

E3M0075120D

Silicon Carbide Power MOSFET

E-Series Automotive

N-Channel Enhancement Mode

Features

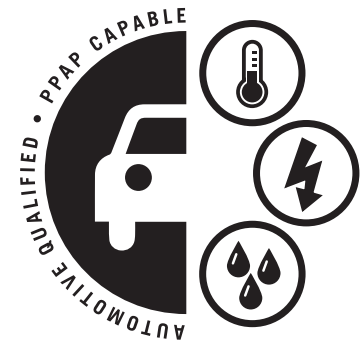
- 3rd generation SiC MOSFET technology
- High blocking voltage with low On-resistance
- High speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Qrr)
- Halogen free, RoHS compliant
- Automotive Qualified (AEC-Q101) and PPAP Capable

Benefits

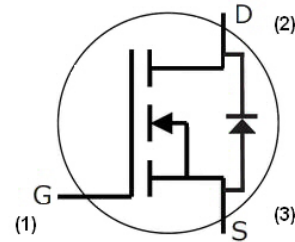
- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency

Applications

- EV battery chargers
- High voltage DC/DC converters



Package



Ordering Part Number	Package	Marking
E3M0075120D	TO 247-3	E3M0075120D

Maximum Ratings ($T_c = 25^\circ\text{C}$ 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, $V_{GS} = 15\text{V}$	$T_C = 25^\circ\text{C}$	32	A	Fig. 19, Note: 2
		$T_C = 100^\circ\text{C}$	23		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_p limited by T_{jmax}	80	A	Fig. 22	
P_D	Power Dissipation, $T_c=25^\circ\text{C}$, $T_j = 175^\circ\text{C}$	145	W	Fig. 20 Note: 2	
T_J, T_{stg}	Operating Junction and Storage Temperature	-55 to +175	$^\circ\text{C}$		
T_L	Solder Temperature, 1.6mm (0.063") from case for 10s	260	$^\circ\text{C}$		
M_d	Mounting Torque, M3 or 6-32 screw	1	Nm		
		8.8			lbf-in

Note (1): Recommended turn off / turn on gate voltage $V_{GS} = -4V...0V / +15V$

Note (2): Verified by design

Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.6	3.6	V	$V_{DS} = V_{GS}, I_D = 5\text{ mA}$	Fig. 11
			2.1		V	$V_{DS} = V_{GS}, I_D = 5\text{ mA}, T_J = 175^\circ\text{C}$	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	μA	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$	
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		75	97.5	m Ω	$V_{GS} = 15\text{ V}, I_D = 17.9\text{ A}$	Fig. 4, 5, 6
			135			$V_{GS} = 15\text{ V}, I_D = 17.9\text{ A}, T_J = 175^\circ\text{C}$	
g_{fs}	Transconductance		11		S	$V_{DS} = 20\text{ V}, I_{DS} = 17.9\text{ A}$	Fig. 7
			10.5			$V_{DS} = 20\text{ V}, I_{DS} = 17.9\text{ A}, T_J = 175^\circ\text{C}$	
C_{iss}	Input Capacitance		1480		pF	$V_{GS} = 0\text{ V}, V_{DS} = 1000\text{ V}$ $f = 1\text{ MHz}$ $V_{AC} = 25\text{ mV}$	Fig. 17, 18
C_{oss}	Output Capacitance		58				
C_{riss}	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	$V_{GS} = 0\text{ V}, V_{DS} = 0 \dots 800\text{V}$	Note (3)
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		96				
E_{ON}	Turn-On Switching Energy (External Diode)		719		μJ	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 20\text{ A},$ $R_{G(ext)} = 2.5\ \Omega, L = 135\ \mu\text{H},$ 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	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 20\text{ A},$ $R_{G(ext)} = 2.5\ \Omega, L = 135\ \mu\text{H},$ 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	$V_{DD} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 20\text{ A}, R_{G(ext)} = 2.5\ \Omega,$ 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	$f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$	
Q_{gs}	Gate to Source Charge		19		nC	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 20\text{ A}$ 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 C_{oss} while V_{ds} is rising from 0 to 800V
 $C_{o(tr)}$, a lumped capacitance that gives same charging time as C_{oss} while V_{ds} is rising from 0 to 800V

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	$V_{GS} = -4\text{ V}, I_{SD} = 9\text{ A}$	Fig. 8, 9, 10
		4.2		V	$V_{GS} = -4\text{ V}, I_{SD} = 9\text{ A}, T_J = 175^\circ\text{C}$	
I_S	Continuous Diode Forward Current		27	A	$V_{GS} = -4\text{ V}, T_J = 25^\circ\text{C}$	
$I_{S, pulse}$	Diode pulse Current		80	A	$V_{GS} = -4\text{ V}$, Pulse width t_p limited by T_{jmax}	
t_{rr}	Reverse Recover time	34		ns	$V_{GS} = -4\text{ V}, I_{SD} = 20\text{ A}, V_R = 800\text{ V}$ $dif/dt = 885\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	286		nC		
I_{rrm}	Peak Reverse Recovery Current	13		A		
t_{rr}	Reverse Recover time	40		ns	$V_{GS} = -4\text{ V}, I_{SD} = 20\text{ A}, V_R = 800\text{ V}$ $dif/dt = 740\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
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	$^\circ\text{C}/\text{W}$		Fig. 21

