E3M0060065D

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 (Q_{rr})
- Halogen free, RoHS compliant
- Automotive Qualified (AEC-Q101) and PPAP Capable

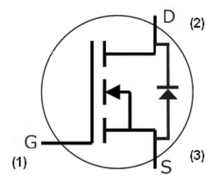
Benefits

- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

Applications

- EV Battery Chargers
- High Voltage DC/DC Converters

Package



Part Number	Package	Marking
E3M0060065D	TO-247-3L	E3M0060065D

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

Symbol	Parameter		Value	Unit	Note
V_{DSmax}	Drain - Source Voltage		650	V	
V_{GSmax}	Gate - Source Voltage		-8/+19	V	Note: 1
I_D	Continuous Drain Current, V_{GS} = 15 V	T_C = 25˚C	37	A	Fig. 19 Note: 2
		T_C = 100˚C	26		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_P limited by T_{jmax}		99	A	Fig. 22
P_D	Power Dissipation, T_C=25˚C, T_J = 175 ˚C		131	W	Fig. 20 Note: 2
T_J , T_{stg}	Operating Junction and Storage Temperature		-40 to +175	˚C	
T_L	Solder Temperature, 1.6mm (0.063") from case for 10s		260	˚C	
M_d	Mounting Torque , M3 or 6-32 screw		1 8.8	Nm 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˚C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	650			V	V_{GS} = 0 V, I_D = 100 μA	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.8	3.6	V	V_{DS} = V_{GS}, I_D = 3.6 mA	Fig. 11
			2.2		V	V_{DS} = V_{GS}, I_D = 3.6 mA, T_J = 175ºC	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	μA	V_{DS} = 650 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		60	79	mΩ	V_{GS} = 15 V, I_D = 13.2 A	Fig. 4, 5, 6
			83			V_{GS} = 15 V, I_D = 13.2 A, T_J = 175ºC	
g_{fs}	Transconductance		9		S	V_{DS}= 20 V, I_{DS}= 13.2 A	Fig. 7
			9			V_{DS}= 20 V, I_{DS}= 13.2 A, T_J = 175ºC	
C_{iss}	Input Capacitance		1170		pF	V_{GS} = 0 V, V_{DS} = 0V to 600 V F = 1 Mhz V_{AC} = 25 mV	Fig. 17, 18
C_{oss}	Output Capacitance		72				
C_{rss}	Reverse Transfer Capacitance		6				
E_{oss}	C_{oss} Stored Energy		14		μJ		Fig. 16
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		85		pF	V_{GS} = 0 V, V_{DS} = 0... 400V	Note: 3
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		122		pF		
E_{ON}	Turn-On Switching Energy (External Diode)		126		μJ	V_{DS} = 400 V, V_{GS} = -4 V/15 V, I_D = 13.2A, $R_{G(ext)}$ = 2.5 Ω, L= 135 μH, T_J = 175ºC FWD = External SiC DIODE	Fig. 26
E_{OFF}	Turn Off Switching Energy (External Diode)		25				
E_{ON}	Turn-On Switching Energy (Body Diode FWD)		169		μJ	V_{DS} = 400 V, V_{GS} = -4 V/15 V, I_D = 13.2A, $R_{G(ext)}$ = 2.5 Ω, L= 135 μH, T_J = 175ºC FWD = Internal Body Diode	Fig. 26
E_{OFF}	Turn-Off Switching Energy (Body Diode FWD)		23				
$t_{d(on)}$	Turn-On Delay Time		10		ns	V_{DD} = 400 V, V_{GS} = -4 V/15 V I_D = 13.2 A, $R_{G(ext)}$ = 2.5 Ω, Timing relative to V_{DS} Inductive load	Fig. 27
t_r	Rise Time		33				
$t_{d(off)}$	Turn-Off Delay Time		17				
t_f	Fall Time		8				
$R_{G(int)}$	Internal Gate Resistance		4		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{gs}	Gate to Source Charge		16		nC	V_{DS} = 400 V, V_{GS} = -4 V/15 V I_D = 13.2 A Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		13				
Q_g	Total Gate Charge		46				

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as Coss while Vds is rising from 0 to 400V
$C_{o(tr)}$, a lumped capacitance that gives same charging time as Coss while Vds is rising from 0 to 400V

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

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage	4.6		V	V_{GS} = -4 V, I_{SD} = 6.6 A, T_J = 25 °C	Fig. 8, 9, 10
		4.1		V	V_{GS} = -4 V, I_{SD} = 6.6 A, T_J = 175 °C	
I_S	Continuous Diode Forward Current		23	A	V_{GS} = -4 V, T_C = 25˚C	
$I_{S, pulse}$	Diode pulse Current		99	A	V_{GS} = -4 V, pulse width t_P limited by T_{jmax}	
t_{rr}	Reverse Recover time	23		ns	V_{GS} = -4 V, I_{SD} = 13.2 A, V_R = 400 V dif/dt = 1720 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	108		nC		
I_{rrm}	Peak Reverse Recovery Current	8		A		
t_{rr}	Reverse Recover time	30		ns	V_{GS} = -4 V, I_{SD} = 13.2 A, V_R = 400 V dif/dt = 790 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	97		nC		
I_{rrm}	Peak Reverse Recovery Current	6		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	1.02	1.14	°C/W		Fig. 21

