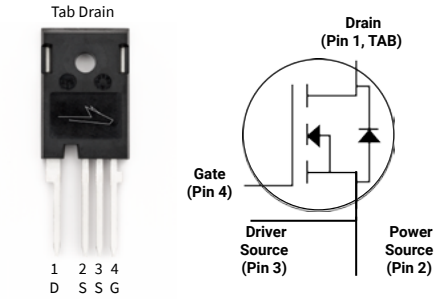
C3M0040120K

1200V 40mohm Silicon Carbide Power MOSFET
N-Channel Enhancement Mode

Features

- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- 8mm of creepage distance between drain and source
- 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



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Part Number	Package	Marking
C3M0040120K	TO-247-4	C3M0040120K

Typical Applications

- Solar inverters
- EV motor drive
- High voltage DC/DC converters
- Switched mode power supplies
- Load switch

Benefits

- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

Key Parameters

Parameter	Symbol	Min.	Typ.	Max	Unit	Conditions	Note
Drain - Source Voltage	V_{DS}			1200	v	T_C = 25°C	
Maximum Gate - Source Voltage	$V_{GS(max)}$	-8		+19		Transient	
Operational Gate-Source Voltage	$V_{GS\ op}$		-4/15			Static	Note 1
DC Continuous Drain Current	I_D			66	A	V_{GS} = 15 V, T_C = 25 °C, T_J ≤175 °C	Fig. 19 Note 2
				48		V_{GS} = 15 V, T_C = 100 °C, T_J ≤175 °C	
Pulsed Drain Current	I_{DM}			223		t_{Pmax} limited by T_{jmax} V_{GS} = 15V, T_C = 25 °C	Fig. 22
Power Dissipation	P_D			326	W	T_C = 25 °C, T_J = 175 °C	Fig. 20
Operating Junction and Storage Temperature	T_J, T_{stg}			-40 to +175	°C		
Solder Temperature	T_L			260		According to JEDEC J-STD-020	
Mounting Torque	M_D			1 8.8	Nm lbf-in	M3 or 6-32 screw	

Note (1): Recommended turn-on gate voltage is 15V with ±5% regulation tolerance, see Application Note PRD-04814 for additional details
Note (2): Verified by design

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1200	—	—	V	V_{GS} = 0 V, I_D = 100 µA	
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.7	3.6	V	V_{DS} = $V_{GS,}$ I_D = 9.2 mA, T_J=25°C	Fig. 11
Gate Threshold Voltage		—	2.2	—		V_{DS} = $V_{GS,}$ I_D = 9.2 mA, T_J=175°C	Fig. 11
Zero Gate Voltage Drain Current	I_{DSS}	—	1	50	µA	V_{DS} = 1200 V, V_{GS} = 0 V	
Gate-Source Leakage Current	I_{GSS}	—	10	250	nA	V_{GS} = 15 V, V_{DS} = 0 V	
Drain-Source On-State Resistance	$R_{DS(on)}$	—	40	53.5	mΩ	V_{GS} = 15 V, I_D = 33.3 A	Fig. 4, 5, 6
		—	68	—		V_{GS} = 15 V, I_D = 33.3 A, T_J = 175°C	
Transconductance	g_{fs}	—	21	—	S	V_{DS} = 20 V, I_{DS} = 33.3 A	Fig. 7
			20			V_{DS} = 20 V, I_{DS} = 33.3 A, T_J = 175°C	
Input Capacitance	C_{iss}	—	2900	—	pF	V_{GS} = 0 V, V_{DS} = 1000 V f = 100 khz V_{AC} = 25 mV	Fig. 17, 18
Output Capacitance	C_{oss}	—	103	—			
Reverse Transfer Capacitance	C_{rss}	—	5	—			
C_{oss} Stored Energy	E_{oss}	—	60	—	µJ		Fig. 16
Turn-On Switching Energy (SiC Diode FWD)	E_{on}	—	243	—	µJ	V_{DS} = 800 V, V_{GS} = -4 V/15 V, I_D = 33.3 A, $R_{G(ext)}$ = 2.5 Ω, L= 99 µH, T_J = 175°C	Fig. 26
Turn Off Switching Energy (SiC Diode FWD)	E_{off}	—	104	—			
Turn-On Switching Energy (Body Diode FWD)	E_{on}	—	611	—			
Turn-Off Switching Energy (Body Diode FWD)	E_{off}	—	99	—			
Turn-On Delay Time	$t_{d(on)}$	—	13	—	ns	V_{DD} = 800 V, V_{GS} = -4 V/15 V I_D = 33.3 A, $R_{G(ext)}$ = 2.5 Ω, L= 99 µH Timing relative to V_{DS} Inductive load	Fig. 27
Rise Time	t_r	—	17	—			
Turn-Off Delay Time	$t_{d(off)}$	—	23	—			
Fall Time	t_f	—	9	—			
Internal Gate Resistance	$R_{G(int)}$	—	3.5	—	Ω	f = 1 MHz, V_{AC} = 25 mV	
Effective Output Capacitance (Energy Related)	$C_{O(er)}$	—	127	—	pF	V_{GS}= 0V, V_{DS}= 0...800V	Note 3
Effective Output Capacitance (Time Related)	$C_{o(tr)}$	—	197	—			
Gate to Source Charge	Q_{gs}	—	34	—	nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V I_D = 33.3 A Per IEC60747-8-4 pg 21	Fig. 12
Gate to Drain Charge	Q_{gd}	—	28	—			
Total Gate Charge	Q_g	—	99	—			