Typical Performance

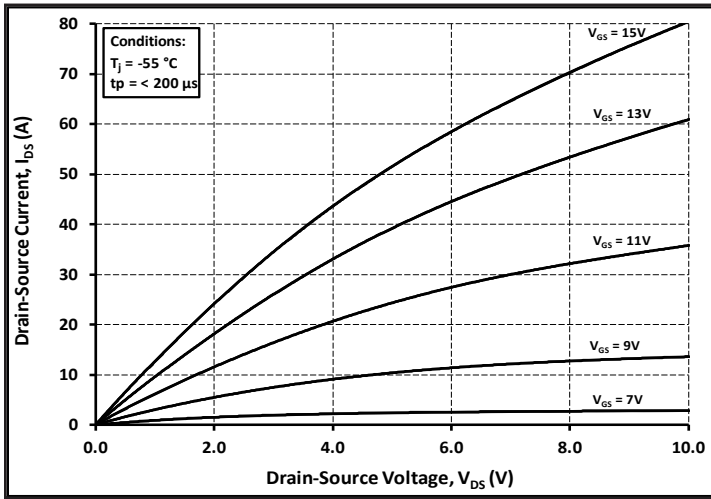


Figure 1. Output Characteristics $T_J = -55\text{ }^\circ\text{C}$

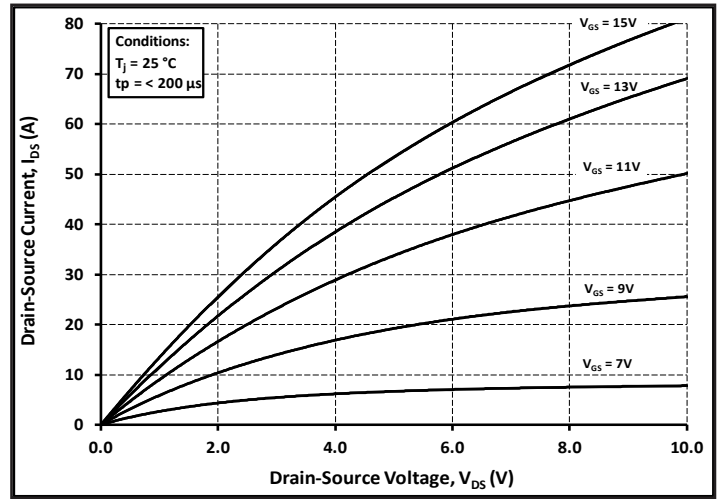


Figure 2. Output Characteristics $T_J = 25\text{ }^\circ\text{C}$

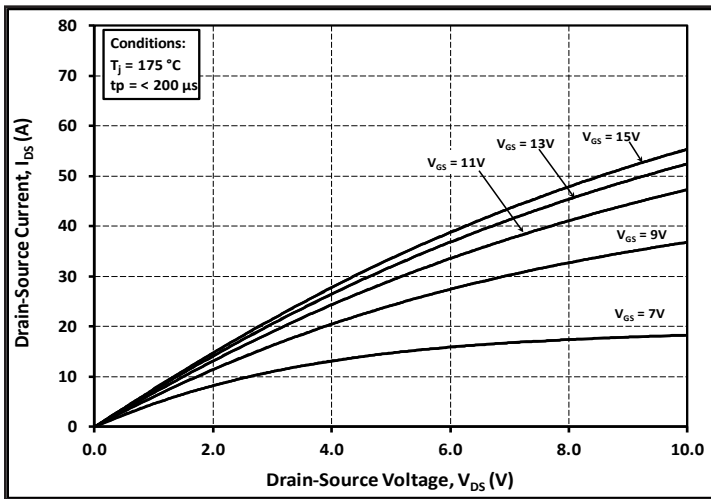


Figure 3. Output Characteristics $T_J = 175\text{ }^\circ\text{C}$

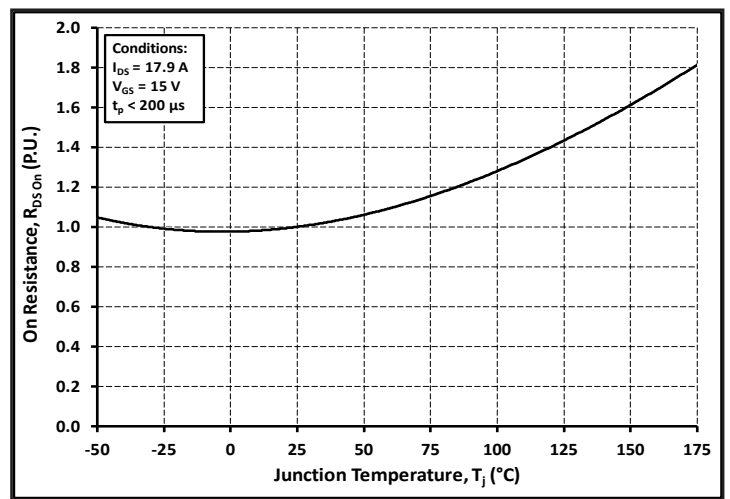


Figure 4. Normalized On-Resistance vs. Temperature

