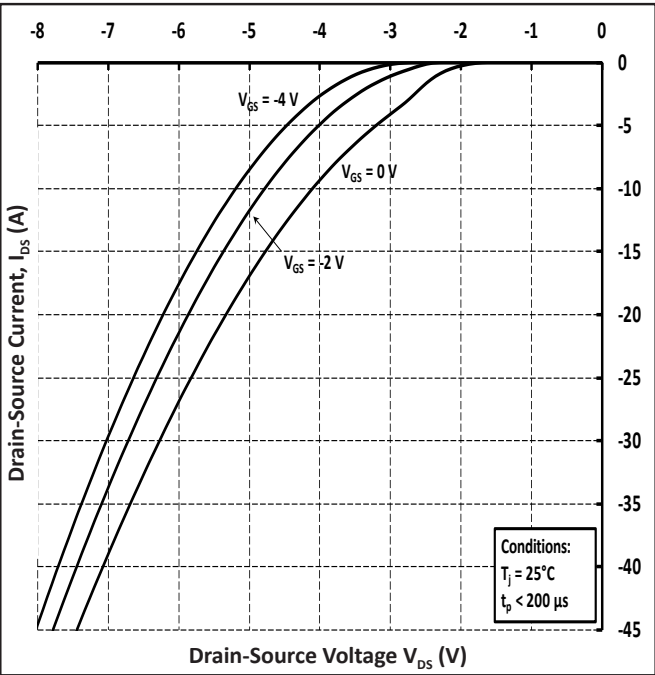


Figure 9. Body Diode Characteristic at 25 °C

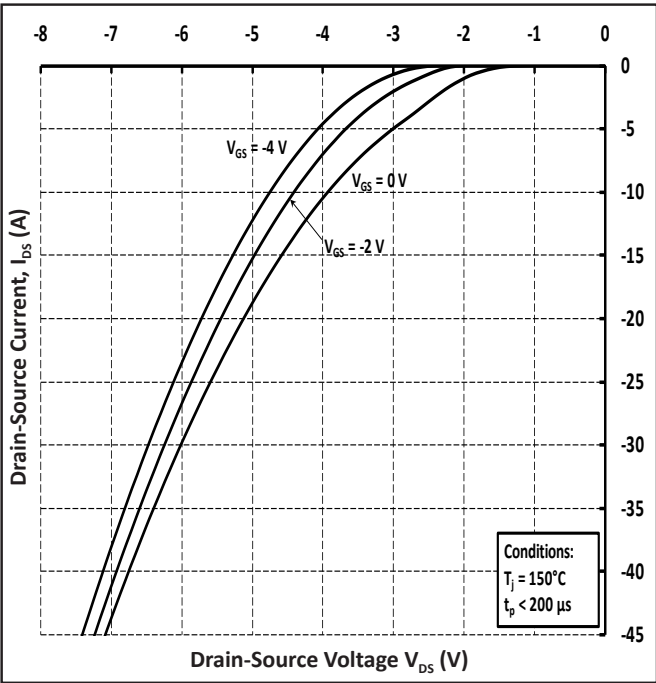


Figure 10. Body Diode Characteristic at 150 °C

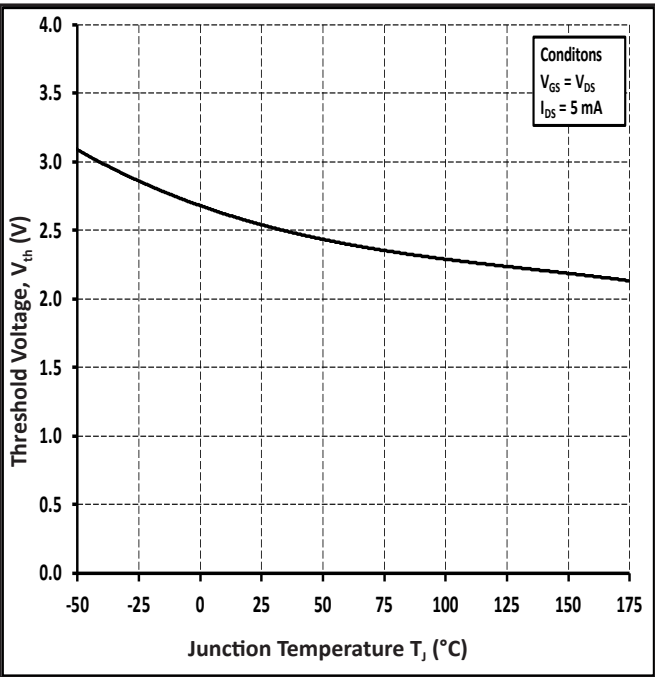


Figure 11. Threshold Voltage vs Temperature

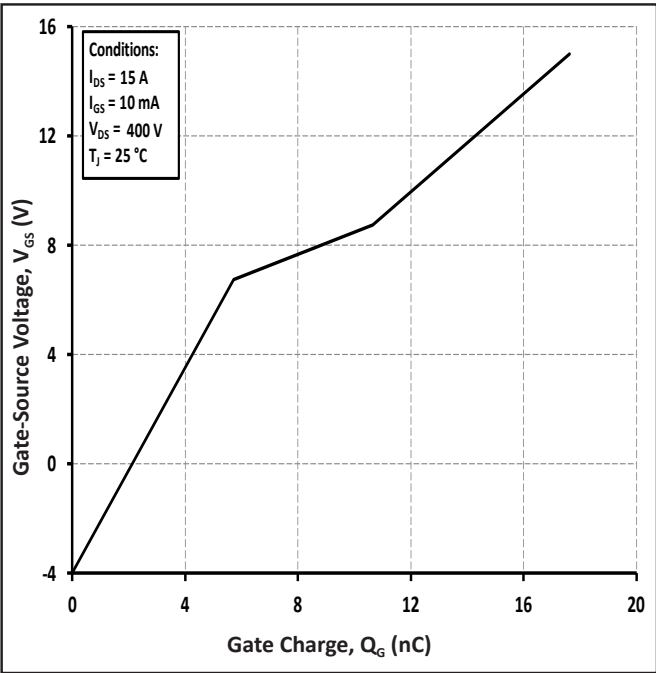


Figure 12. Gate Charge Characteristic

Typical Performance

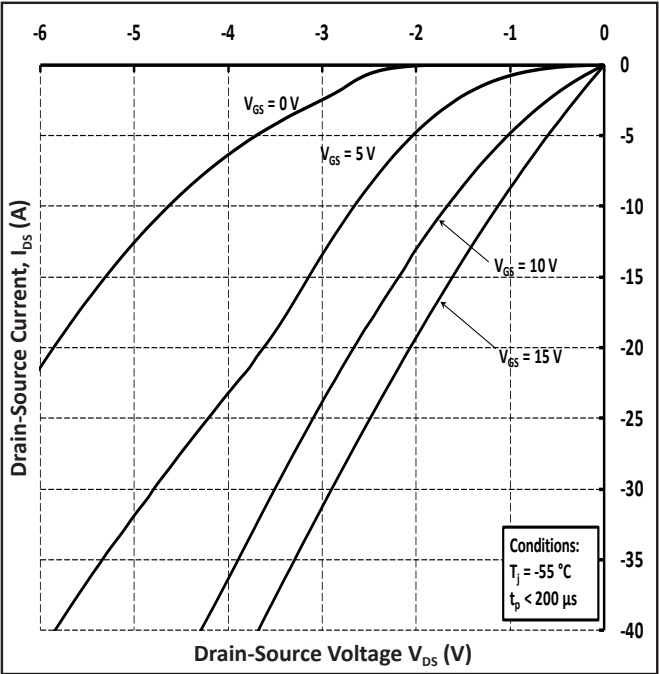


Figure 13. 3rd Quadrant Characteristic at $-55\text{ }^{\circ}\text{C}$

