



MDDG2C065R060K3

650V N-Channel SiC Power MOSFET

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

Benefits

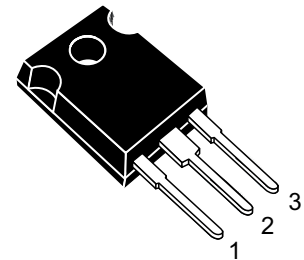
- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency
- Easy to parallel and simple to drive
- Enable new hard switching PFC topologies (Totem-Pole)

Applications

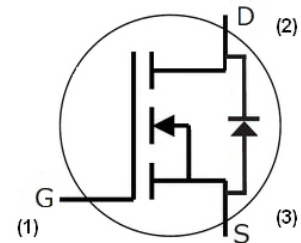
- EV charging
- Server power supplies
- Solar PV inverters
- UPS
- DC/DC converters

V_{DS}	650V
$I_D(T_C=25^\circ\text{C})$	29A
$R_{DS(on)}$	60mΩ

Package TO-247-3L



Equivalent Circuit



Maximum Ratings

Symbol	Parameter	Value	Unit	Note
V_{DSS}	Drain - Source Voltage, $T_C = 25^\circ\text{C}$	650	V	
V_{GS}	Gate - Source voltage (Under transient events < 100 ns)	-8/+19	V	Fig. 29
I_D	Continuous Drain Current, $V_{GS} = 15\text{ V}$, $T_C = 25^\circ\text{C}$	29	A	Fig. 19 Note 1
	Continuous Drain Current, $V_{GS} = 15\text{ V}$, $T_C = 100^\circ\text{C}$	20		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_p limited by T_{jmax}	99	A	
P_D	Power Dissipation, $T_C=25^\circ\text{C}$, $T_J = 175^\circ\text{C}$	150	W	Fig. 20
T_J, T_{stg}	Operating Junction and Storage Temperature	-40 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 lbf-in	
		8.8		

Note (1): Die limits are 37A (25°C) and 27A (100°C)



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 _{GSon}	Gate-Source Recommended Turn-On Voltage		15		V	Static	Fig. 29
V _{GSoff}	Gate-Source Recommended Turn-Off Voltage		-4		V		
V _{GS(th)}	Gate Threshold Voltage	1.8	2.3	3.6	V	V _{DS} = V _{GS} , I _D = 5 mA	Fig. 11
			1.9		V	V _{DS} = V _{GS} , I _D = 5 mA, T _J = 175°C	
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	42	60	79	mΩ	V _{GS} = 15 V, I _D = 13.2 A	Fig. 4, 5, 6
			80			V _{GS} = 15 V, I _D = 13.2 A, T _J = 175°C	
g _{fs}	Transconductance		10		S	V _{DS} = 20 V, I _{DS} = 13.2 A	Fig. 7
			9			V _{DS} = 20 V, I _{DS} = 13.2 A, T _J = 175°C	
C _{iss}	Input Capacitance		1020		pF	V _{GS} = 0 V, V _{DS} = 600 V f = 1 MHz V _{AC} = 25 mV	Fig. 17, 18
C _{oss}	Output Capacitance		80				
C _{rss}	Reverse Transfer Capacitance		9				
C _{o(er)}	Effective Output Capacitance (Energy Related)		95		pF	V _{GS} = 0 V, V _{DS} = 0V to 400 V	Note 1
C _{o(tr)}	Effective Output Capacitance (Time Related)		132				
E _{oss}	C _{oss} Stored Energy		15		μJ	V _{DS} = 600 V, 1 MHz	Fig. 16
E _{oN}	Turn-On Switching Energy (Body Diode)		110		μJ	V _{DS} = 400 V, V _{GS} = -4 V/15 V, I _D = 13.2 A, R _{G(ext)} = 2.5Ω, L = 135 μH, T _J = 175°C FWD = Internal Body Diode of MOSFET	Fig. 25
E _{oFF}	Turn Off Switching Energy (Body Diode)		22				
E _{oN}	Turn-On Switching Energy (External SiC Diode)		63		μJ	V _{DS} = 400 V, V _{GS} = -4 V/15 V, I _D = 13.2 A, R _{G(ext)} = 2.5Ω, L = 135 μH, T _J = 175°C FWD = External SiC Diode	Fig. 25
E _{oFF}	Turn Off Switching Energy (External SiC Diode)		28				
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, L = 135 μH Timing relative to V _{DS} Inductive load	Fig. 26
t _r	Rise Time		20				
t _{d(off)}	Turn-Off Delay Time		17				
t _f	Fall Time		8				
R _{G(int)}	Internal Gate Resistance		3		Ω	f = 1 MHz, V _{AC} = 25 mV	
Q _{gs}	Gate to Source Charge		14		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		14				
Q _g	Total Gate Charge		46				

