E3M0060065K

Silicon Carbide Power MOSFET
E-Series Automotive
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
- Automotive Qualified (AEC-Q101) and PPAP Capable

Benefits

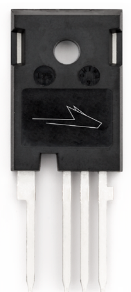
- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

Applications

- EV Battery Chargers
- High Voltage DC/DC Converters

Package

Tab
Drain



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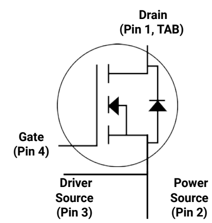


Part Number	Package	Marking
E3M0060065K	TO-247-4L	E3M0060065K

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)		29		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. 25
E_{OFF}	Turn Off Switching Energy (External Diode)		12				
E_{ON}	Turn-On Switching Energy (Body Diode FWD)		40		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. 25
E_{OFF}	Turn-Off Switching Energy (Body Diode FWD)		11				
$t_{d(on)}$	Turn-On Delay Time		9		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. 26
t_r	Rise Time		10				
$t_{d(off)}$	Turn-Off Delay Time		16				
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		16				
Q_g	Total Gate Charge		49				

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	12		ns	V_{GS} = -4 V, I_{SD} = 13.2 A, V_R = 400 V dif/dt = 4770 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	173		nC		
I_{rrm}	Peak Reverse Recovery Current	28		A		
t_{rr}	Reverse Recover time	15		ns	V_{GS} = -4 V, I_{SD} = 13.2 A, V_R = 400 V dif/dt = 2200 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	122		nC		
I_{rrm}	Peak Reverse Recovery Current	13		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