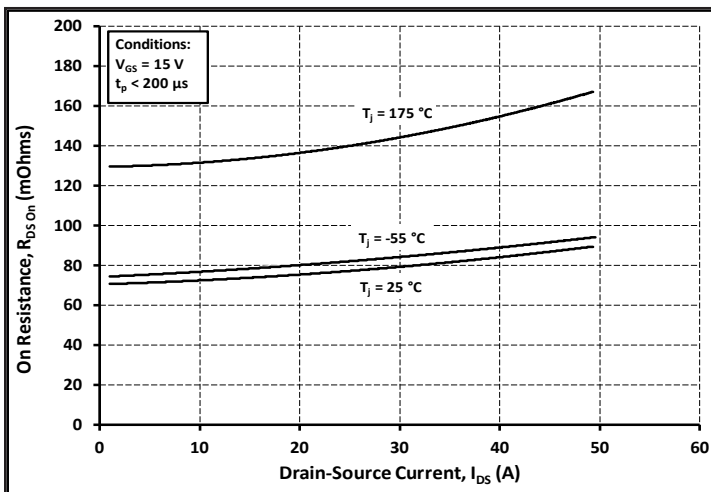


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

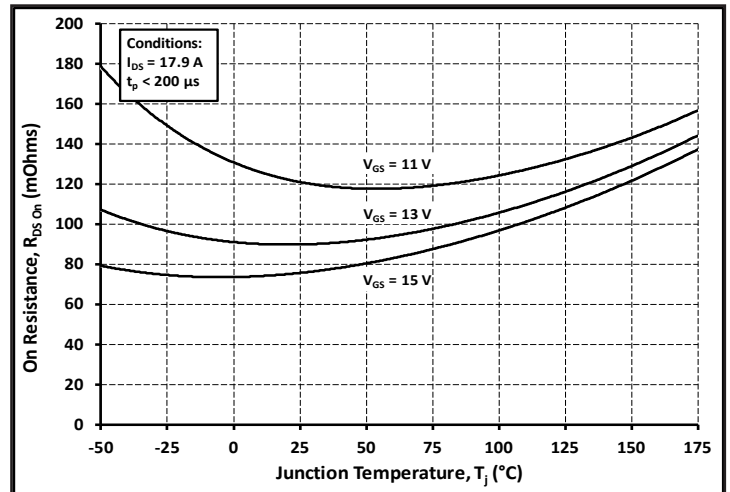


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage

Typical Performance

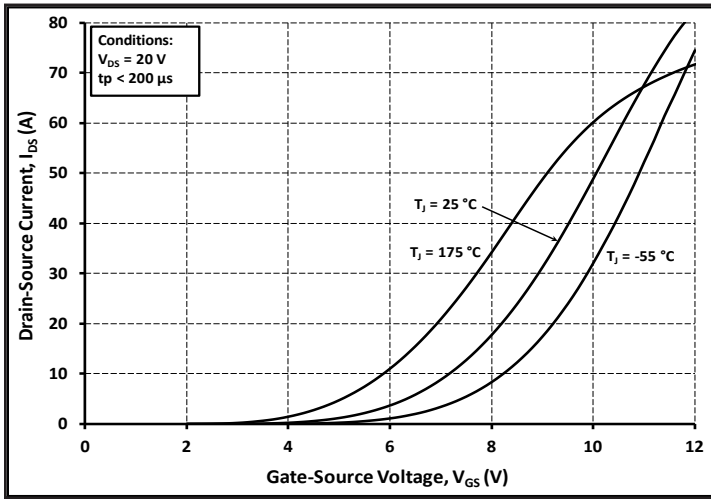


Figure 7. Transfer Characteristic for Various Junction Temperatures

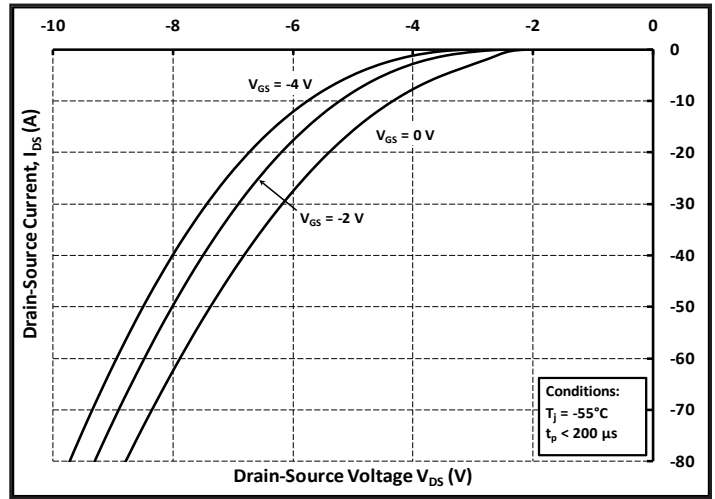


Figure 8. Body Diode Characteristic at $-55\text{ }^\circ\text{C}$

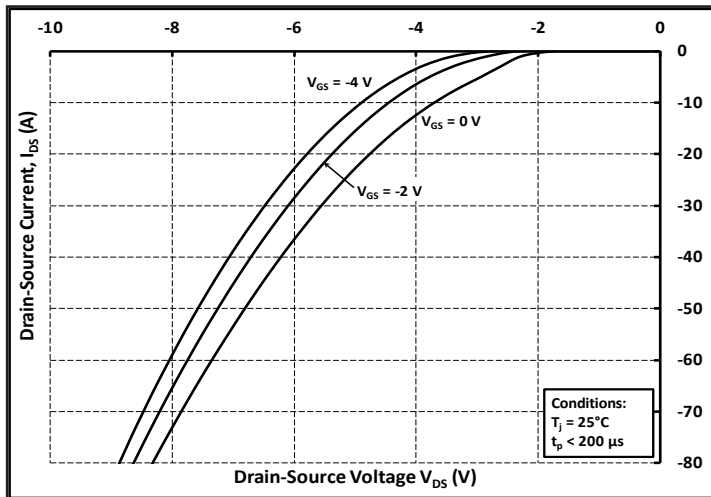