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

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

Parameter	Symbol	Typ.	Max.	Unit	Test Conditions	Notes
Diode Forward Voltage	V_{SD}	5.5	—	V	V_{GS} = -4 V, I_{SD} = 20 A, T_J = 25°C	Fig. 8, 9, 10
		4.9	—		V_{GS} = -4 V, I_{SD} = 20 A, T_J = 175°C	
Continuous Diode Forward Current	I_S	—	51	A	V_{GS} = -4 V, T_J = 25°C	
Diode Pulse Current	I_{SM}	—	223		V_{GS} = -4 V, pulse width t_P limited by $T_{j\,max}$	
Reverse Recovery Time	t_{rr}	17	—	ns	V_{GS} = -4 V, I_{SD} = 33.3 A, V_R = 800 V T_J = 175°C, di_F/dt = 7725 A/µs, T_J = 175°C	
Reverse Recovery Charge	Q_{rr}	850	—	nC		
Peak Reverse Recovery Current	I_{RRM}	79	—	A		
Reverse Recovery Time	t_{rr}	33	—	ns	V_{GS} = -4 V, I_{SD} = 33.3 A, V_R = 800 V T_J = 175°C, di_F/dt = 2325 A/µs, T_J = 175°C	
Reverse Recovery Charge	Q_{rr}	691	—	nC		
Peak Reverse Recovery Current	I_{RRM}	30	—	A		

Thermal Characteristics

Parameter	Symbol	Typ	Unit	Note
Thermal Resistance from Junction to Case	$R_{\theta JC}$	0.46	°C/W	Fig. 21