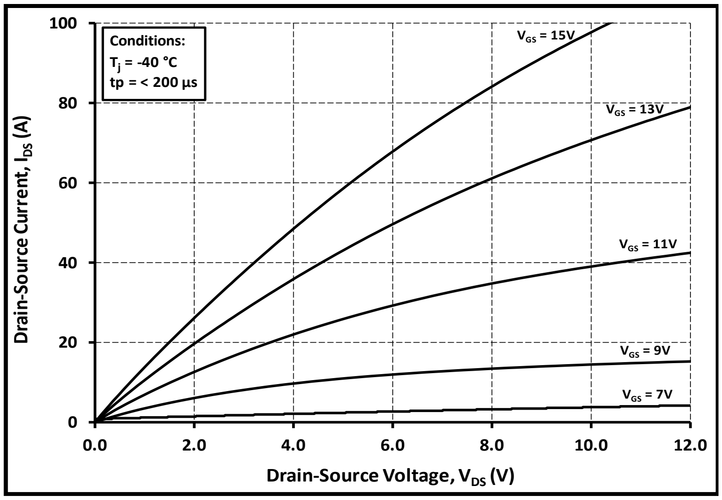


Figure 1. Output Characteristics T_J = -40 °C

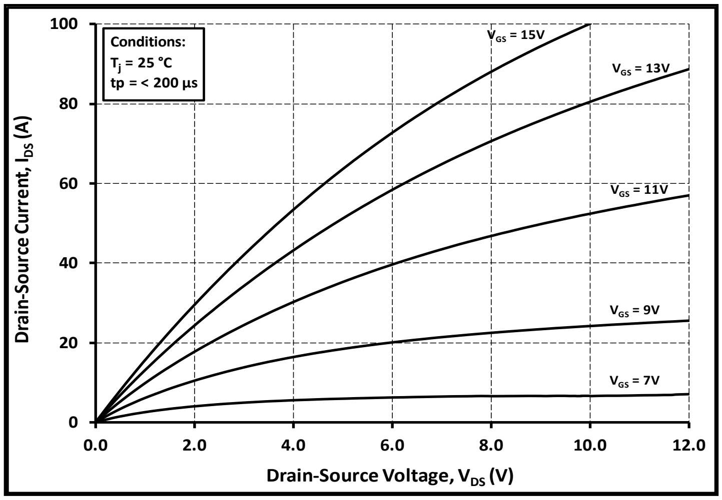


Figure 2. Output Characteristics T_J = 25 °C

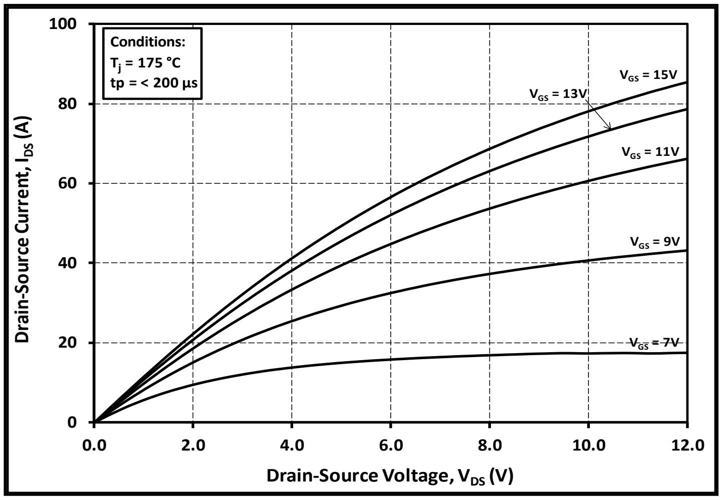


Figure 3. Output Characteristics T_J = 175 °C

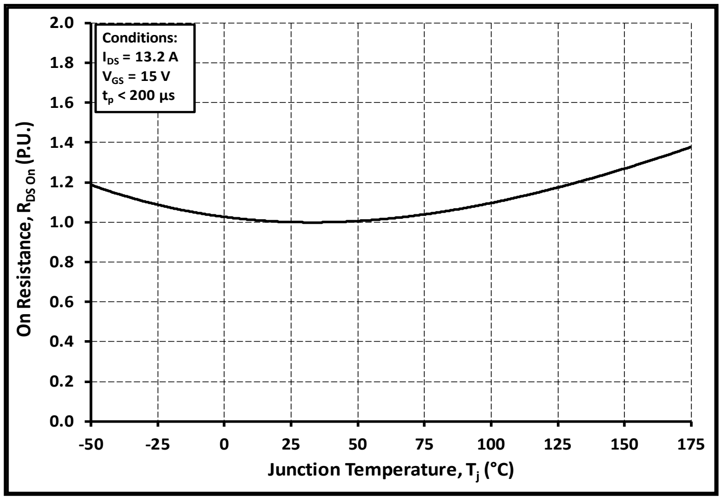


Figure 4. Normalized On-Resistance vs. Temperature

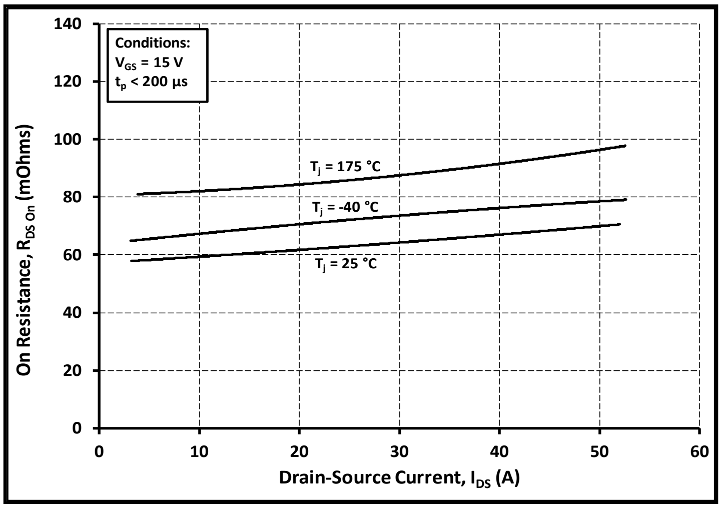