Figure 9. Body Diode Characteristic at $25\text{ }^\circ\text{C}$

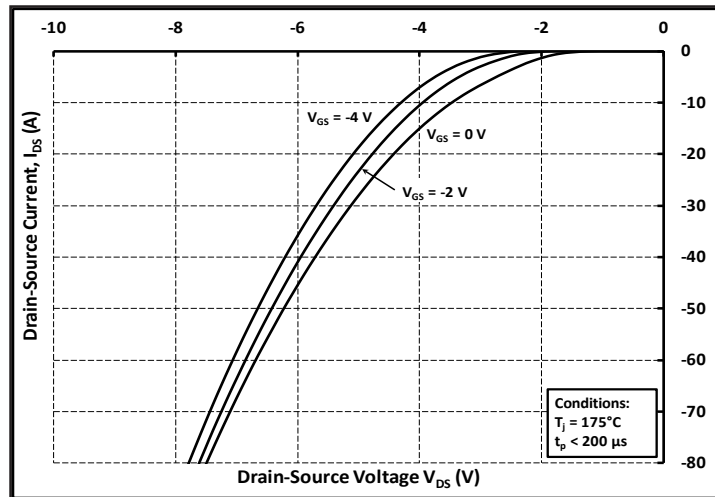


Figure 10. Body Diode Characteristic at $175\text{ }^\circ\text{C}$

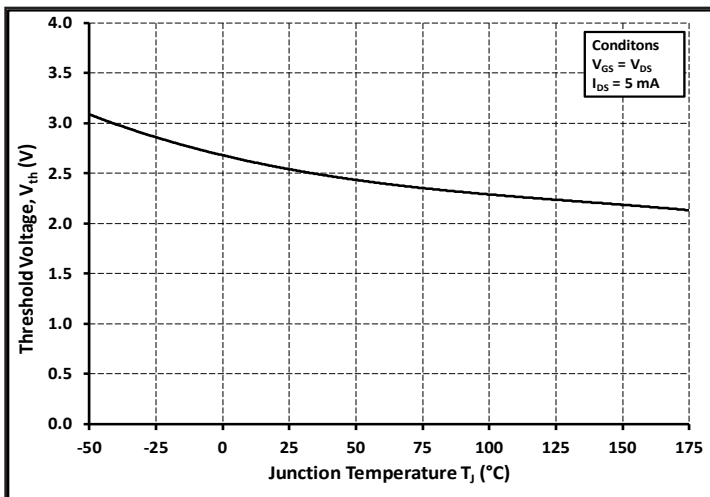


Figure 11. Threshold Voltage vs. Temperature

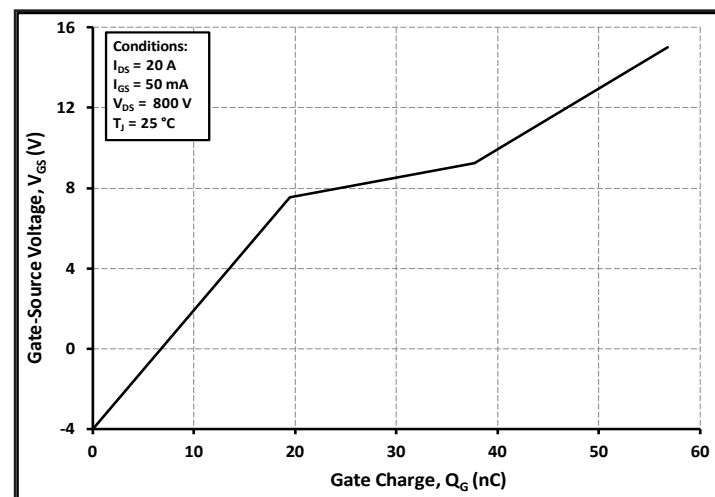


Figure 12. Gate Charge Characteristics

Typical Performance

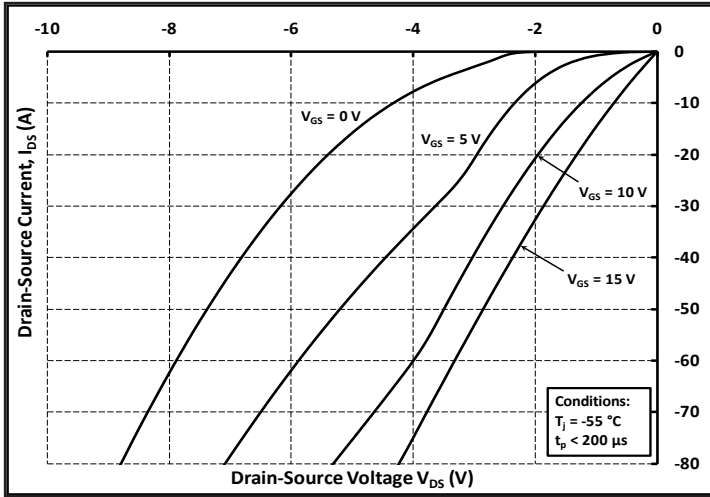


Figure 13. 3rd Quadrant Characteristic at -55 °C