Typical Performance

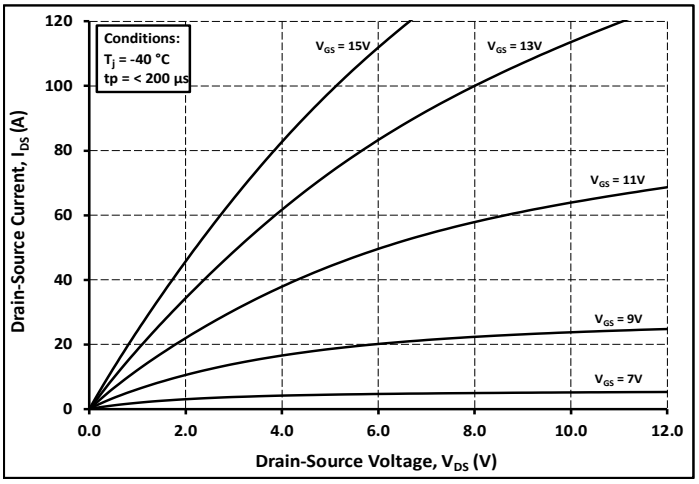


Figure 1. Output Characteristics T_J = -40°C

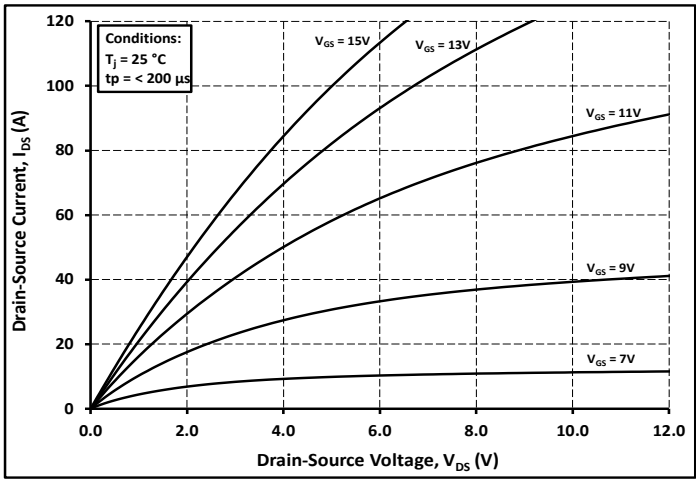


Figure 2. Output Characteristics T_J = 25°C

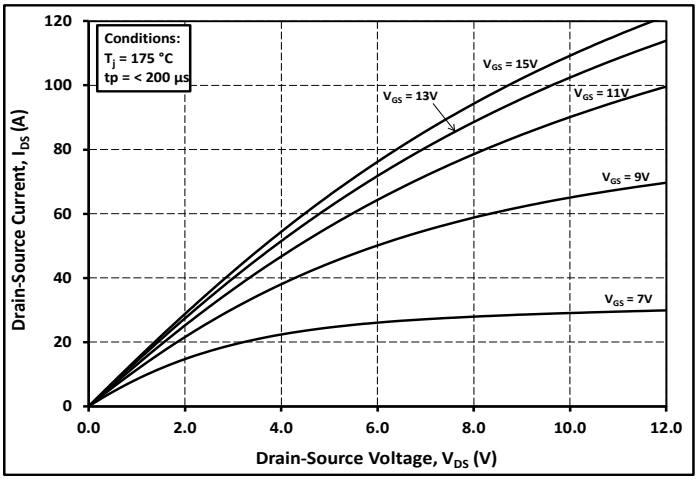


Figure 3. Output Characteristics T_J = 175°C

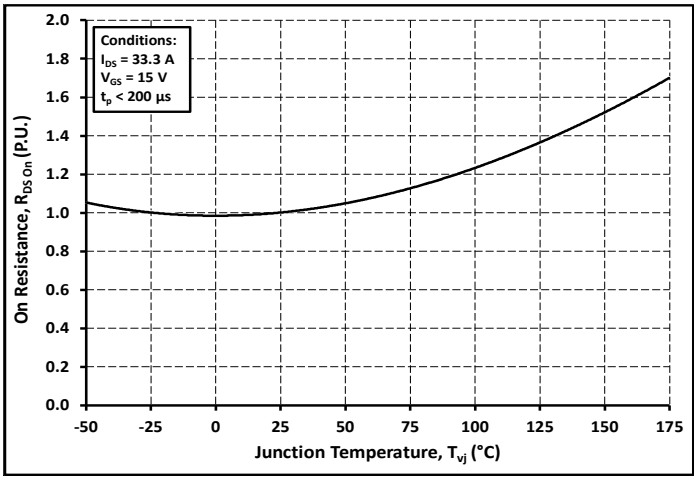


Figure 4. Normalized On-Resistance vs. Temperature

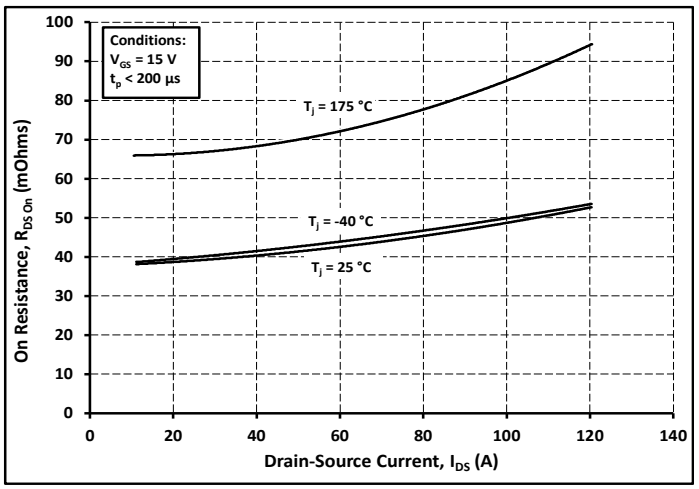


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

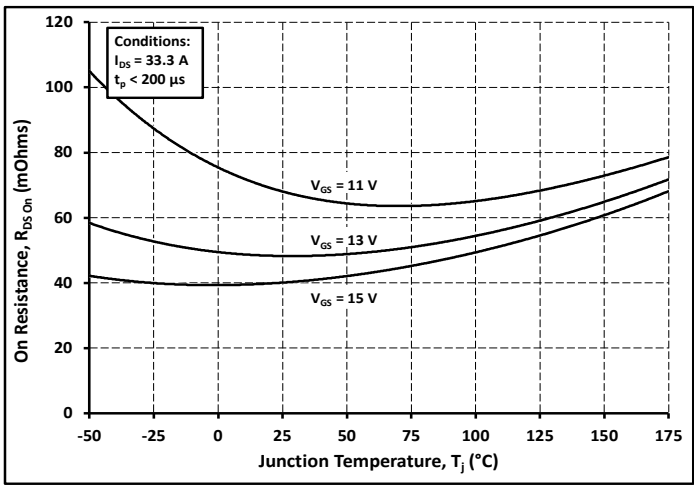


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage