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

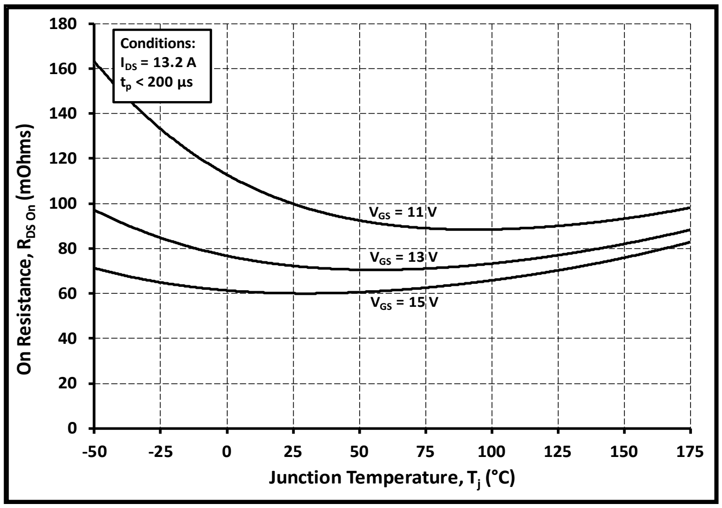


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

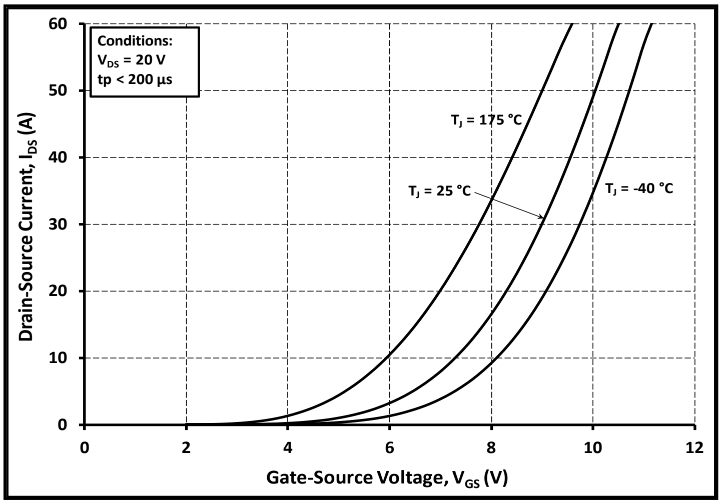


Figure 7. Transfer Characteristic for Various Junction Temperatures

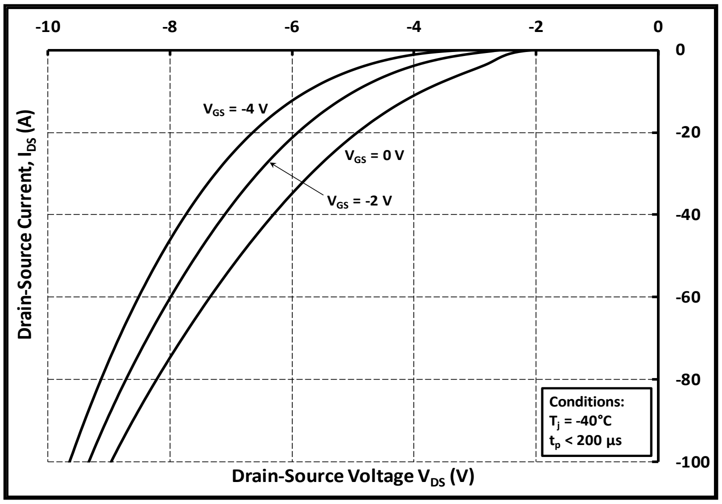


Figure 8. Body Diode Characteristic at -40 °C

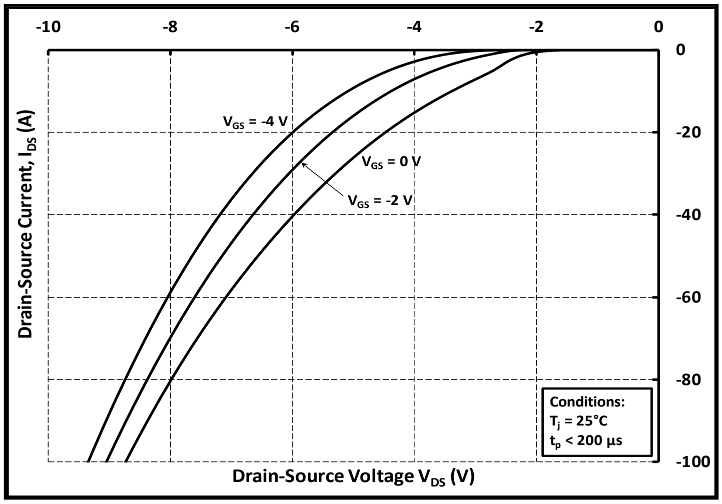


Figure 9. Body Diode Characteristic at 25 °C