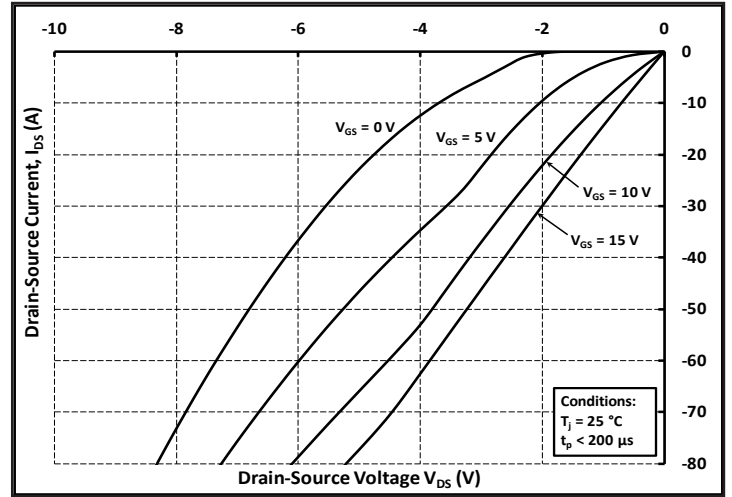


Figure 14. 3rd Quadrant Characteristic at 25 °C

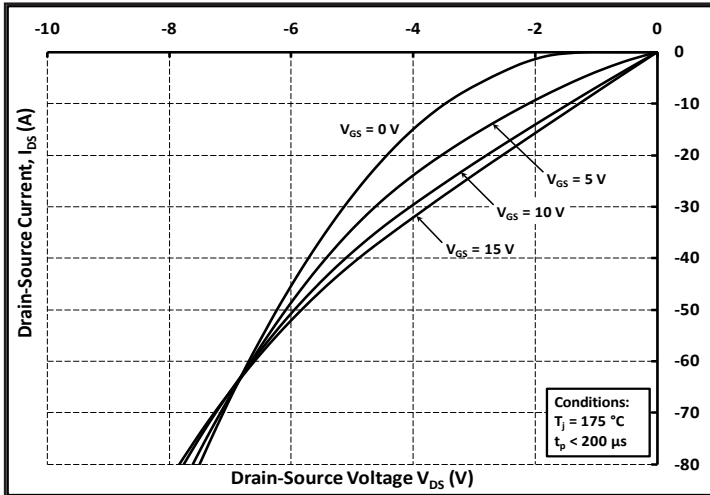


Figure 15. 3rd Quadrant Characteristic at 175 °C

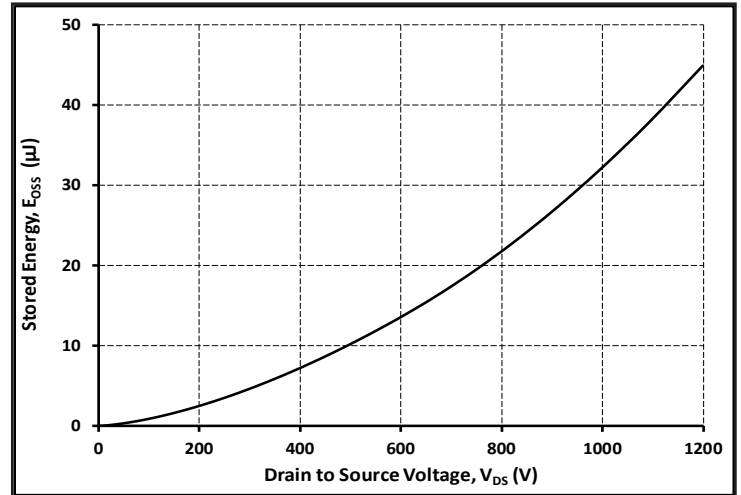


Figure 16. Output Capacitor Stored Energy

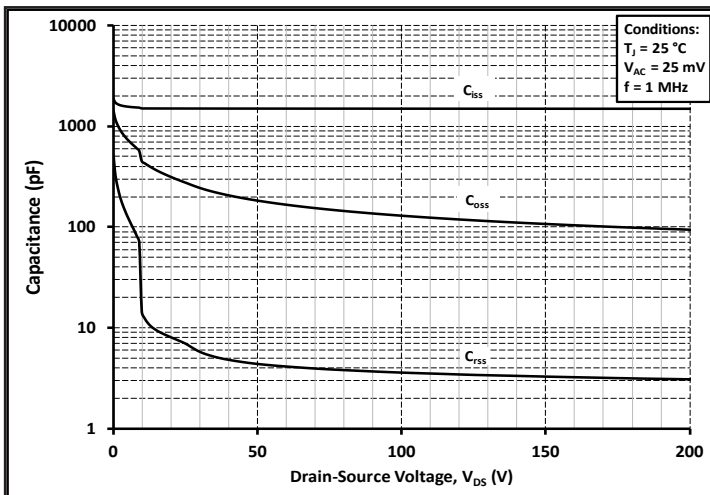


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

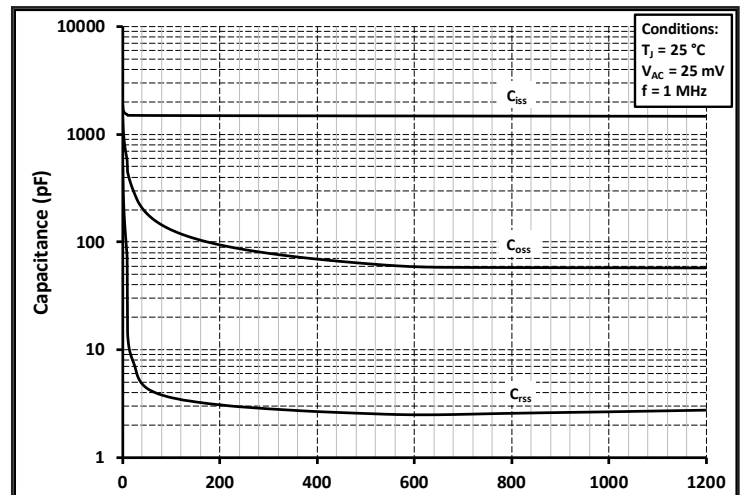


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1000V)