Typical Performance

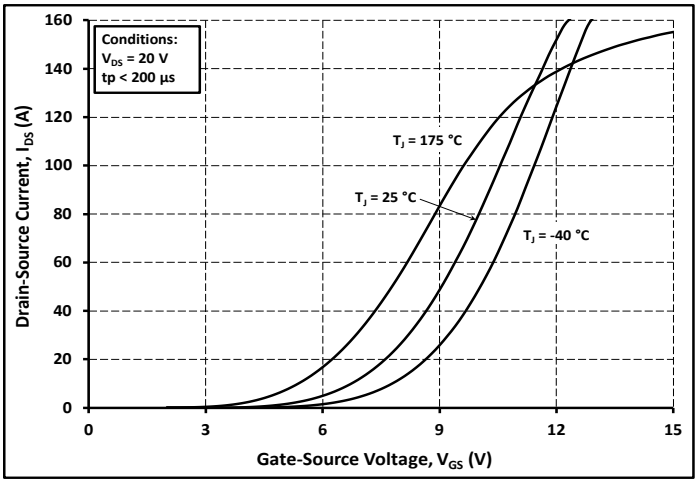


Figure 7. Transfer Characteristic for Various Junction Temperatures

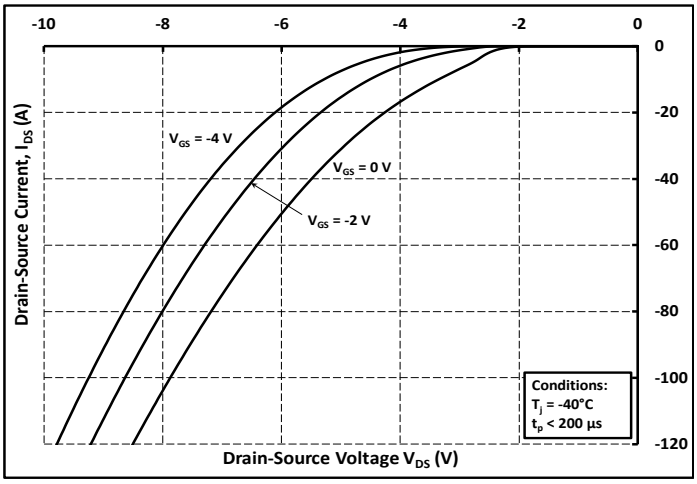


Figure 8. Body Diode Characteristic at -40°C

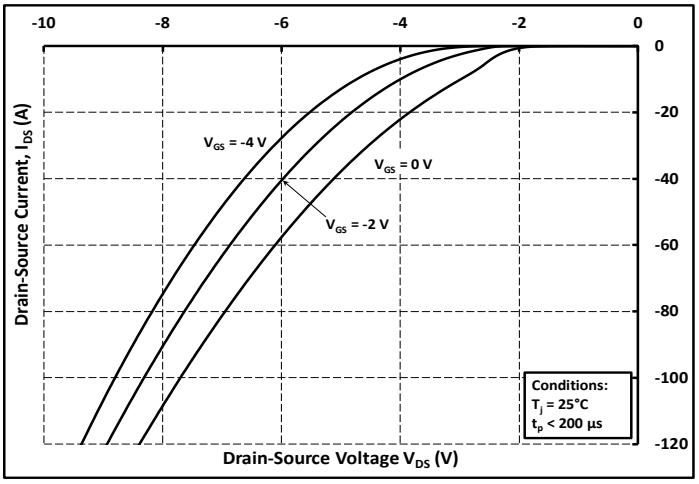


Figure 9. Body Diode Characteristic at 25°C

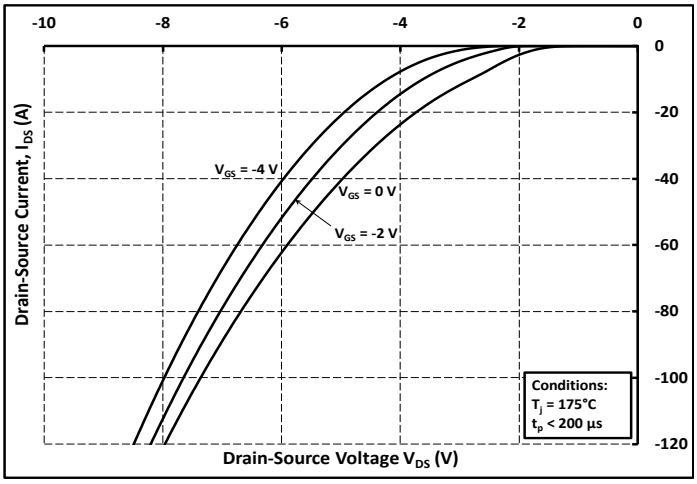


Figure 10. Body Diode Characteristic at 175°C

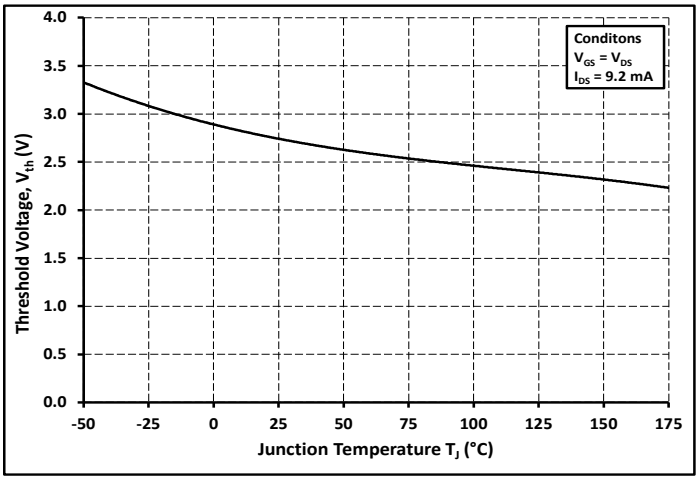


Figure 11. Threshold Voltage vs. Temperature

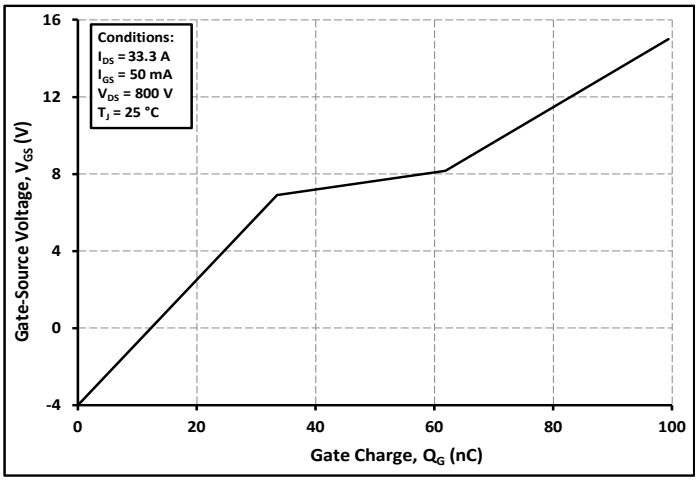


Figure 12. Gate Charge Characteristics