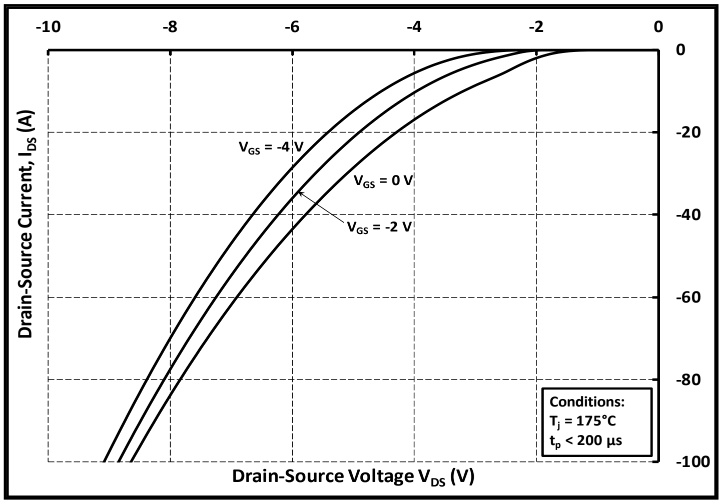


Figure 10. Body Diode Characteristic at 175 °C

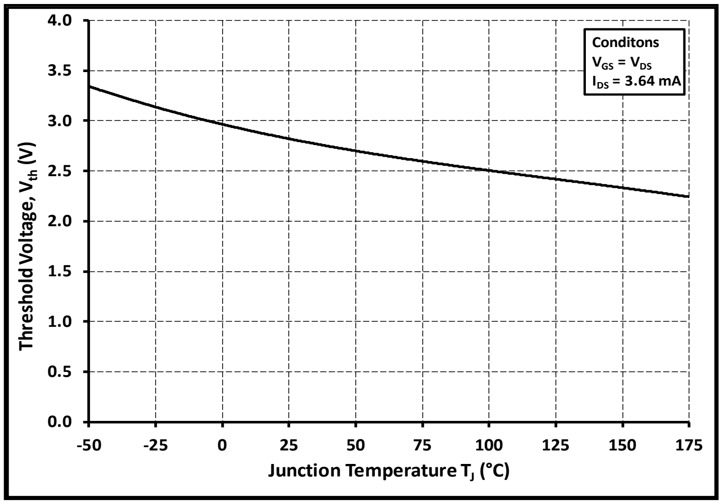


Figure 11. Threshold Voltage vs. Temperature

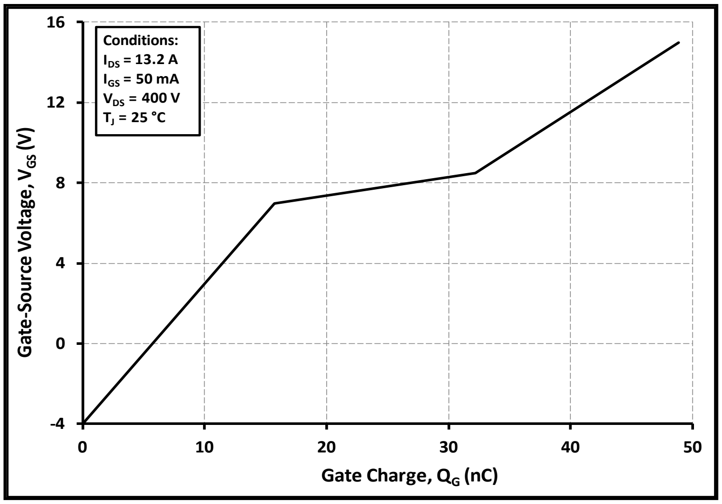


Figure 12. Gate Charge Characteristics

Typical Performance

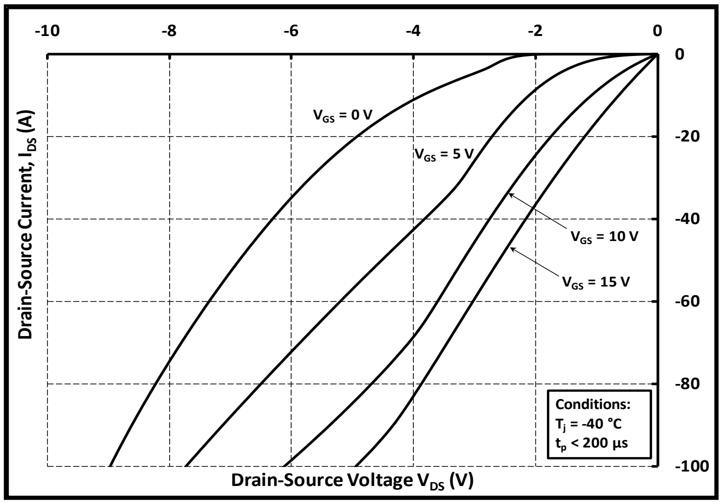


Figure 13. 3rd Quadrant Characteristic at -40 °C

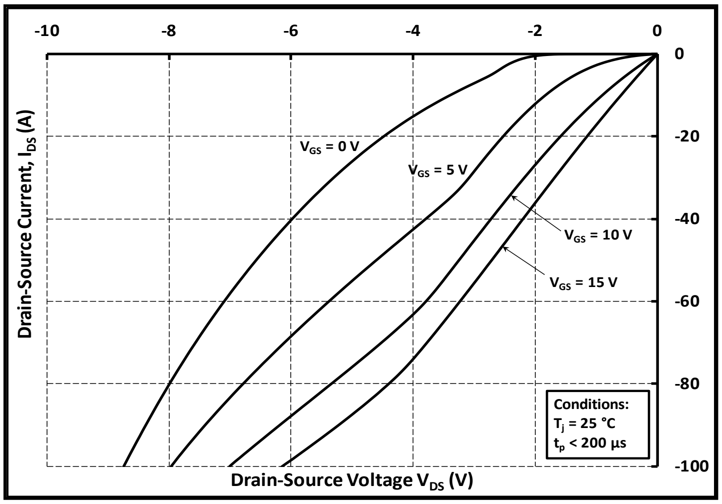