Typical Performance

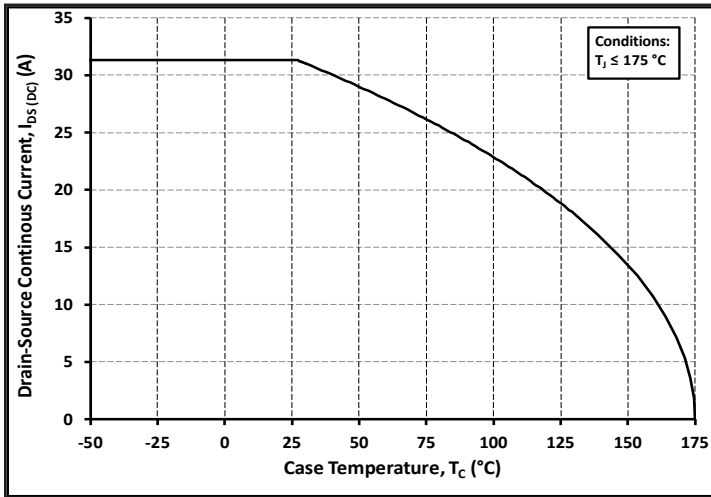


Figure 19. Continuous Drain Current Derating vs. Case Temperature

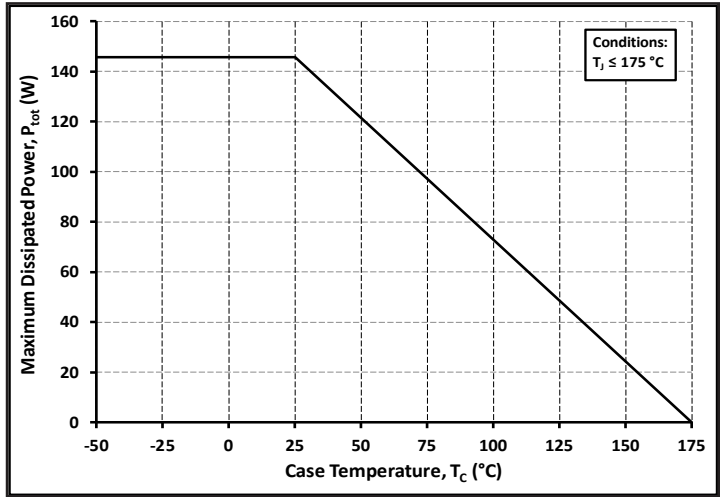


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

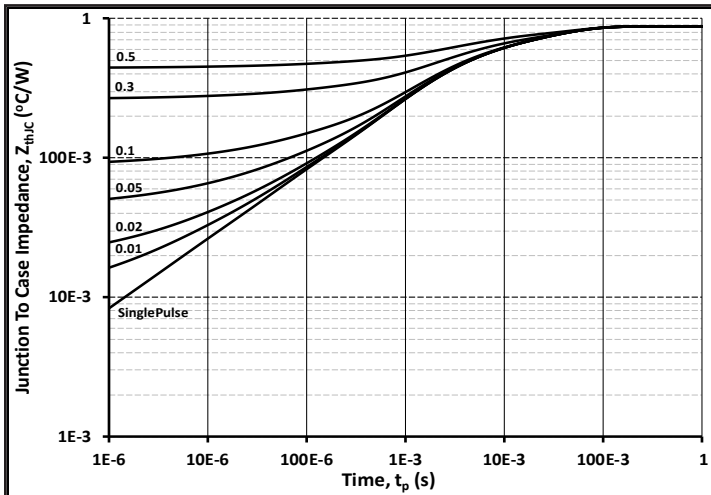


Figure 21. Transient Thermal Impedance (Junction - Case)