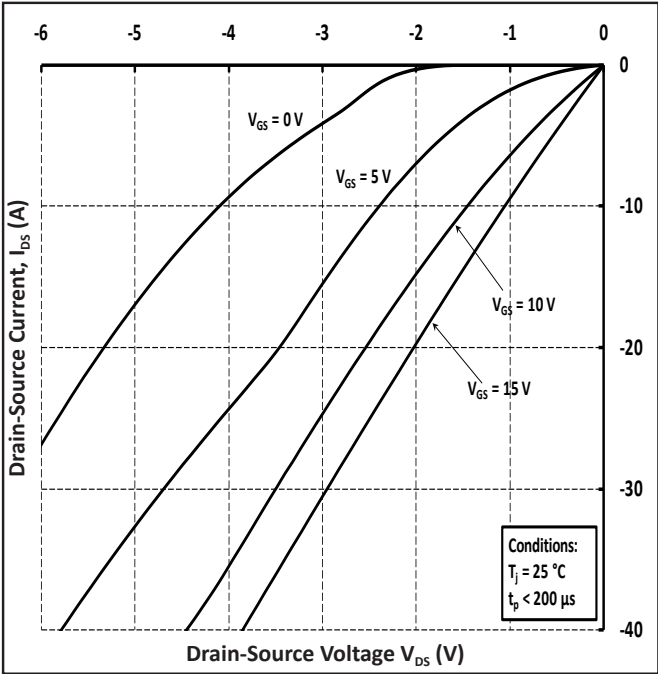


Figure 14. 3rd Quadrant Characteristic at $25\text{ }^{\circ}\text{C}$

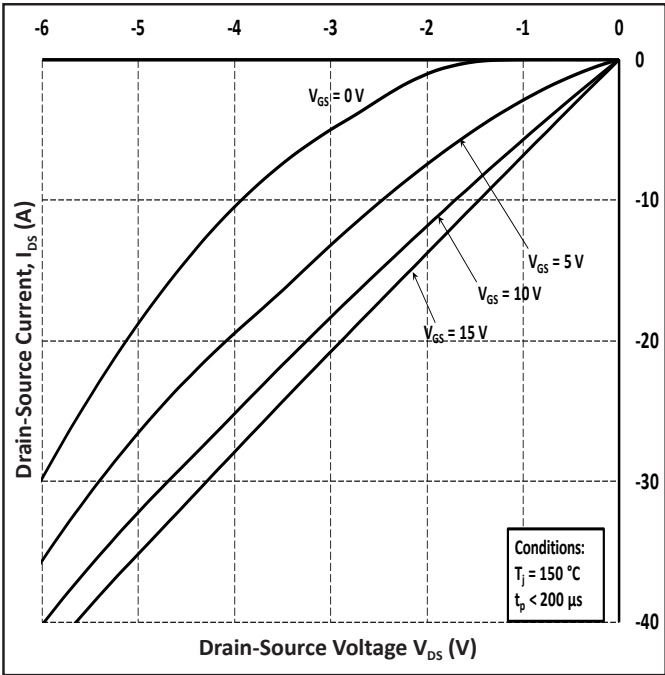


Figure 15. 3rd Quadrant Characteristic at $150\text{ }^{\circ}\text{C}$

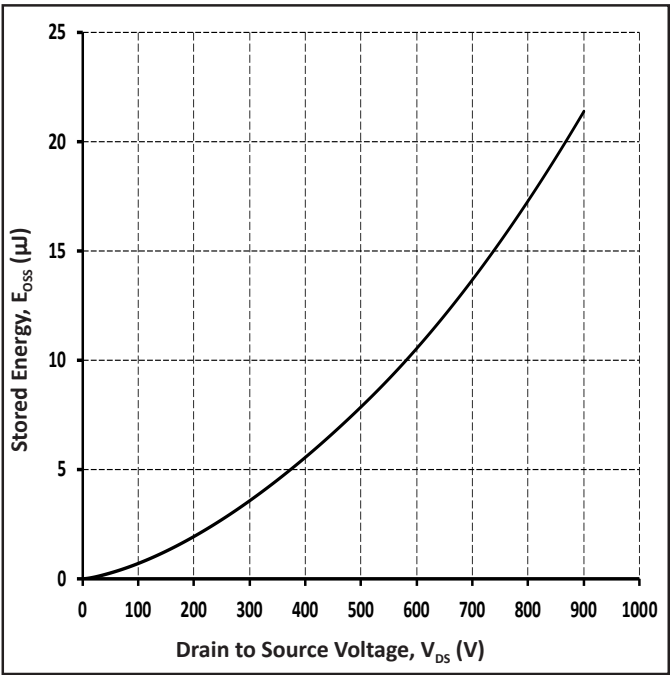


Figure 16. Output Capacitor Stored Energy

Typical Performance

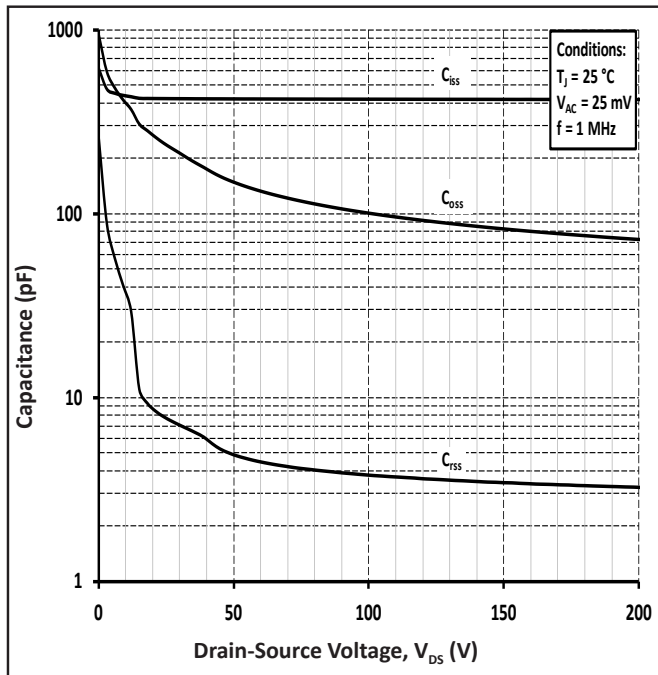


Figure 17. Capacitances vs Drain-Source Voltage (0-200 V)