Figure 14. 3rd Quadrant Characteristic at 25 °C

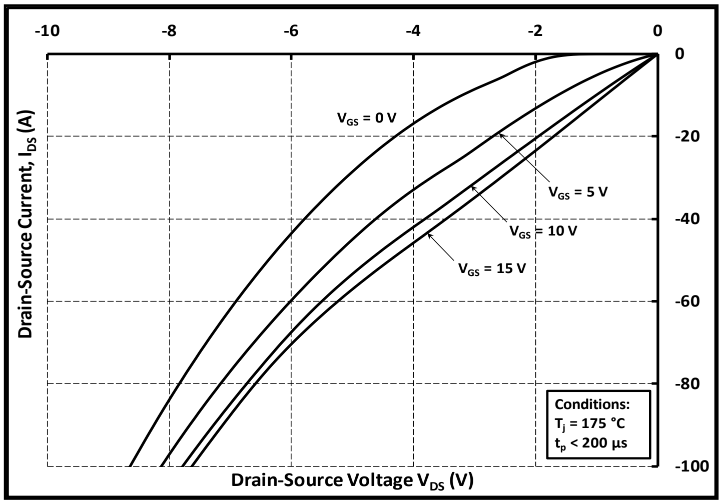


Figure 15. 3rd Quadrant Characteristic at 175 °C

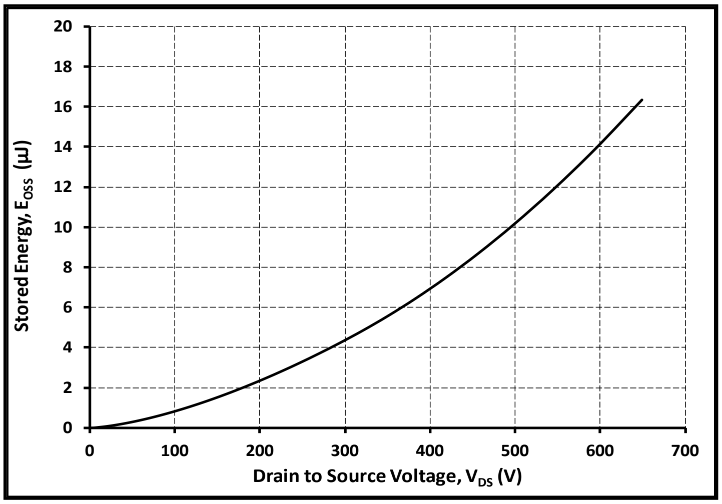


Figure 16. Output Capacitor Stored Energy

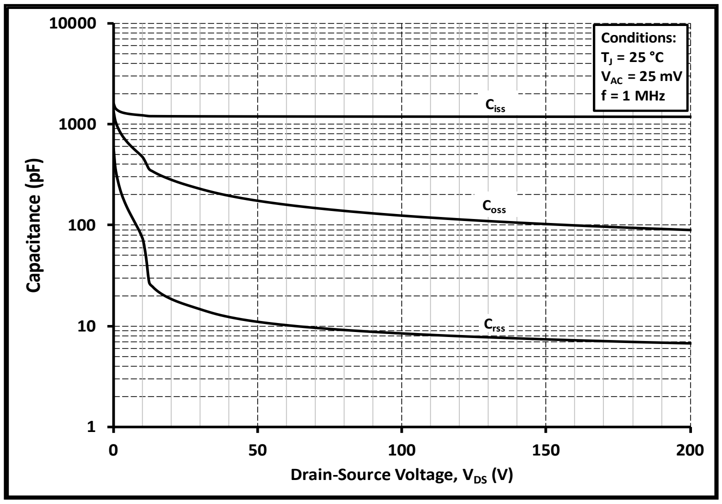


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

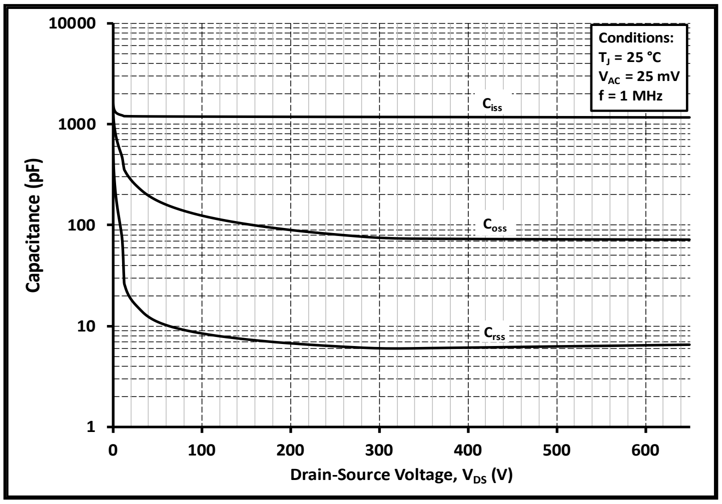


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)