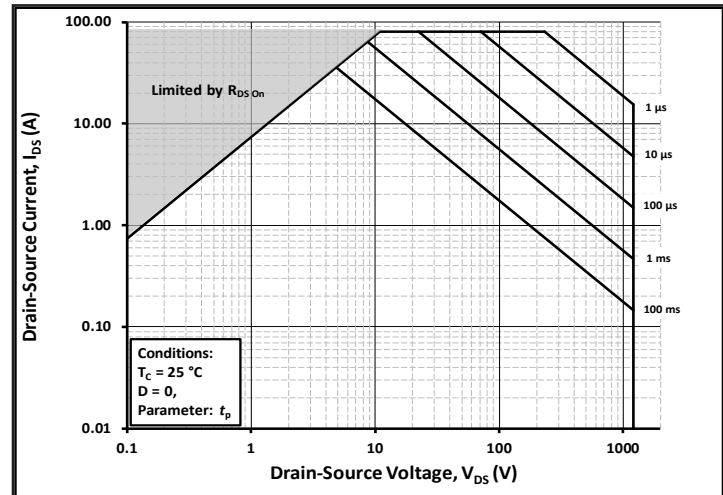


Figure 22. Safe Operating Area

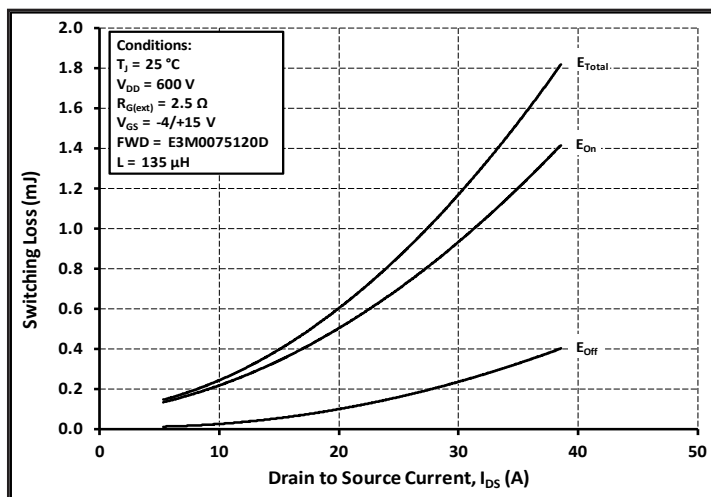


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 600V$)

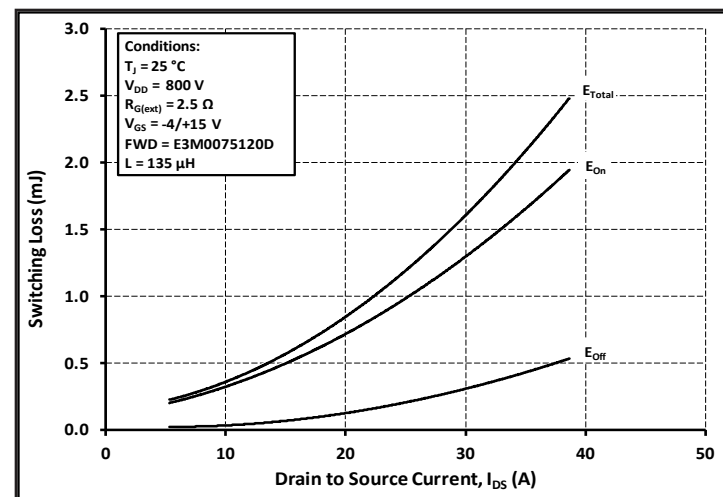


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 800V$)