Typical Performance

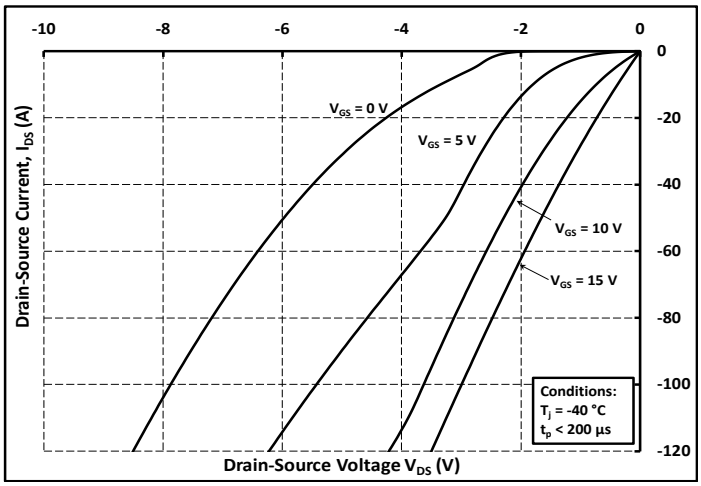


Figure 13. 3rd Quadrant Characteristic at -40°C

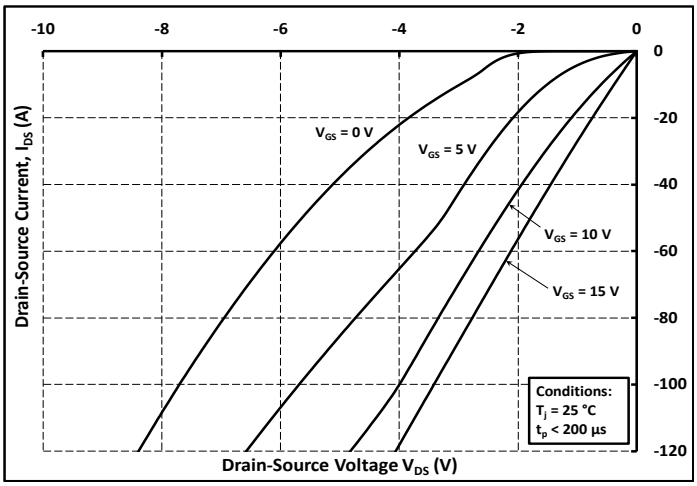


Figure 14. 3rd Quadrant Characteristic at 25°C

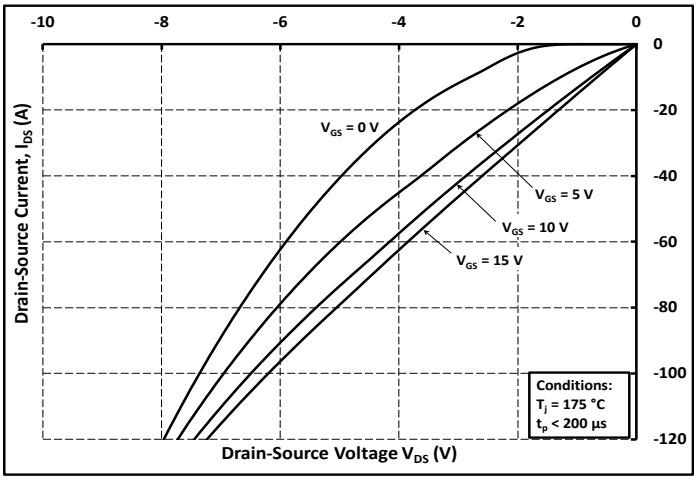


Figure 15. 3rd Quadrant Characteristic at 175°C

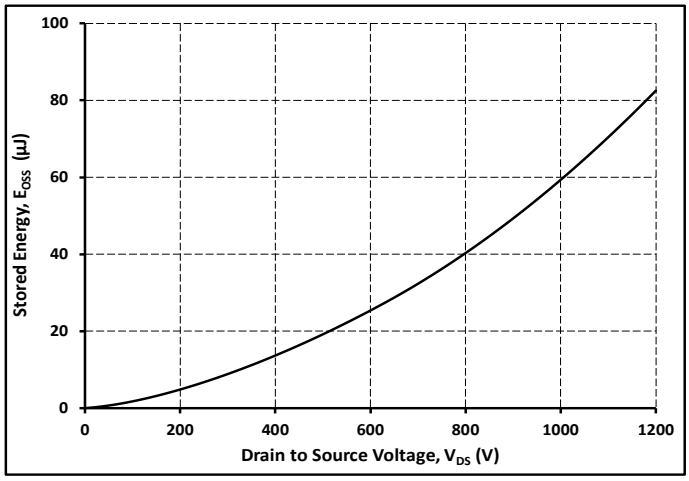


Figure 16. Output Capacitor Stored Energy

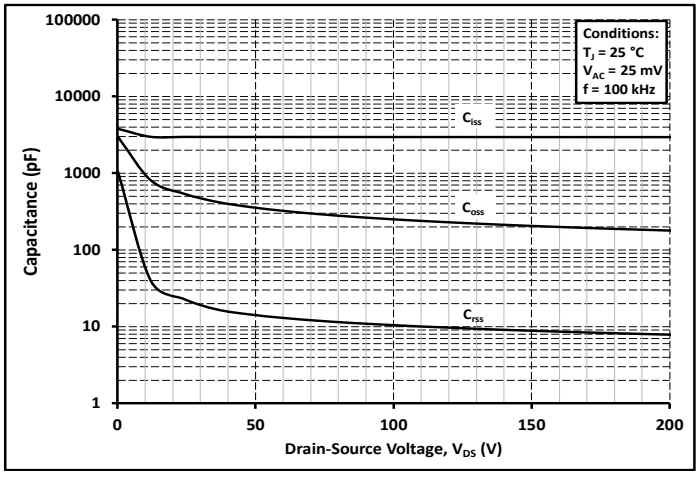


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200 V)

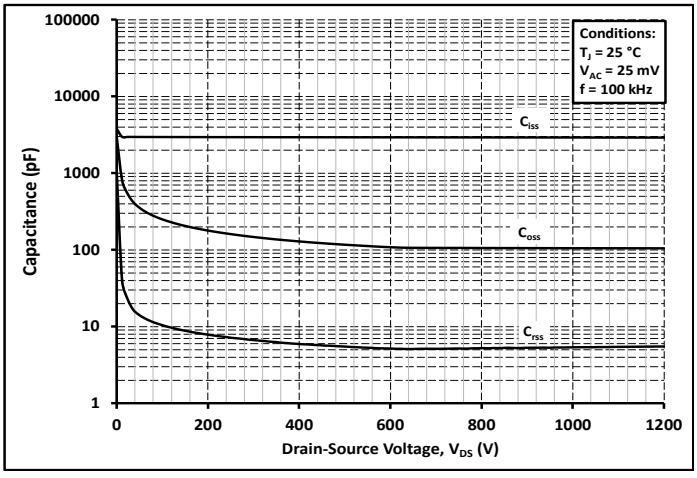


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200 V)