Typical Performance

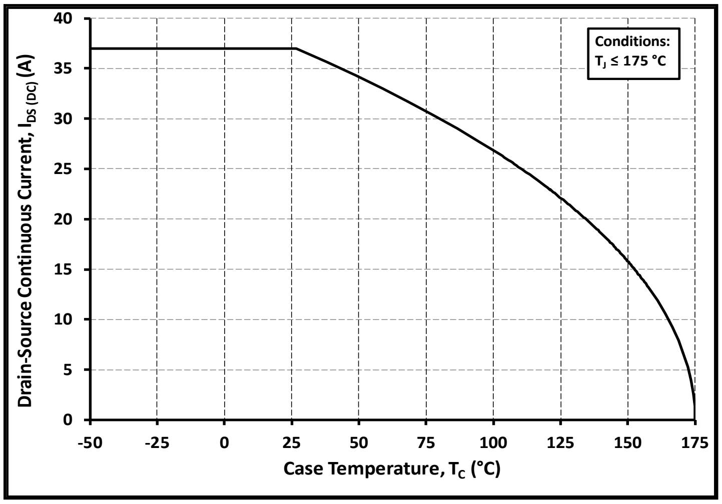


Figure 19. Continuous Drain Current Derating vs. Case Temperature

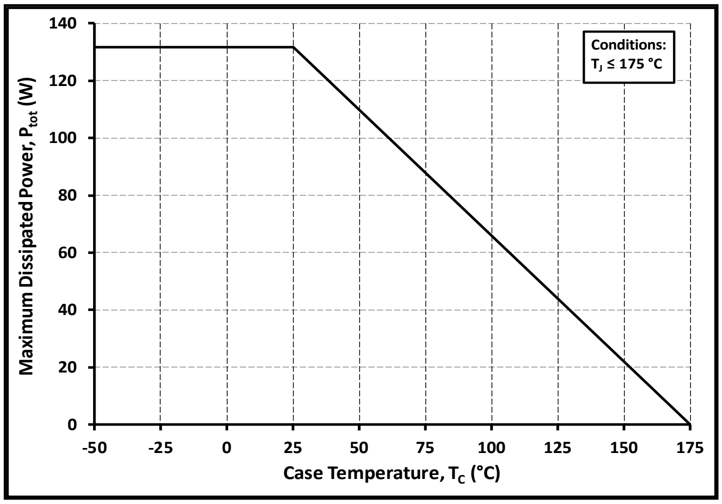


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

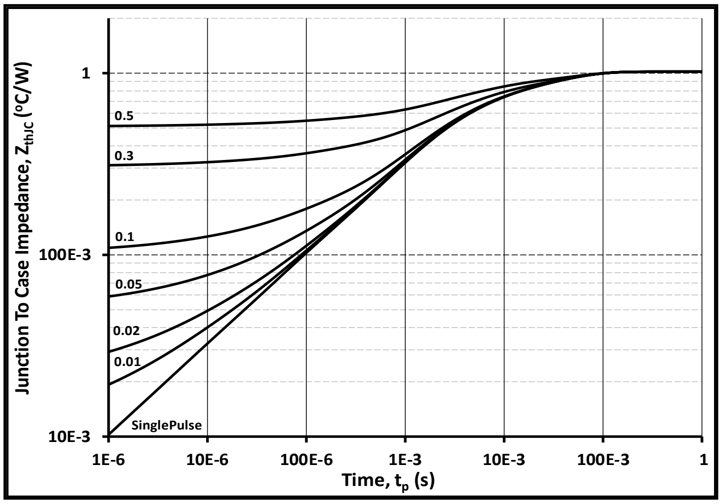


Figure 21. Transient Thermal Impedance (Junction - Case)

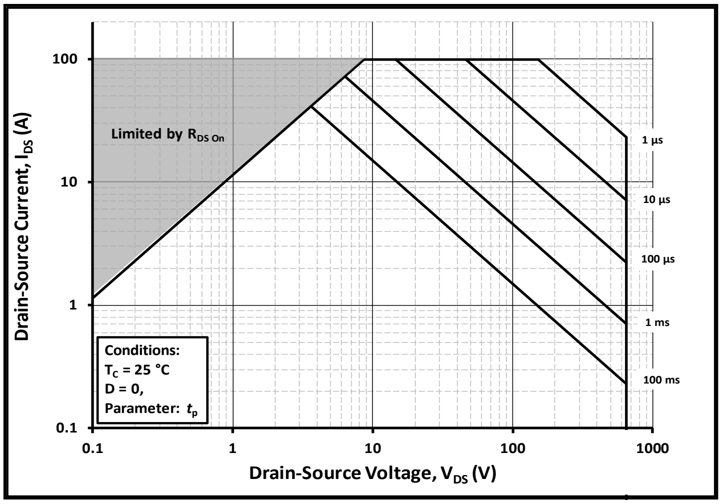


Figure 22. Safe Operating Area

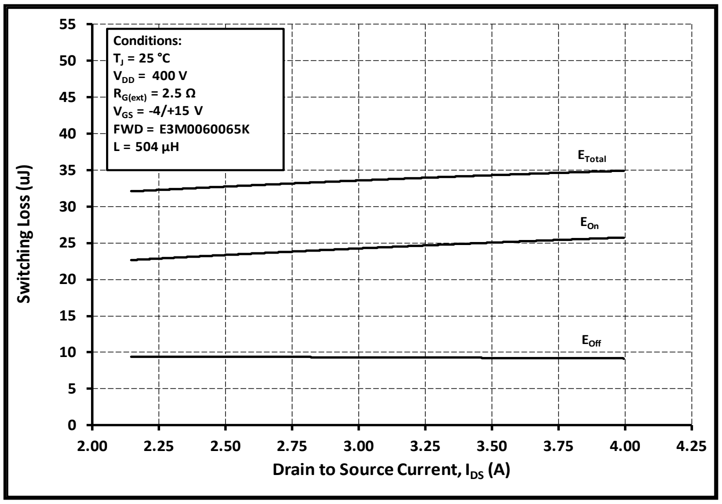


Figure 23. Clamped Inductive Switching Energy vs. Low Drain Current (V_{DD} = 400V)

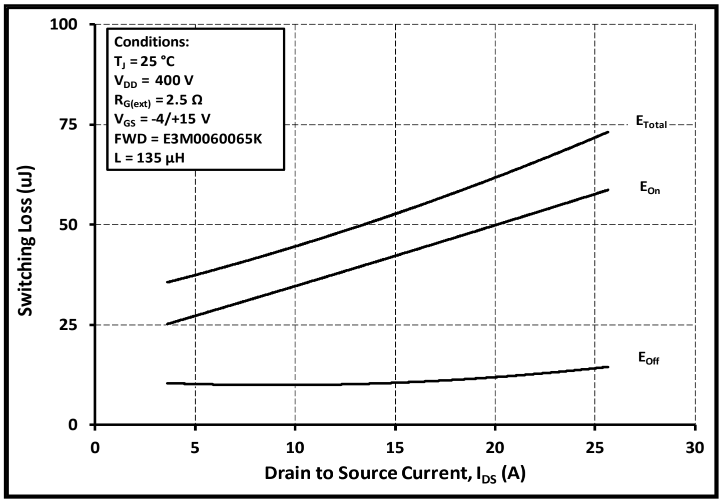


Figure 24. lamped Inductive Switching Energy vs. High Drain Current (V_{DD} = 400V)