Typical Performance

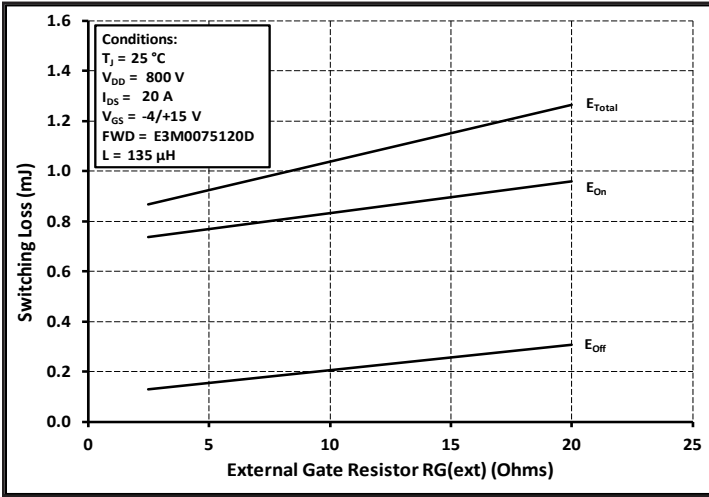


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

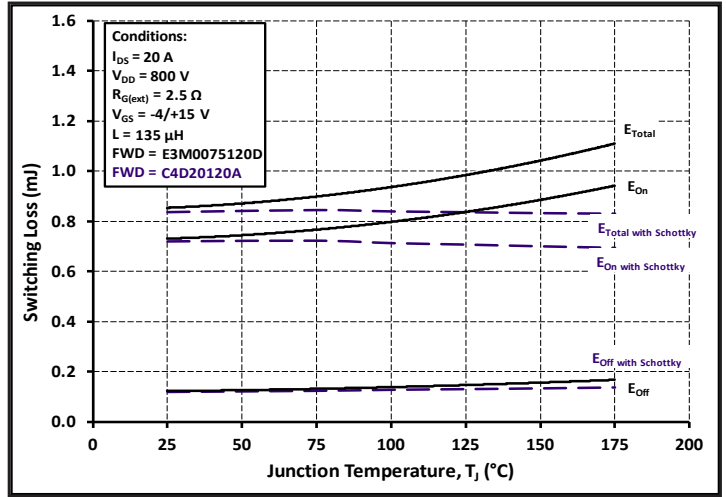


Figure 26. Clamped Inductive Switching Energy vs. Temperature

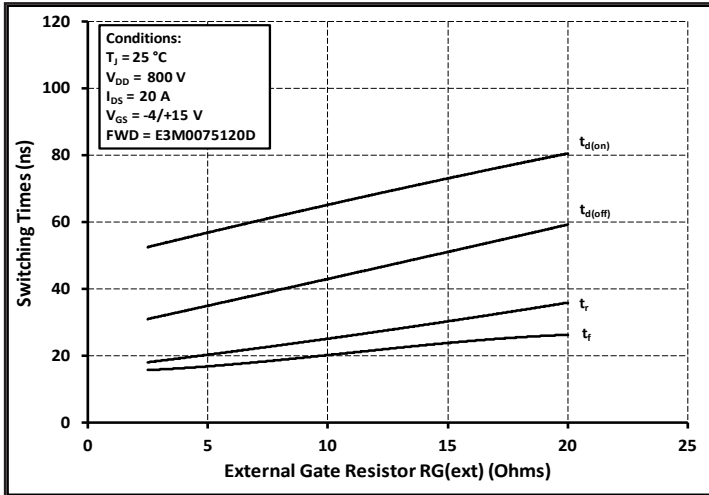


Figure 27. Switching Times vs. $R_{G(ext)}$

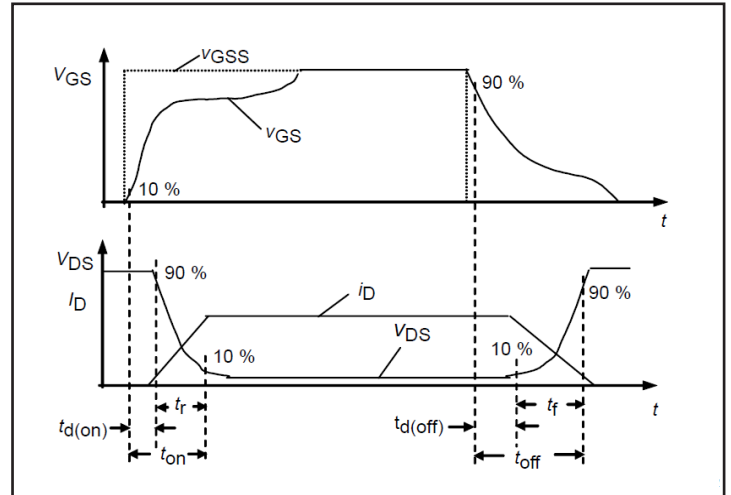


Figure 28. Switching Times Definition

Test Circuit Schematic

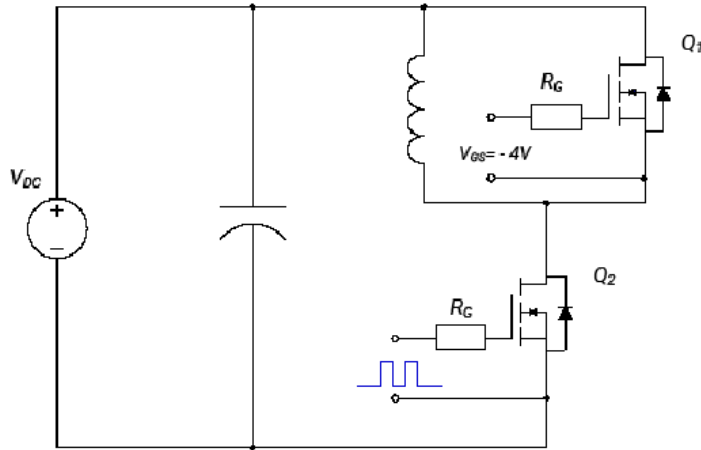
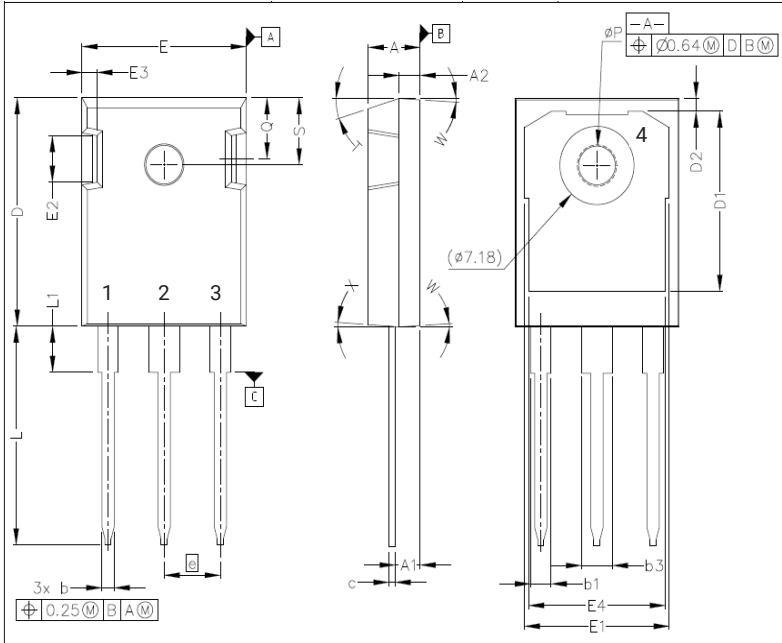


Figure 29. Clamped Inductive Switching Waveform Test Circuit

Package Dimensions

Package TO-247-3

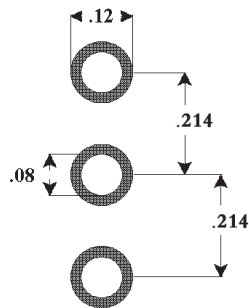


SYM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	.190	.205
A1	2.29	2.54	.090	.100
A2	1.91	2.16	.075	.085
b	1.07	1.33	.042	.052
b1	1.91	2.41	.075	.095
b3	2.87	3.38	.113	.133
c	0.55	0.68	.022	.027
D	20.80	21.10	.819	.831
D1	16.25	17.65	.640	.695
D2	0.95	1.25	.037	.049
E	15.75	16.13	.620	.635
E1	13.10	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
φP	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.			

Pinout Information:

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

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>