Typical Performance

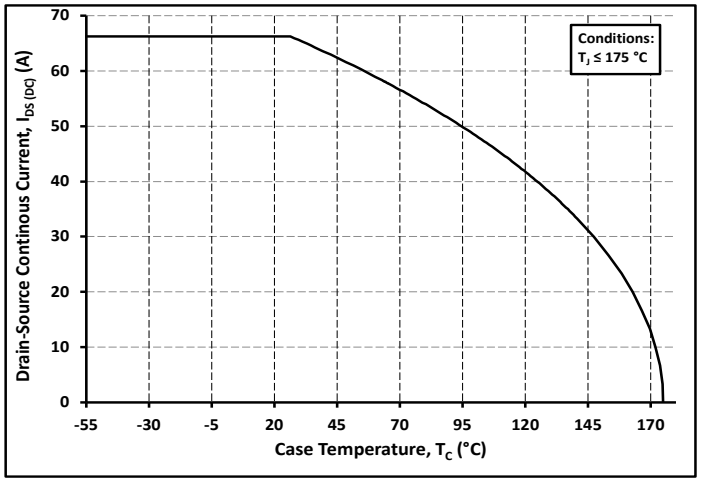


Figure 19. Continuous Drain Current Derating vs. Case Temperature

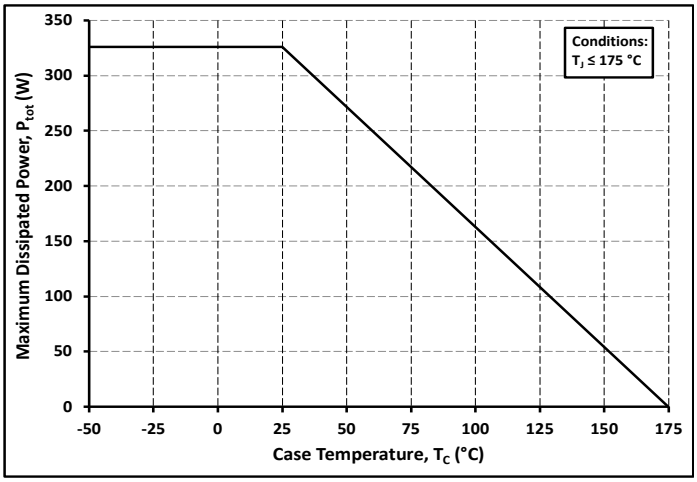


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

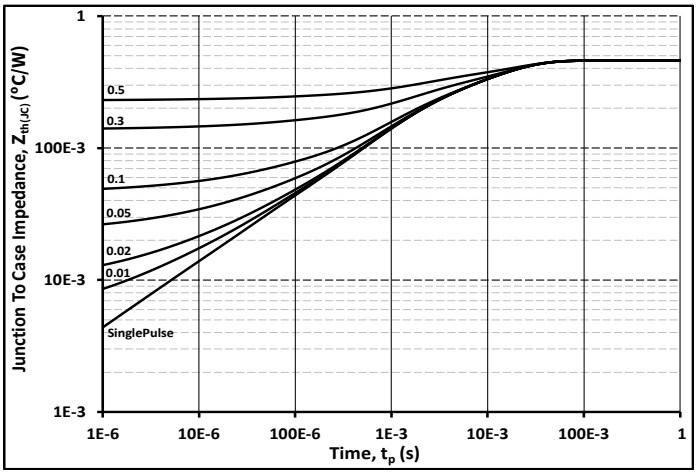


Figure 21. Transient Thermal Impedance (Junction - Case)

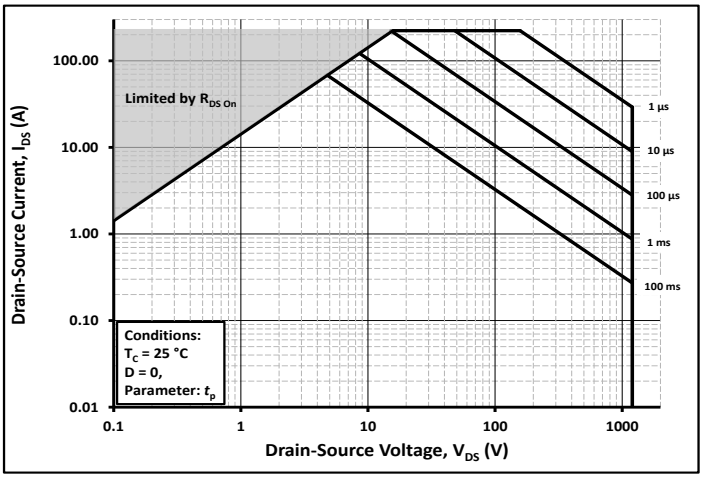


Figure 22. Safe Operating Area

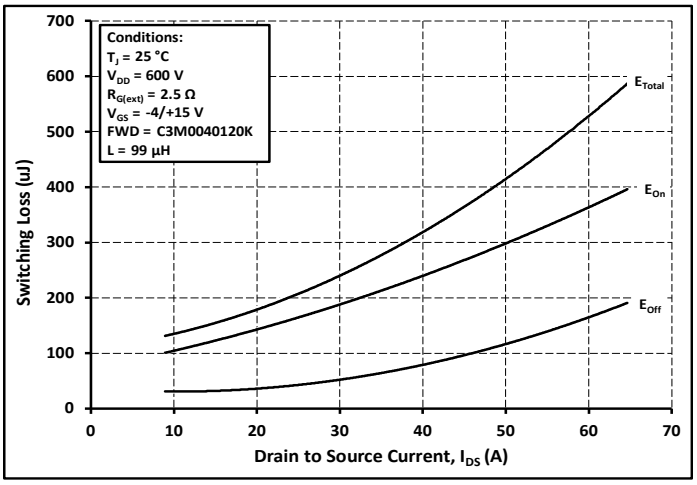


Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 600 V)

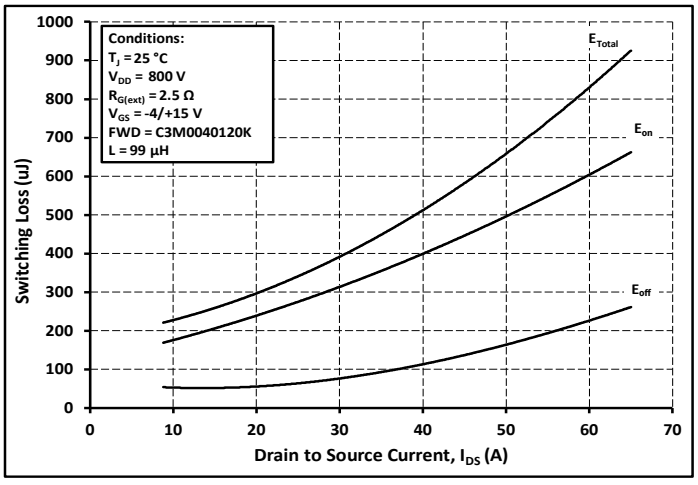


Figure 24. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 800 V)