Typical Performance

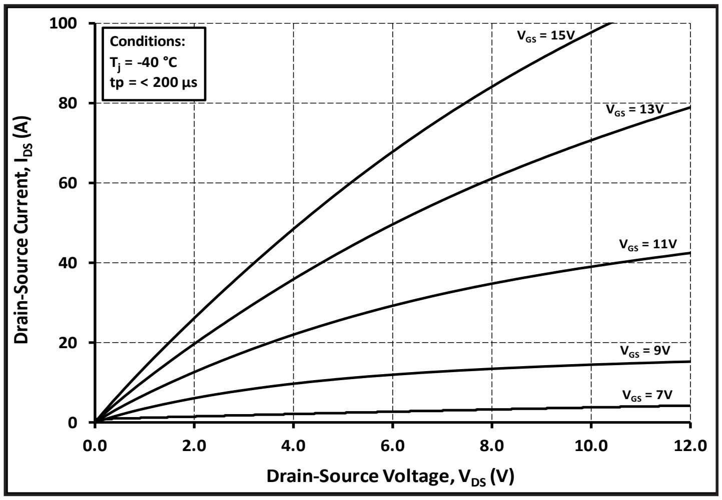


Figure 1. Output Characteristics T_J = -40 °C

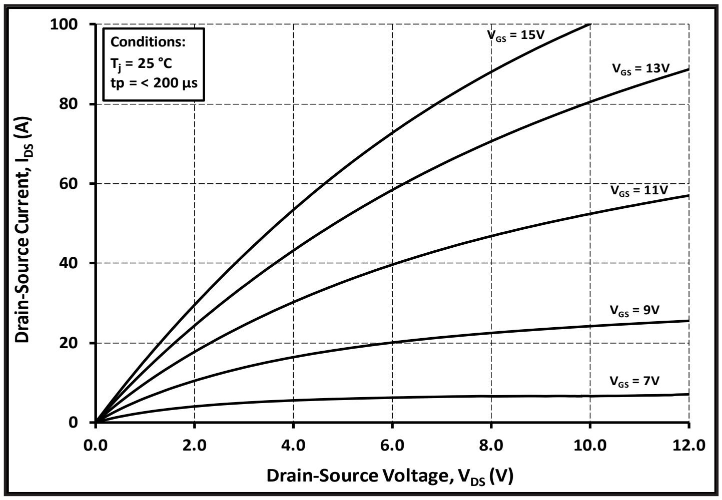


Figure 2. Output Characteristics T_J = 25 °C

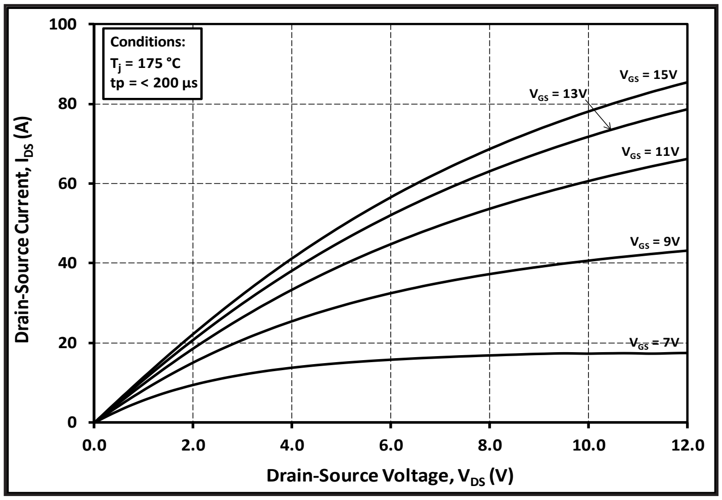


Figure 3. Output Characteristics T_J = 175 °C

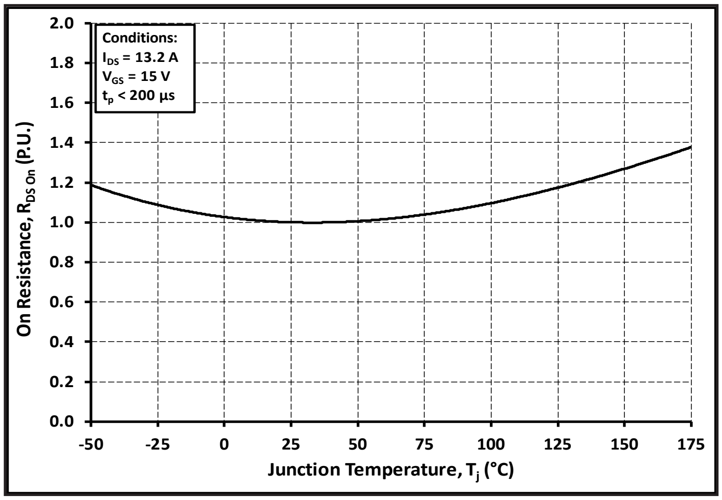


Figure 4. Normalized On-Resistance vs. Temperature

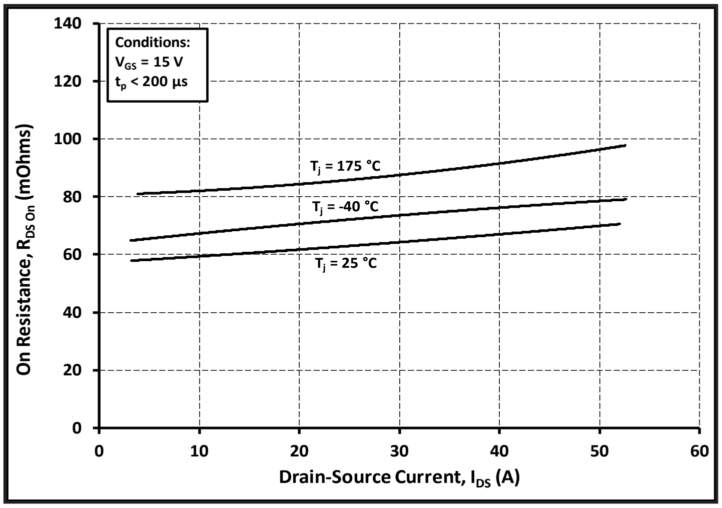