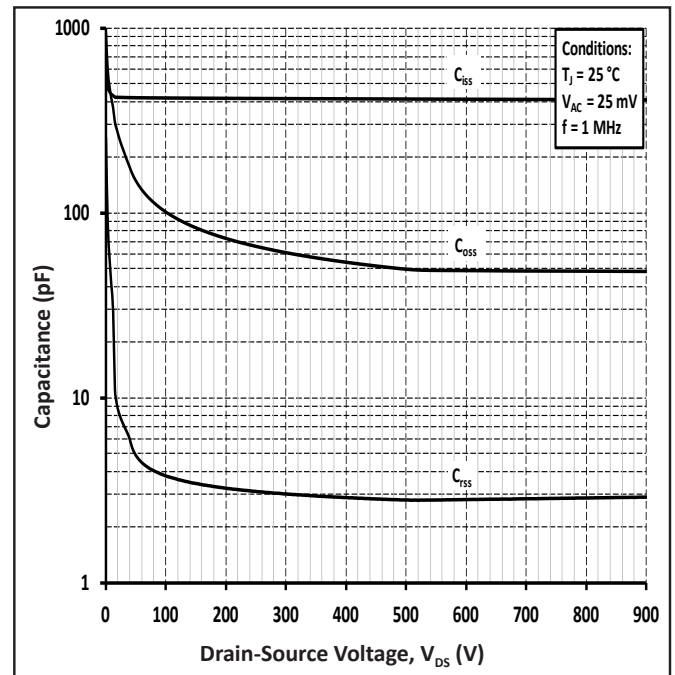


Figure 18. Capacitances vs Drain-Source Voltage (0-900 V)