Typical Performance

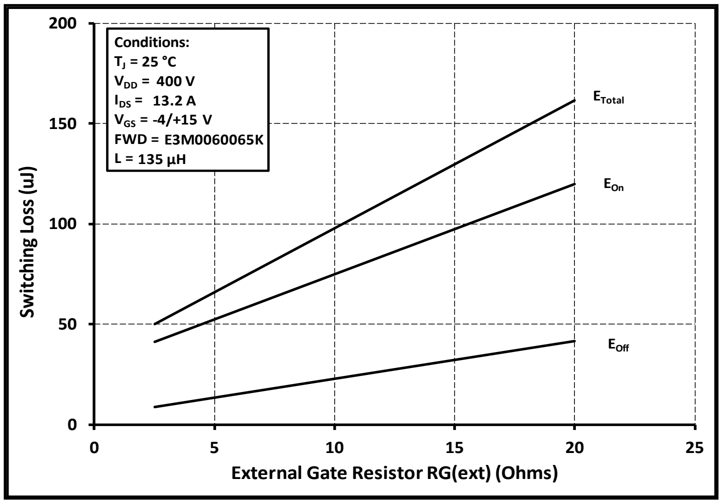


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

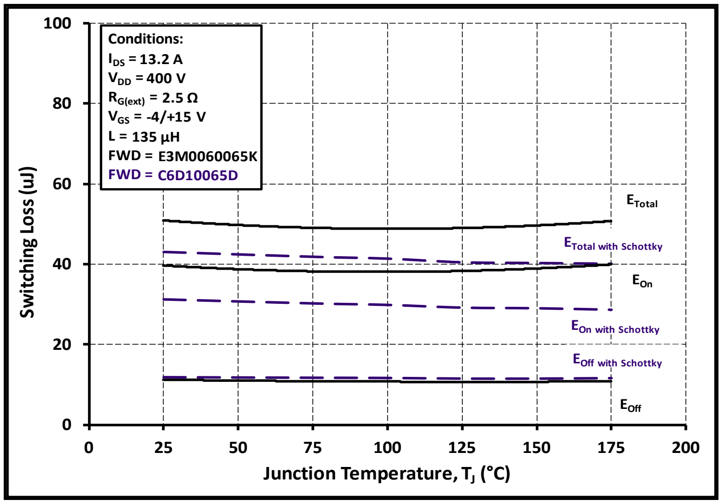


Figure 26. Clamped Inductive Switching Energy vs. Temperature

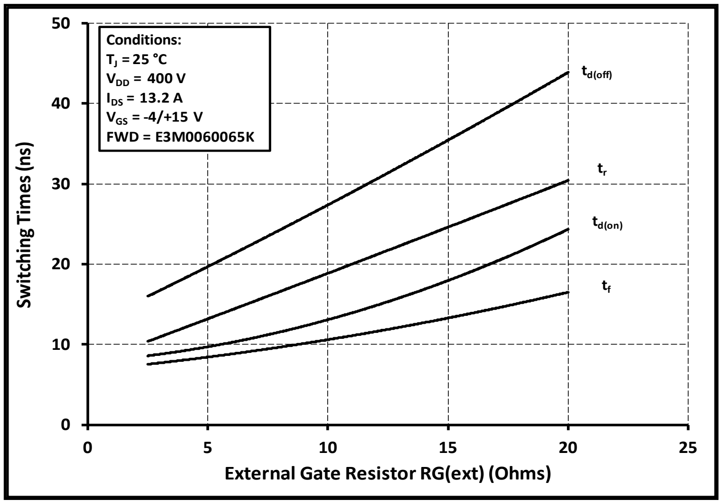


Figure 27. Switching Times vs. $R_{G(ext)}$

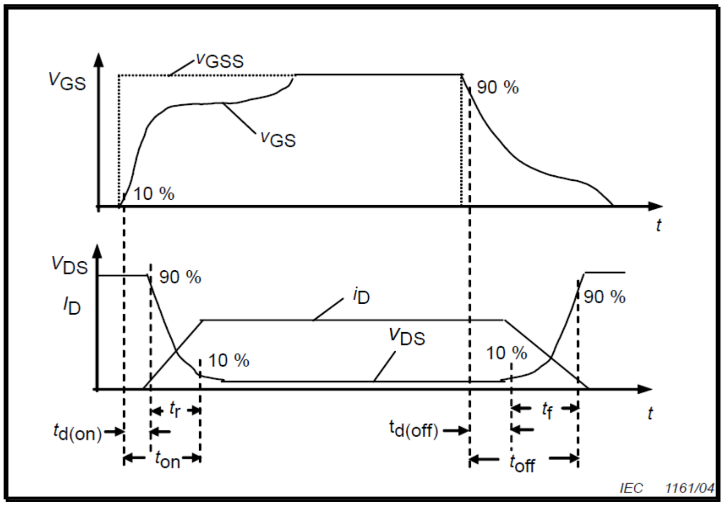


Figure 28. Switching Times Definition

Test Circuit Schematic

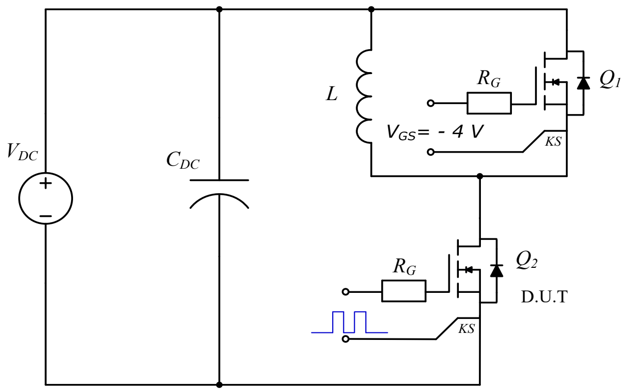
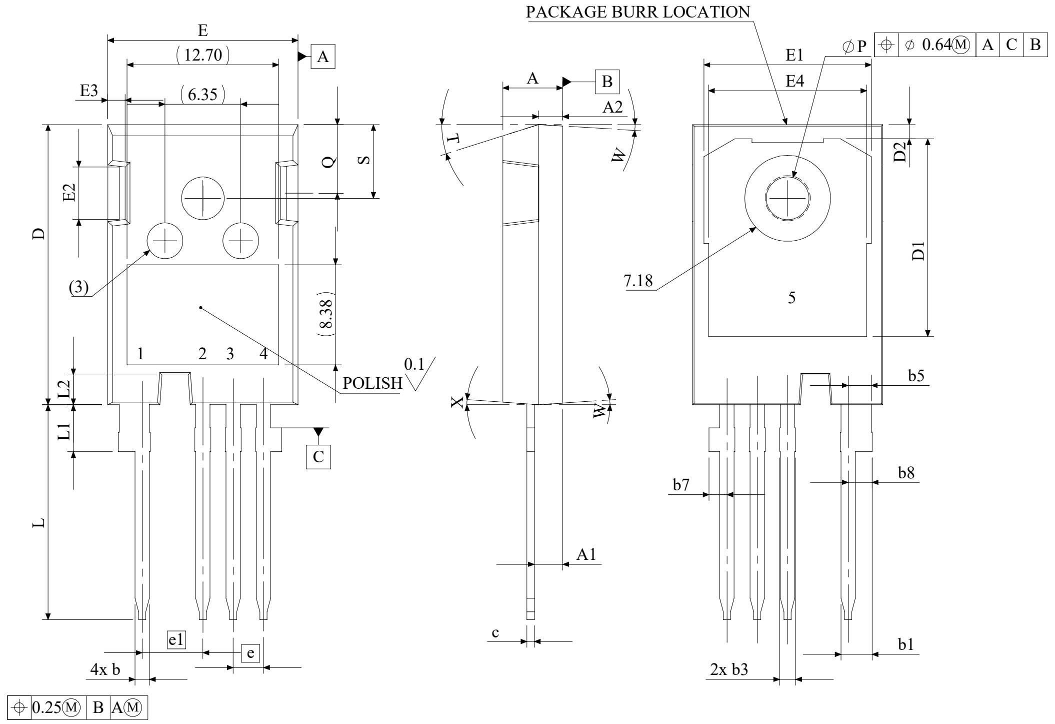


Figure 29. Clamped Inductive Switching
Waveform Test Circuit