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

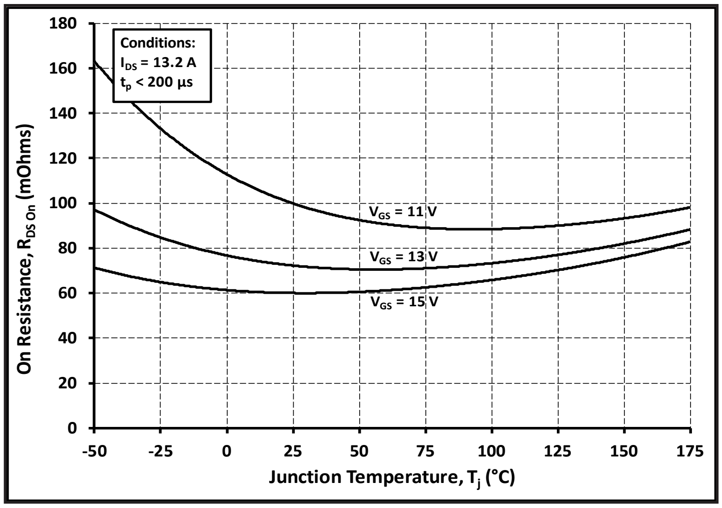


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

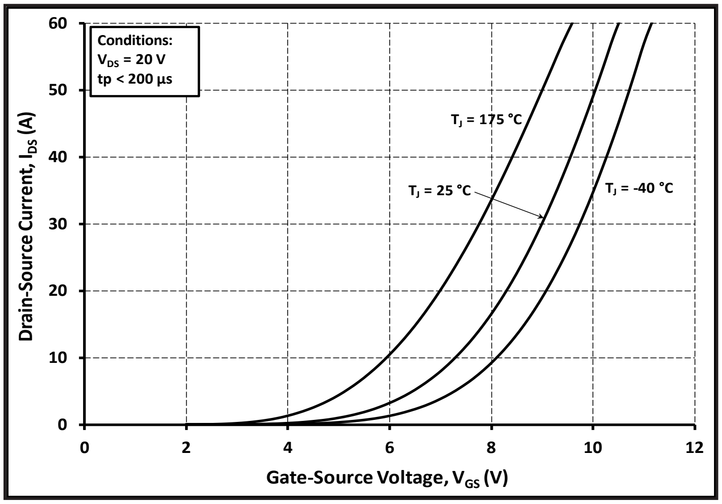


Figure 7. Transfer Characteristic for Various Junction Temperatures

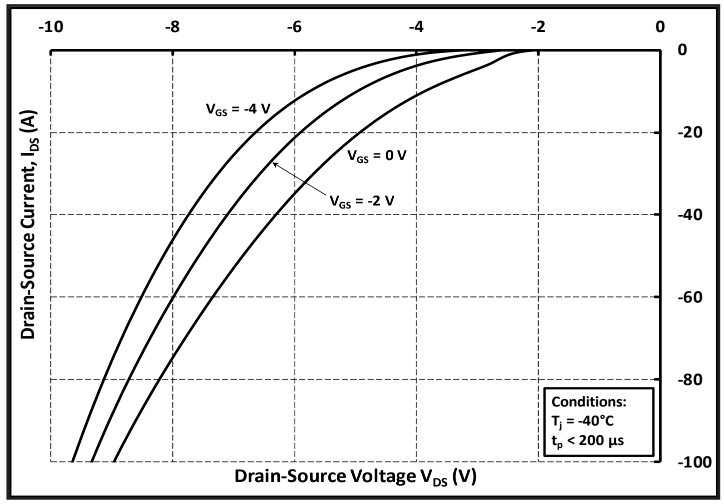


Figure 8. Body Diode Characteristic at -40 °C

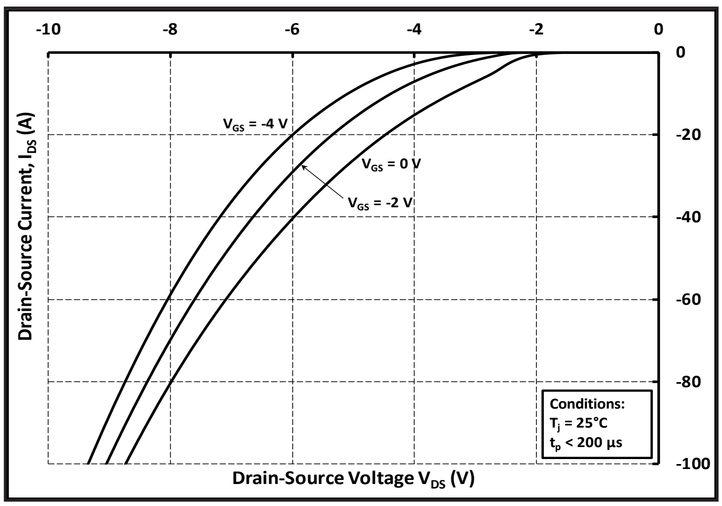


Figure 9. Body Diode Characteristic at 25 °C