Note (1): C_{o(er)}, a lumped capacitance that gives same stored energy as C_{oss} while V_{ds} is rising from 0 to 400V
C_{o(tr)}, a lumped capacitance that gives same charging time as C_{oss} while V_{ds} is rising from 0 to 400V



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	5.1		V	$V_{GS} = -4\text{ V}, I_{SD} = 6.6\text{ A}, T_J = 25^\circ\text{C}$	Fig. 8, 9, 10
		4.8		V	$V_{GS} = -4\text{ V}, I_{SD} = 6.6\text{ A}, T_J = 175^\circ\text{C}$	
I_S	Continuous Diode Forward Current		23	A	$V_{GS} = -4\text{ V}, T_C = 25^\circ\text{C}$	
$I_{S, pulse}$	Diode pulse Current		99	A	$V_{GS} = -4\text{ V}$, pulse width t_p limited by T_{jmax}	
t_{rr}	Reverse Recover time	20		ns	$V_{GS} = -4\text{ V}, I_{SD} = 13.2\text{ A}, V_R = 400\text{ V}$ $dif/dt = 1200\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	190		nC		
I_{rrm}	Peak Reverse Recovery Current	16		A		
t_{rr}	Reverse Recover time	29		ns	$V_{GS} = -4\text{ V}, I_{SD} = 13.2\text{ A}, V_R = 400\text{ V}$ $dif/dt = 750\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	181		nC		
I_{rrm}	Peak Reverse Recovery Current	9		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.99	$^\circ\text{C}/\text{W}$		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			