Typical Performance

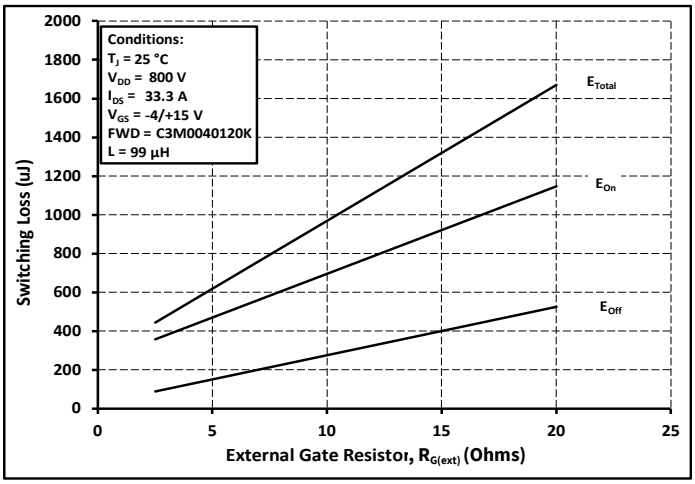


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

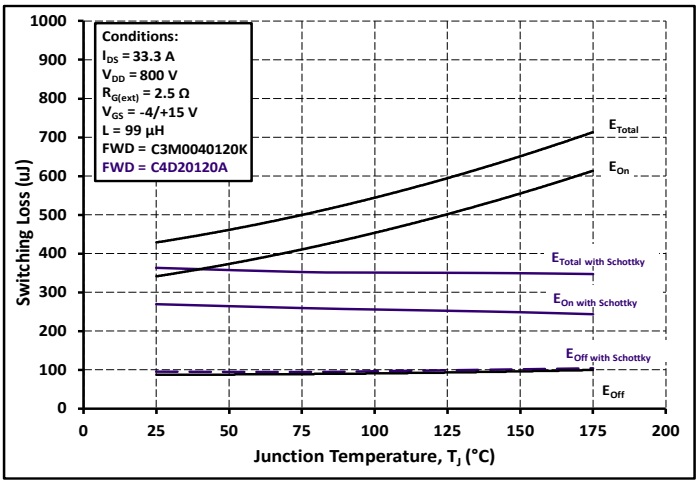


Figure 26. Clamped Inductive Switching Energy vs. Temperature

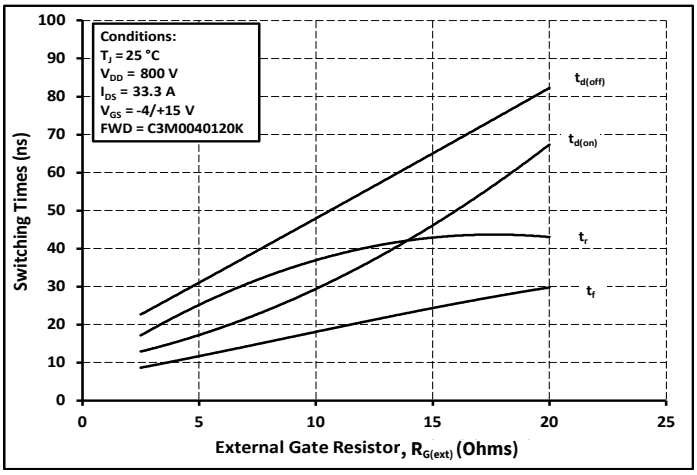


Figure 27. Switching Times vs. $R_{G(ext)}$

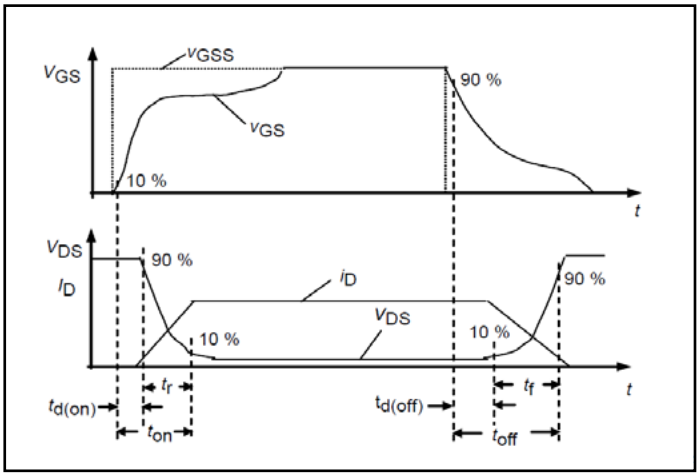


Figure 28. Switching Times Definition

Test Circuit Schematic

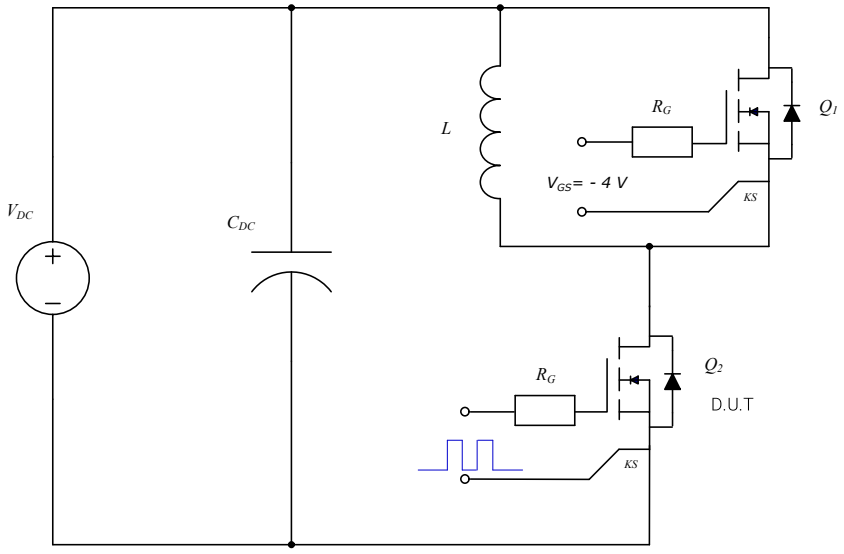
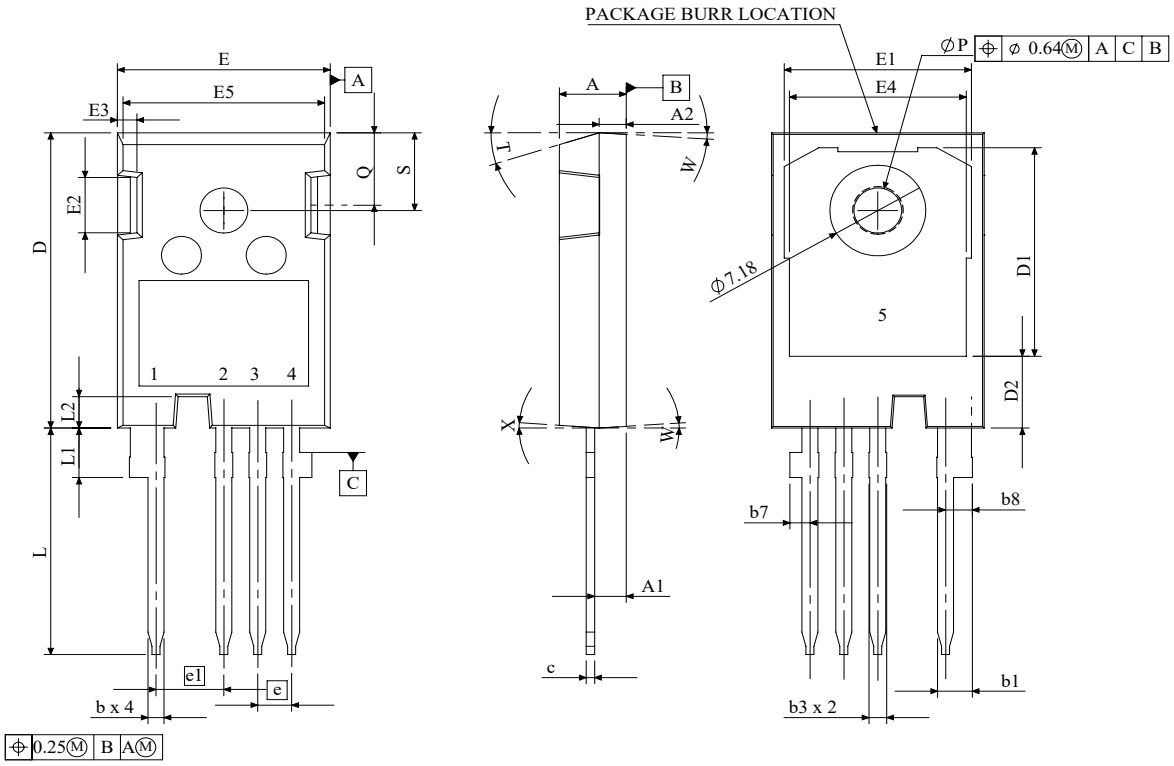


Figure 29. Clamped Inductive Switching Waveform Test Circuit

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

Package Dimensions – Package TO-247-4L



SYMBOL	MIN (mm)	MAX (mm)
A	4.83	5.21
A1	2.23	2.54
A2	1.91	2.16
b	1.07	1.33
b1	2.39	2.94
b3	1.07	1.60
b7	1.30	1.70
b8	1.80	2.20
c	0.55	0.68
D	23.30	23.63
D1	16.25	17.65
D2	5.55	5.95
E	15.75	16.13
E1	13.1	14.15
E2	3.68	5.10
E3	1.00	1.90
E4	12.38	13.43
E5	14.65	15.05
e1	5.08 BSC	
L	17.31	17.82
L1	3.97	4.37
L2	2.35	2.65
ϕP	3.51	3.65