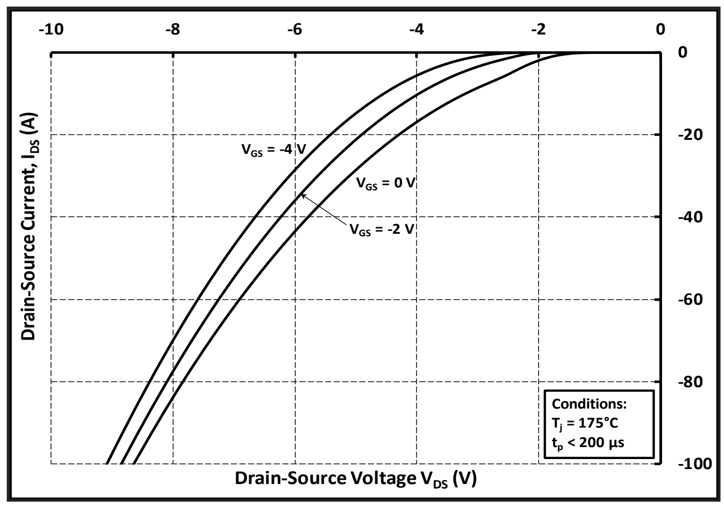


Figure 10. Body Diode Characteristic at 175 °C

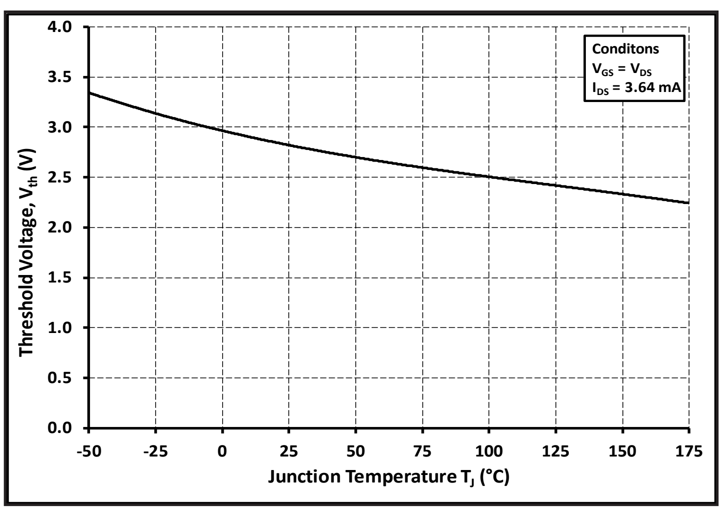


Figure 11. Threshold Voltage vs. Temperature

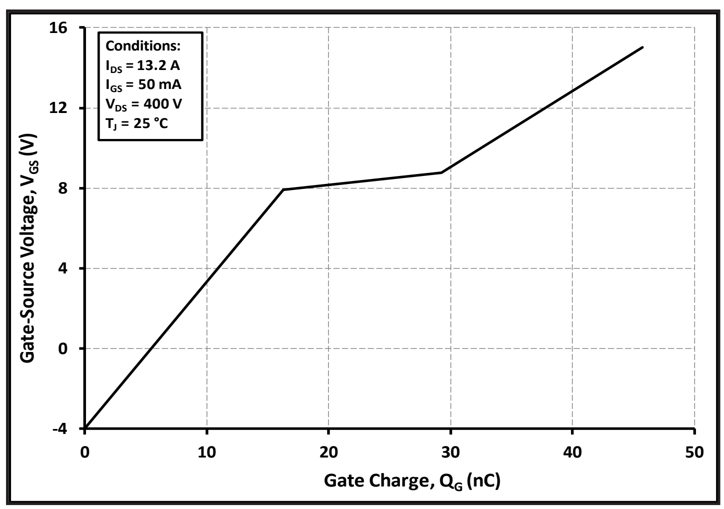


Figure 12. Gate Charge Characteristics

Typical Performance

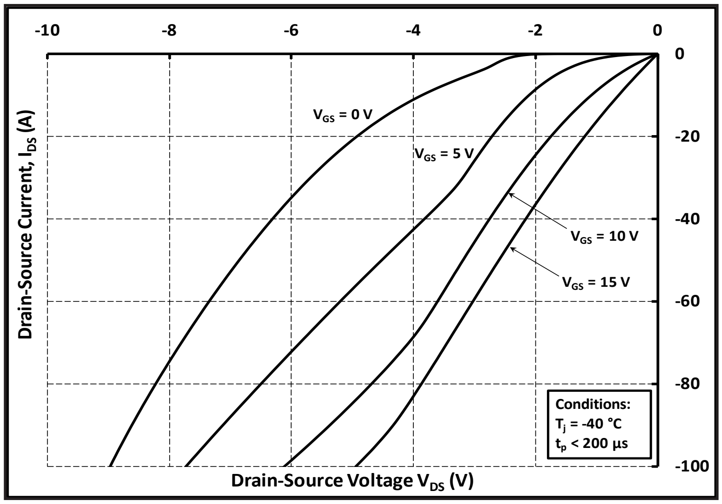


Figure 13. 3rd Quadrant Characteristic at -40 °C

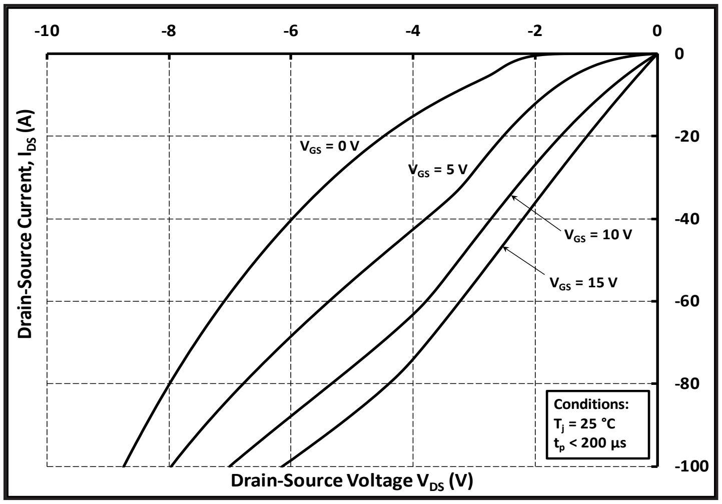