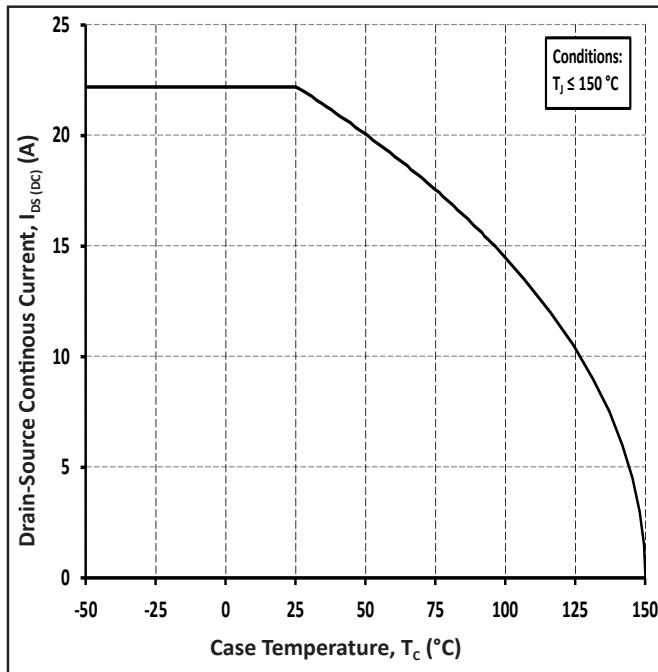


Figure 19. Continuous Drain Current Derating vs Case Temperature

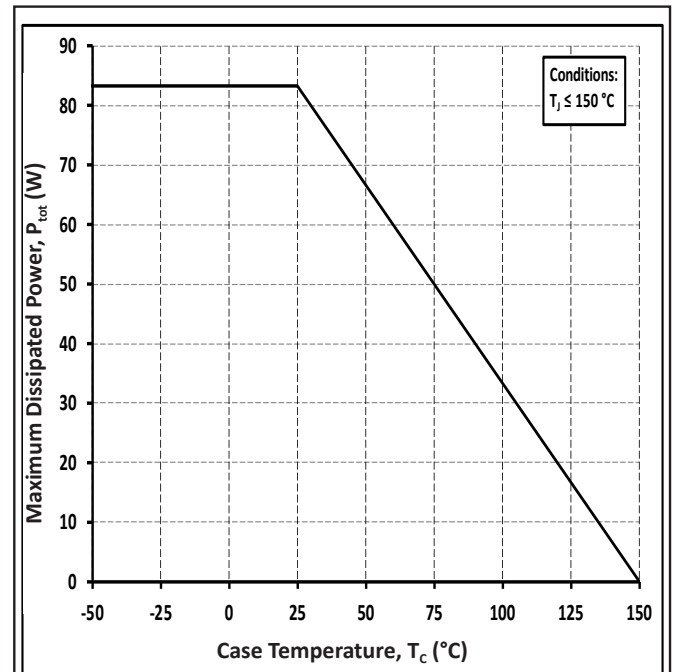


Figure 20. Maximum Power Dissipation Derating vs Case Temperature

Typical Performance

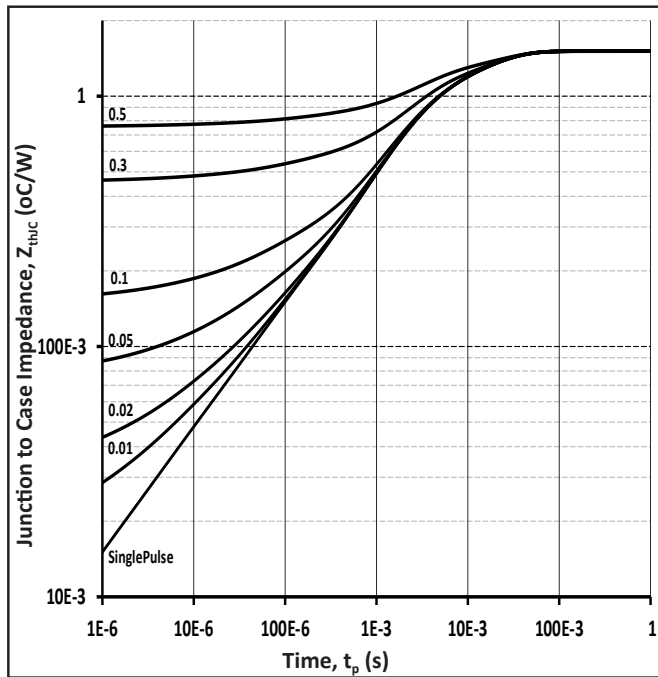


Figure 21. Transient Thermal Impedance (Junction - Case)