Typical Performance

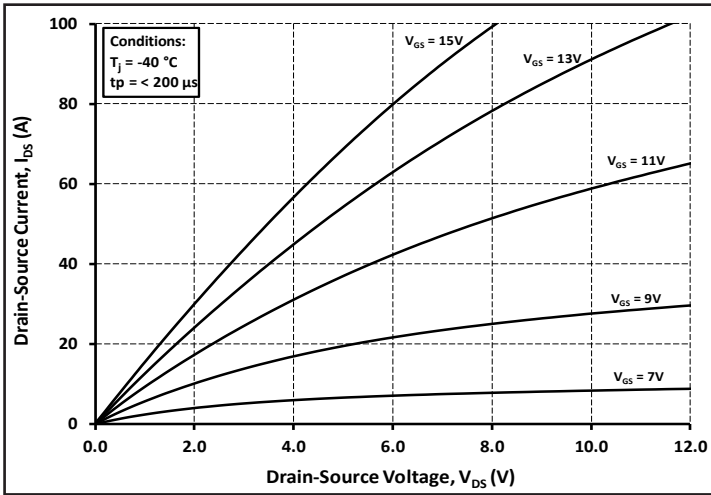


Figure 1. Output Characteristics $T_J = -40\text{ }^\circ\text{C}$

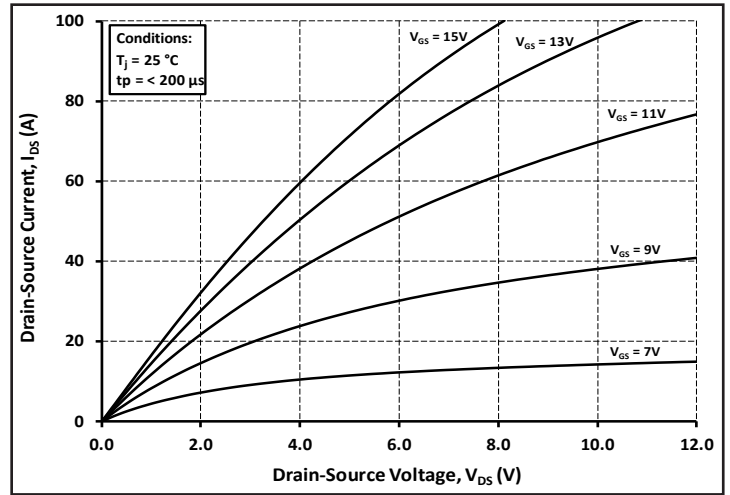


Figure 2. Output Characteristics $T_J = 25\text{ }^\circ\text{C}$

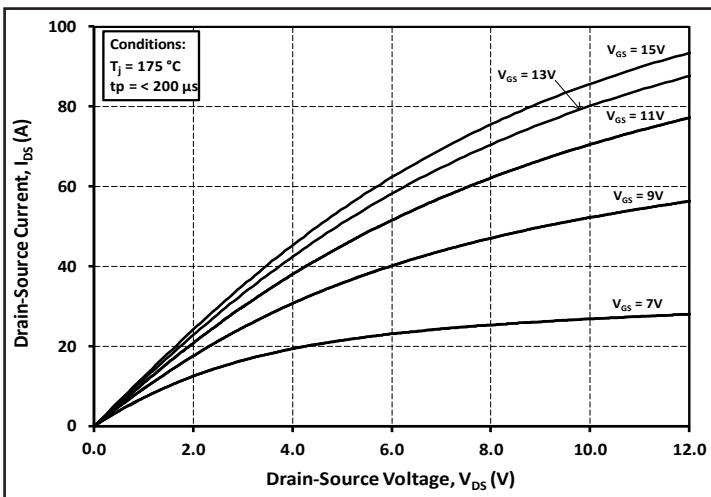


Figure 3. Output Characteristics $T_J = 175\text{ }^\circ\text{C}$

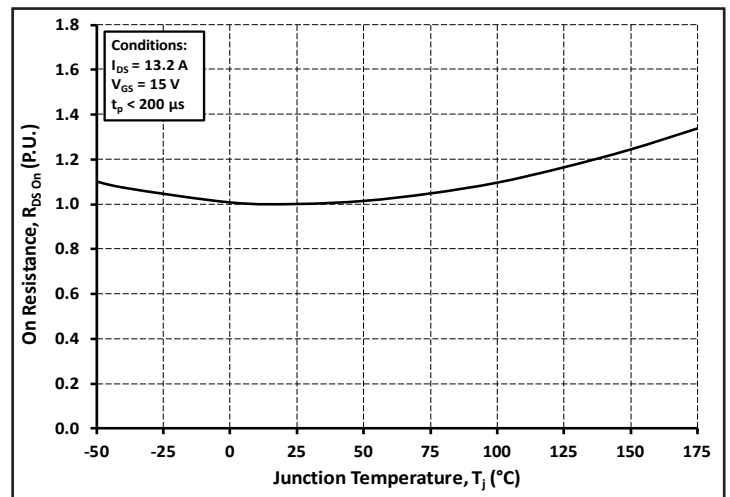


Figure 4. Normalized On-Resistance vs. Temperature