Figure 14. 3rd Quadrant Characteristic at 25 °C

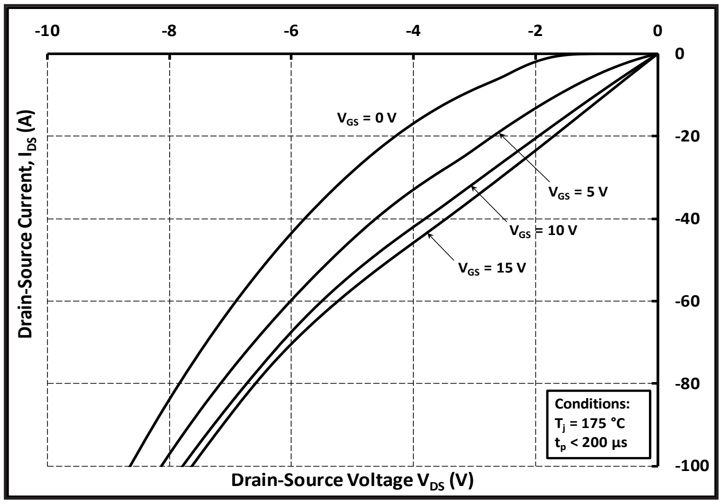


Figure 15. 3rd Quadrant Characteristic at 175 °C

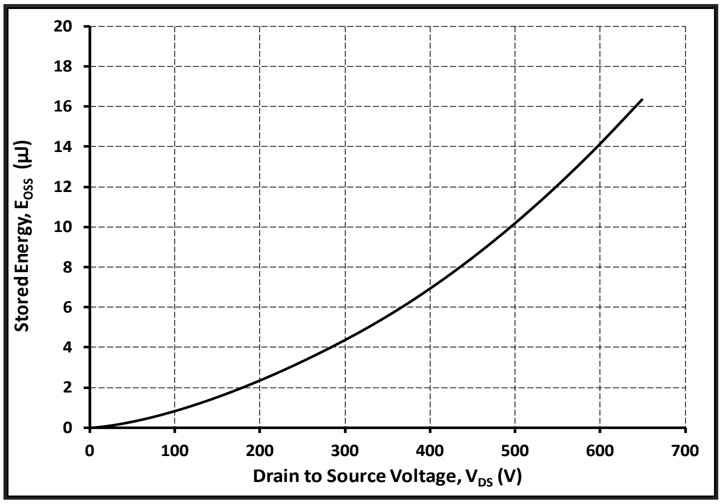


Figure 16. Output Capacitor Stored Energy

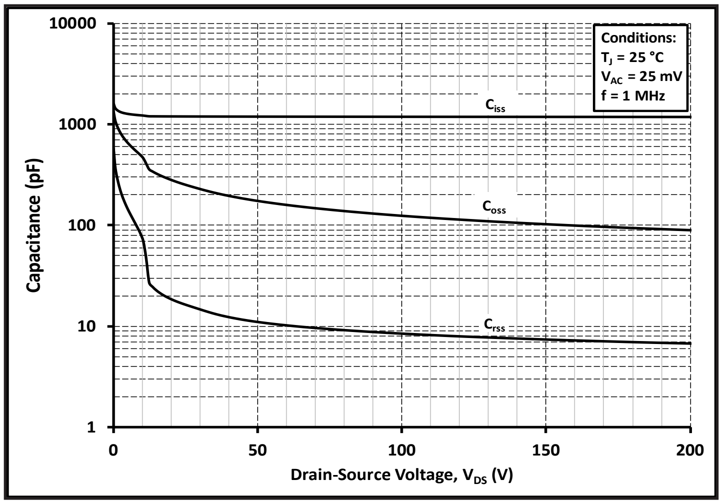


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

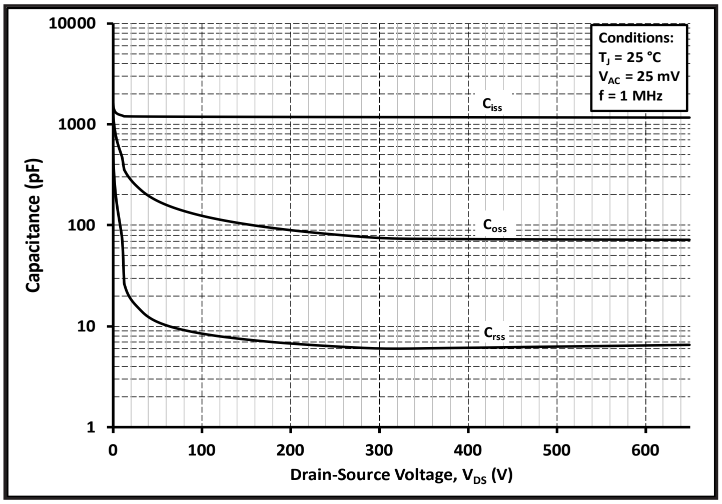


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)