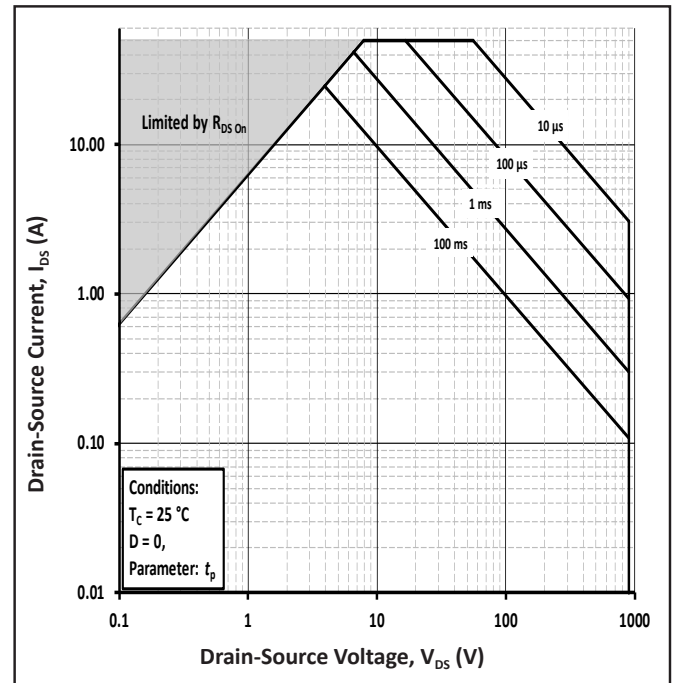


Figure 22. Safe Operating Area

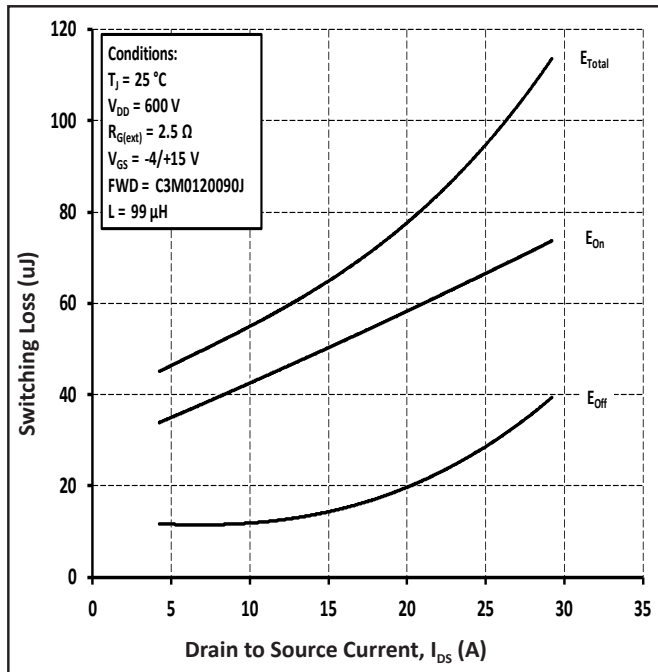


Figure 23. Clamped Inductive Switching Energy vs Drain Current ($V_{DD} = 600 \text{ V}$)

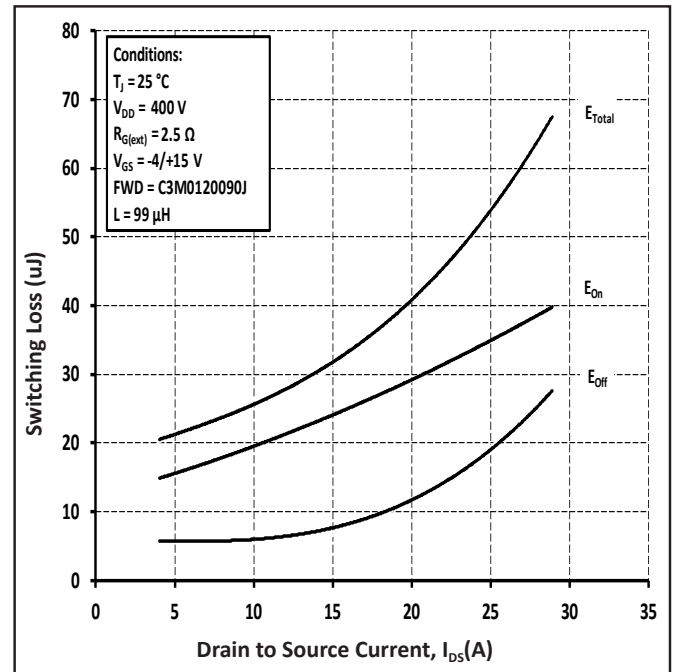


Figure 24. Clamped Inductive Switching Energy vs Drain Current ($V_{DD} = 800 \text{ V}$)