Q	5.49	6.00
S	6.04	6.30
T	17.5° REF.	
W	3.5° REF.	
X	4° REF.	

1	DRAIN
2	SOURCE
3	DRIVER SOURCE
4	GATE
5	DRAIN

NOTE:
1. ALL METAL SURFACES ARE TIN PLATED (MATTE), EXCEPT AREA OF CUT.
2. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE LISTED IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. BURR OR MOLD FLASH SIZE (0.5 mm) IS NOT INCLUDED IN THE DIMENSIONS

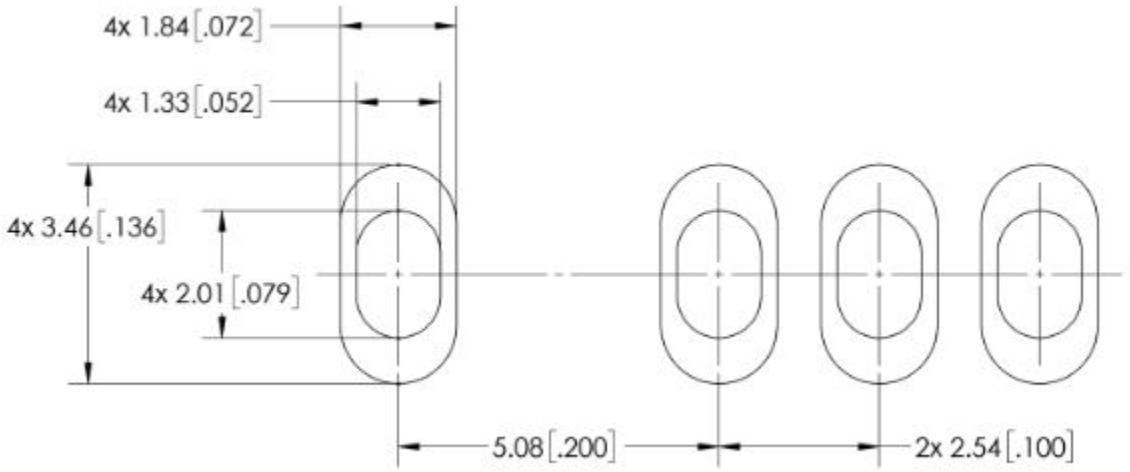
Wolfspeed

TITLE: PACKAGE OUTLINE DRAWING: TO-247-4L

Date: 3/4/24 | REVISION NO. 02 | A4

PRD 05966 | SCALE:1:1 | SHEET 1 OF 1

Recommended Solder Pad Layout



Related Links

- SPICE Models
- SiC MOSFET Isolated Gate Driver reference design
- SiC MOSFET Evaluation Board

Revision History

Document Version	Date of Release	Description of Changes
1	October-2020	Initial Release
2	August-2023	ID Pulse test conditions Updated Package Drawing Updated Landing Pad
3	September - 2024	Legal Disclaimer and POD

Notes & Disclaimer

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