Typical Performance

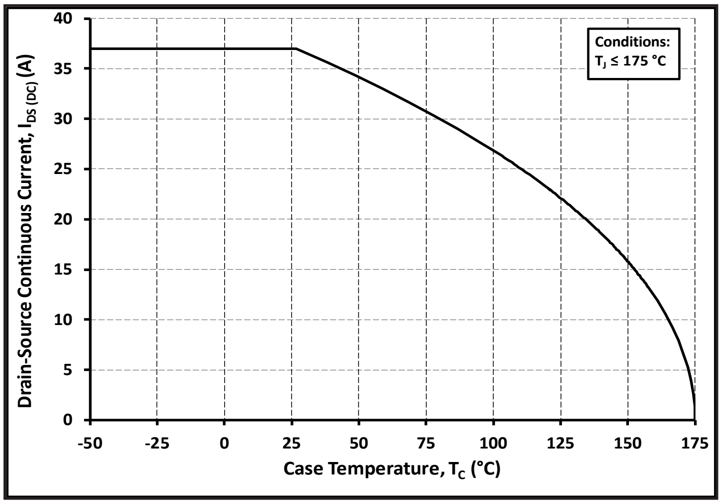


Figure 19. Continuous Drain Current Derating vs. Case Temperature

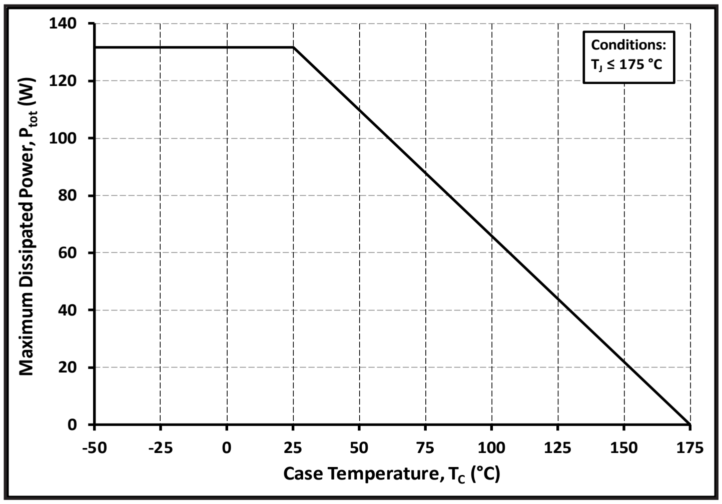


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

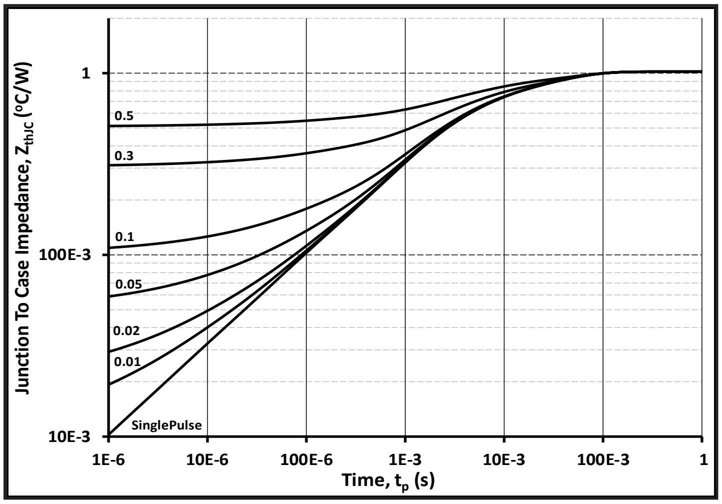


Figure 21. Transient Thermal Impedance (Junction - Case)

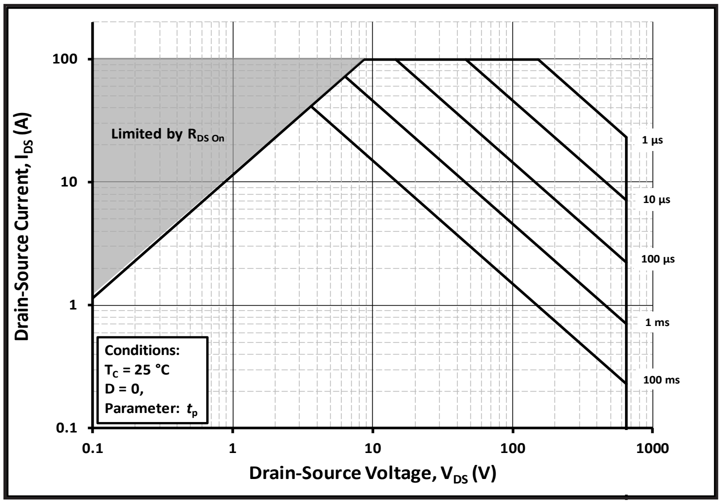


Figure 22. Safe Operating Area

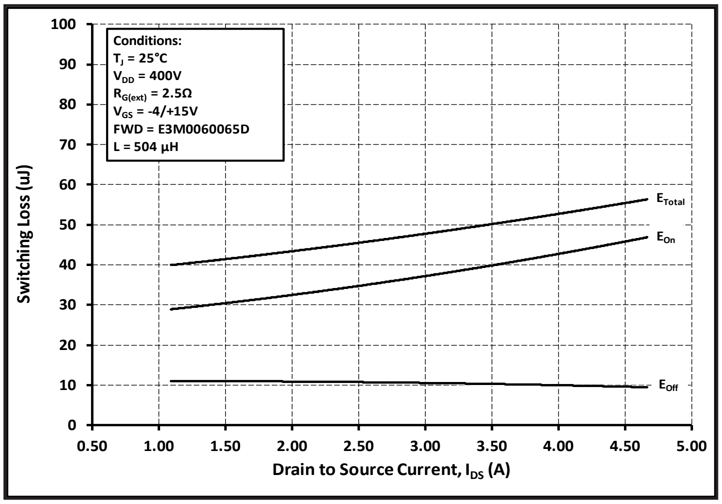


Figure 23. Clamped Inductive Switching Energy vs. Low Drain Current (V_{DD} = 400V)

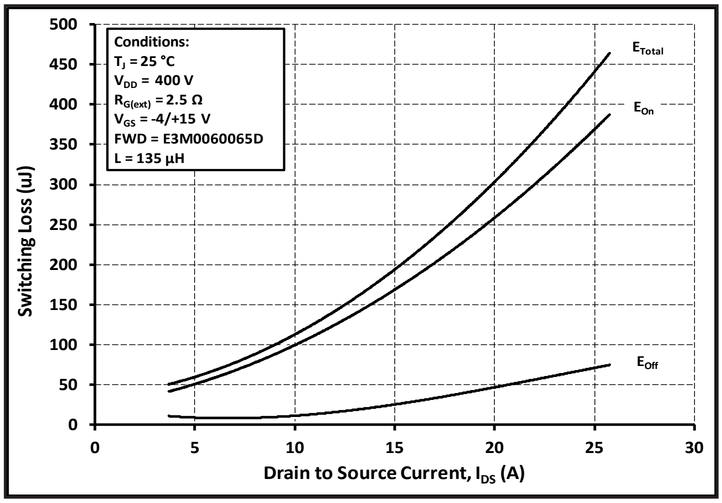


Figure 24. Clamped Inductive Switching Energy vs. High Drain Current (V_{DD} = 400V)