Typical Performance

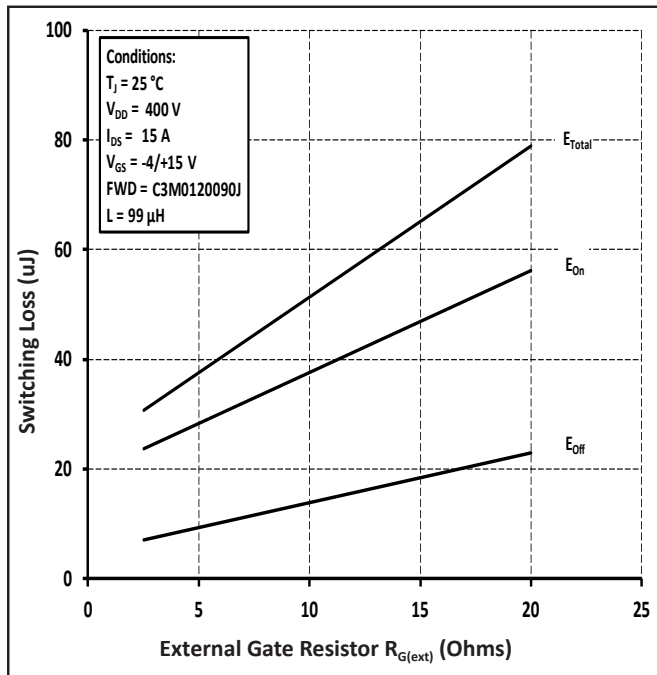


Figure 25. Clamped Inductive Switching Energy vs $R_{G(\text{ext})}$

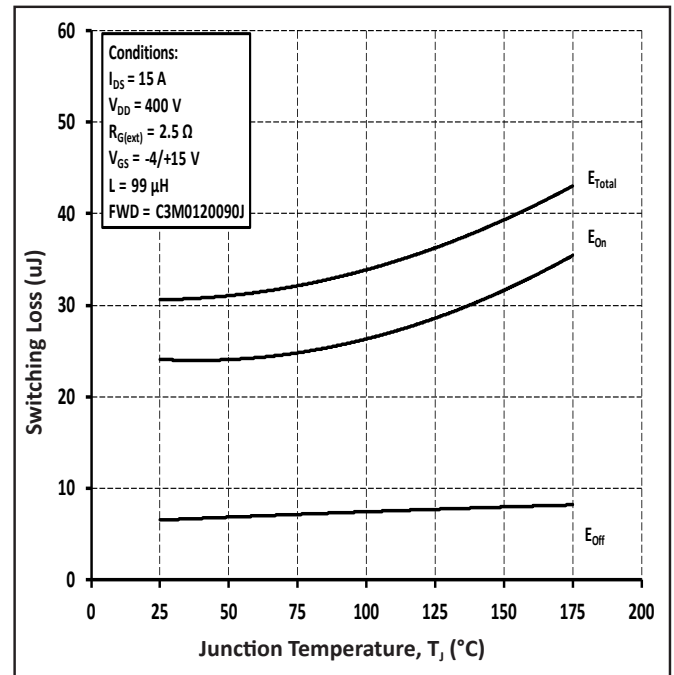


Figure 26. Clamped Inductive Switching Energy vs Temperature

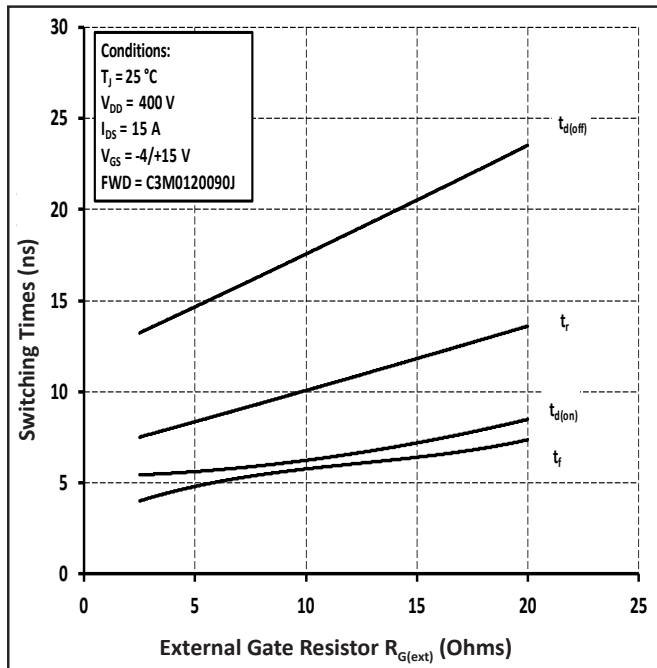