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	2.39	2.94
b3	1.07	1.60
b5	2.39	2.69
b7	1.30	1.70
b8	1.80	2.20
c	0.55	0.68
D	23.30	23.60
D1	16.25	17.65
D2	0.95	1.25
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
e	2.54 BSC	
e1	5.08 BSC	
L	17.31	17.82
L1	3.97	4.37
L2	2.35	2.65
∅P	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: 05/05/22

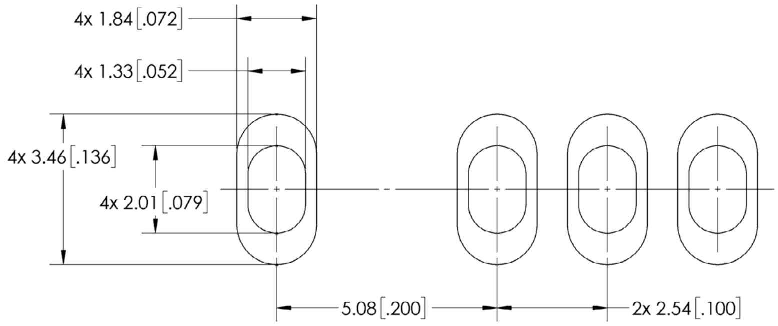
REVISION NO. 01

A4

SCALE:1:1

SHEET 1 OF 1

Recommended Solder Pad Layout



Revision history

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

Notes & Disclaimer

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