Typical Performance

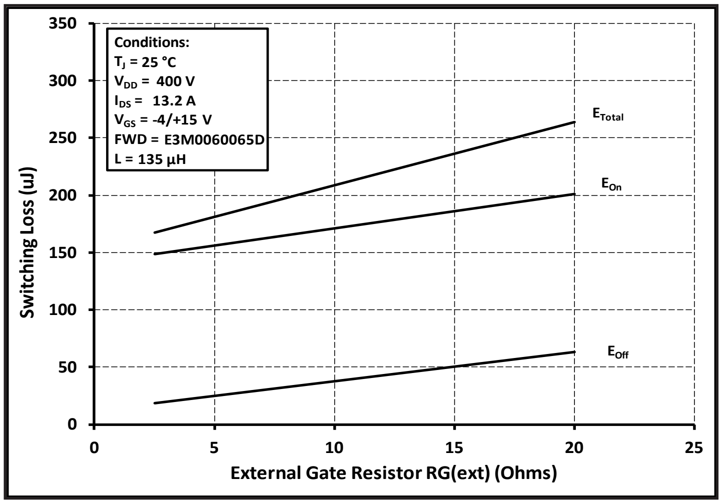


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

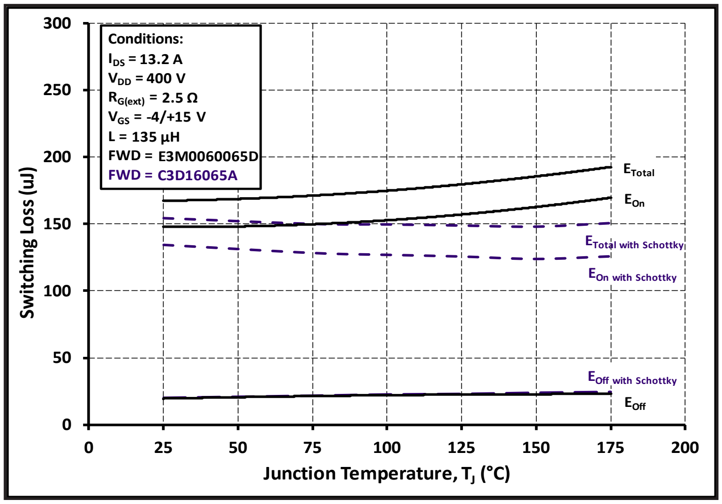


Figure 26. Clamped Inductive Switching Energy vs. Temperature

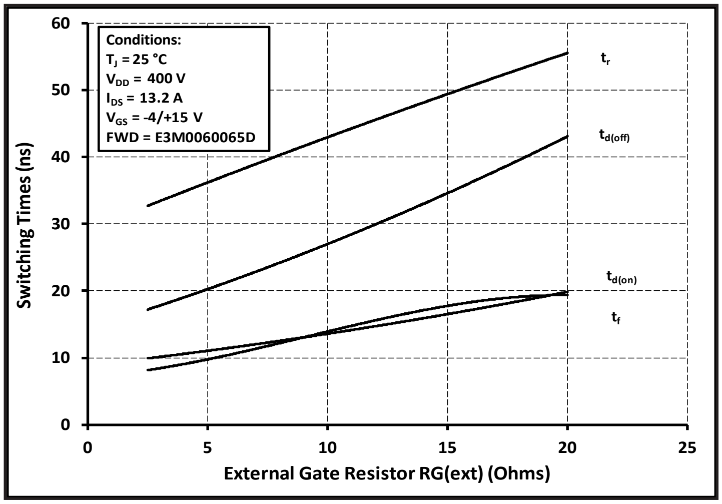


Figure 27. Switching Times vs. $R_{G(ext)}$

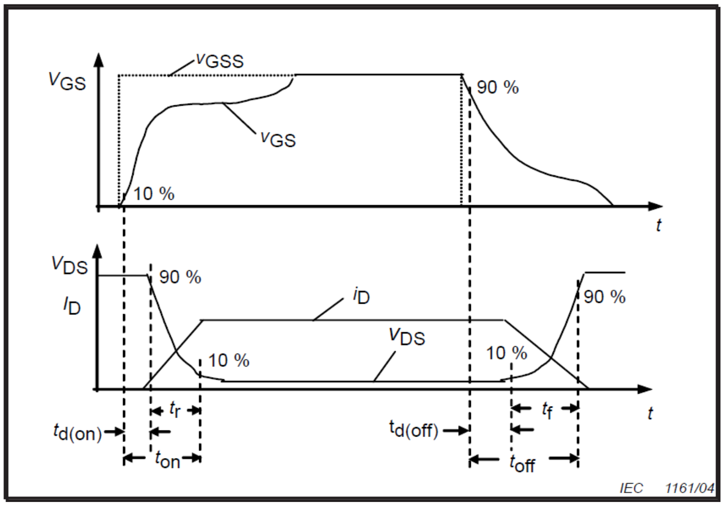


Figure 28. Switching Times Definition

Test Circuit Schematic

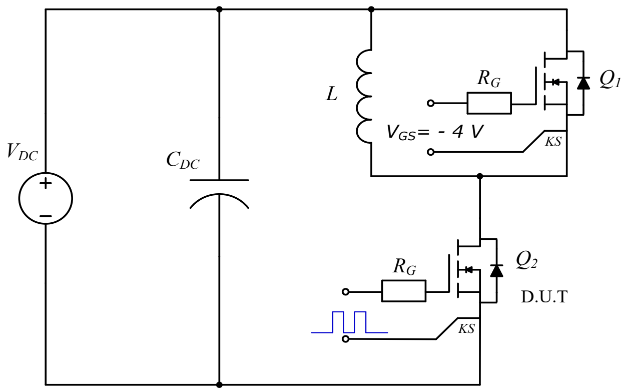
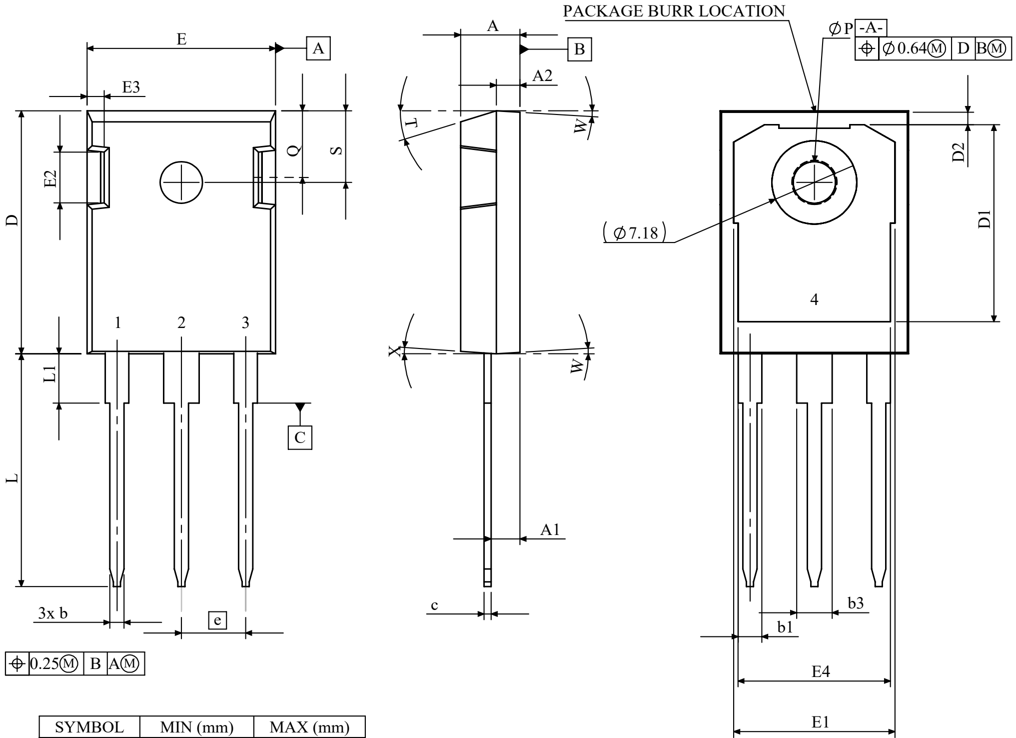


Figure 29. Clamped Inductive Switching
Waveform Test Circuit

Package Dimensions



SYMBOL	MIN (mm)	MAX (mm)
A	4.83	5.21
A1	2.29	2.54
A2	1.91	2.16
b	1.07	1.33
b1	1.91	2.41
b3	2.87	3.38
c	0.55	0.68
D	20.8	21.1
D1	16.25	17.65
D2	0.95	1.25
E	15.75	16.13
E1	13.1	14.15
E2	3.68	5.1
E3	1	1.9
E4	12.38	13.43
e	5.44 BSC	
L	19.81	20.32
L1	4.1	4.4
⌀P	3.51	3.65
Q	5.49	6
S	6.04	6.3
T	17.5° REF.	
W	3.5° REF.	
X	4° REF.	

1	GATE
2	DRAIN
3	SOURCE
4	DRAIN

NOTES:

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.

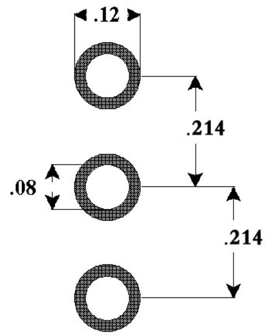
TITLE: PACKAGE OUTLINE DRAWING: TO-247-3L(MOSFET)

Date: 04/13/22

REVISION NO. 01 | A4

SCALE:1:1 | SHEET 1 OF 1

Recommended Solder Pad Layout



TO-247-3

Revision history

Document Version	Date of release	Descriptiion of changes
1.0	June-2022	Initial datasheet

Notes & Disclaimer

This document and the information contained herein are subject to change without notice. Any such change shall be evidenced by the publication of an updated version of this document by Wolfspeed. No communication from any employee or agent of Wolfspeed or any third party shall effect an amendment or modification of this document. No responsibility is assumed by Wolfspeed for any infringement of patents or other rights of third parties which may result from use of the information contained herein. No license is granted by implication or otherwise under any patent or patent rights of Wolfspeed.

Notwithstanding any application-specific information, guidance, assistance, or support that Wolfspeed may provide, the buyer of this product is solely responsible for determining the suitability of this product for the buyer's purposes, including without limitation for use in the applications identified in the next bullet point, and for the compliance of the buyers' products, including those that incorporate this product, with all applicable legal, regulatory, and safety-related requirements.

This product has not been designed or tested for use in, and is not intended for use in, applications in which failure of the product would reasonably be expected to cause death, personal injury, or property damage, including but not limited to equipment implanted into the human body, life-support machines, cardiac defibrillators, and similar emergency medical equipment, aircraft navigation, communication, and control systems, aircraft power and propulsion systems, air traffic control systems, and equipment used in the planning, construction, maintenance, or operation of nuclear facilities.

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 Wolfspeed representative or from the Product Documentation sections of www.wolfspeed.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 your Wolfspeed representative to ensure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

Contact info:

4600 Silicon Drive
Durham, NC 27703 USA
Tel: +1.919.313.5300
www.wolfspeed.com/power

© 2022 Wolfspeed, Inc. All rights reserved. Wolfspeed® and the Wolfstreak logo are registered trademarks and the Wolfspeed logo is a trademark of Wolfspeed, Inc.
The information in this document is subject to change without notice.