Figure 27. Switching Times vs $R_{G(\text{ext})}$

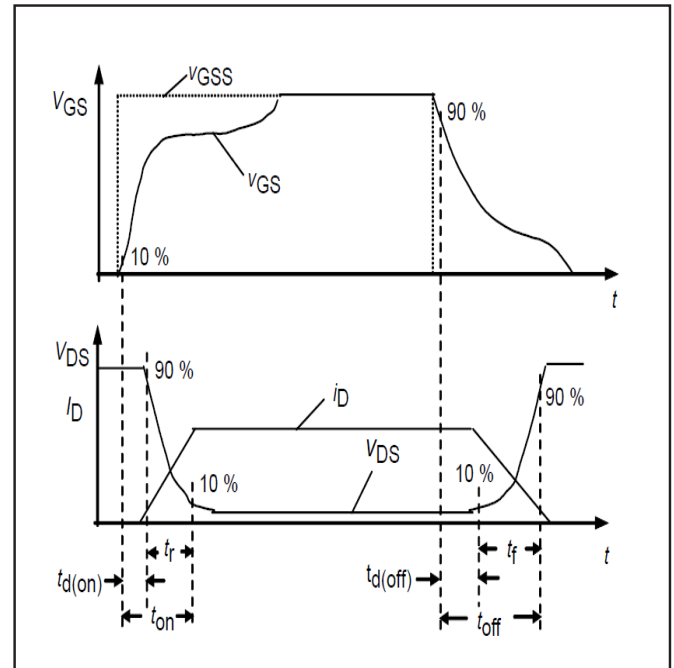


Figure 28. Switching Times Definition

Test Circuit Schematic

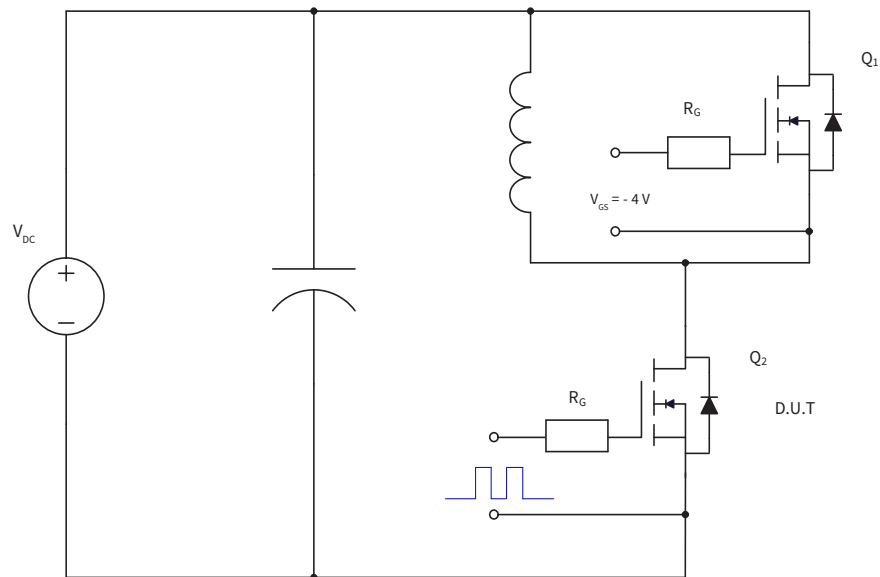
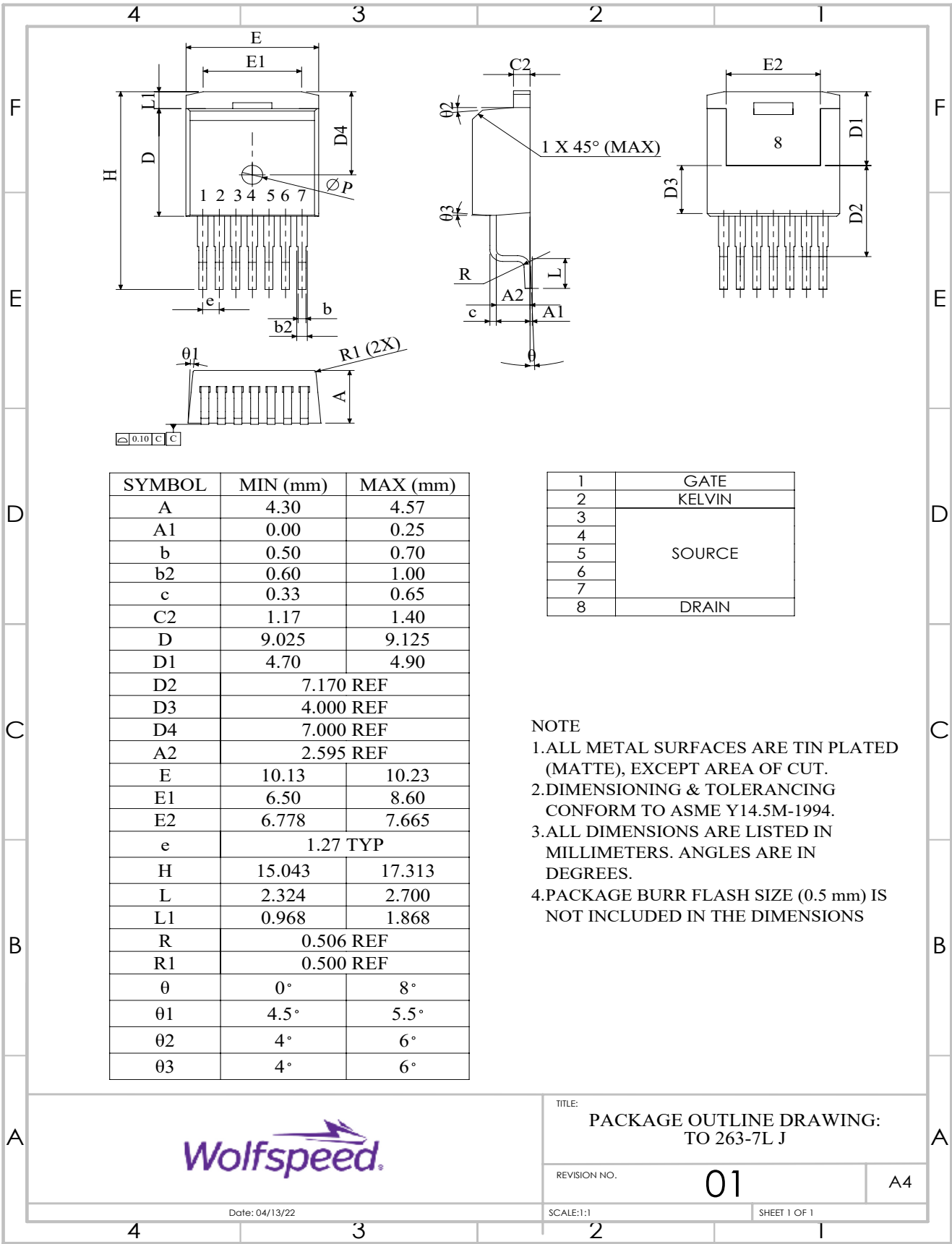


Figure 29. Clamped Inductive Switching Waveform Test Circuit

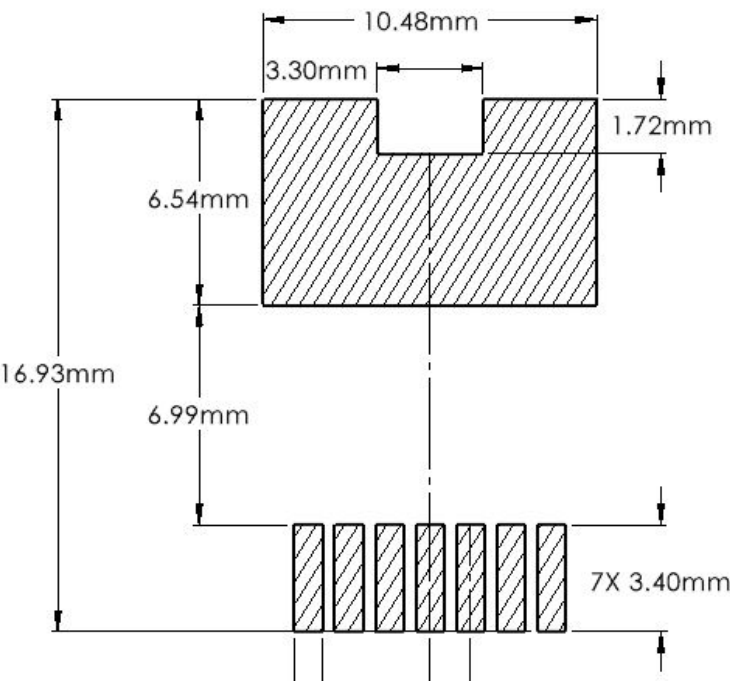
Note (3): Turn-off and Turn-on switching energy and timing values measured using SiC MOSFET Body Diode as shown above.

Package Dimensions

Package: TO-263-7



Recommended Solder Pad Layout



Revision History

Current Revision	Date of Release	Description of Changes
1	November-2020	N/A
2	December-2023	Updated Wolfspeed branding, package drawing, package image, solder pad layout, added Rev history

Related Links

- [SiC MOSFET Isolated Gate Driver reference design](#)
- [SiC MOSFET Evaluation Board](#)



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