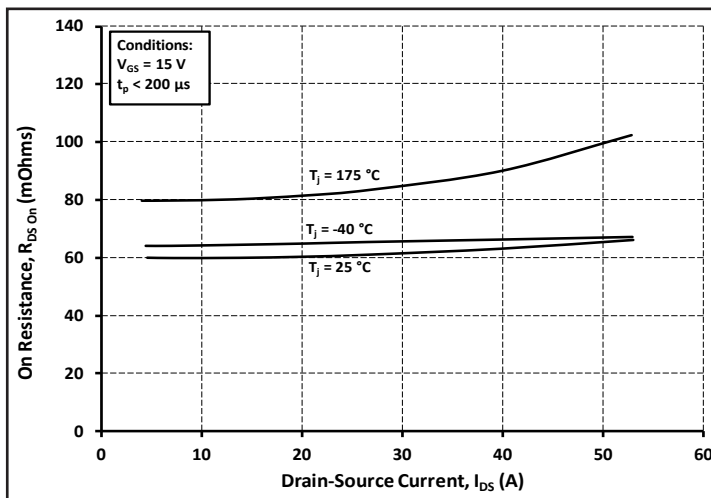


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

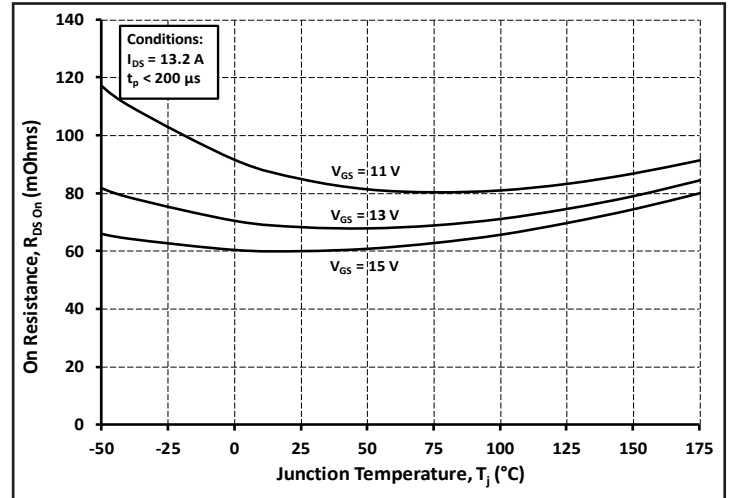


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage



MDDG2C065R060K3

650V N-Channel SiC Power MOSFET

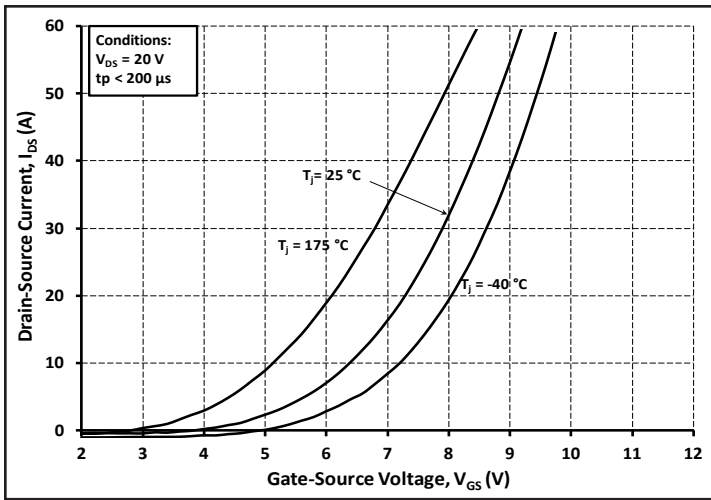


Figure 7. Transfer Characteristic for Various Junction Temperatures

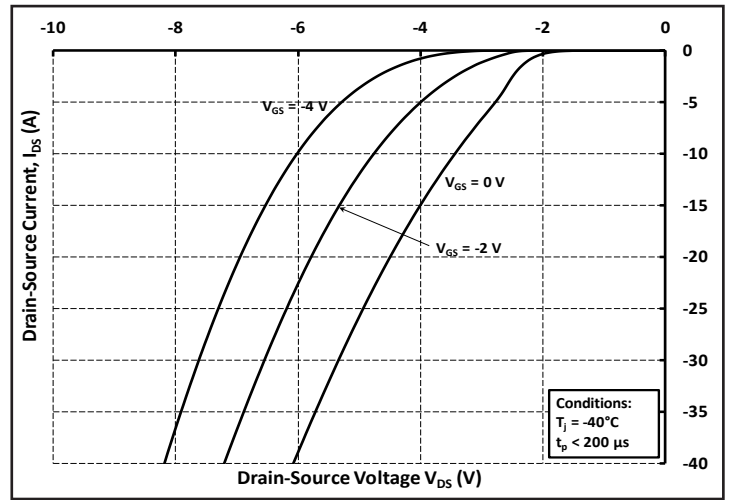


Figure 8. Body Diode Characteristic at -40 °C

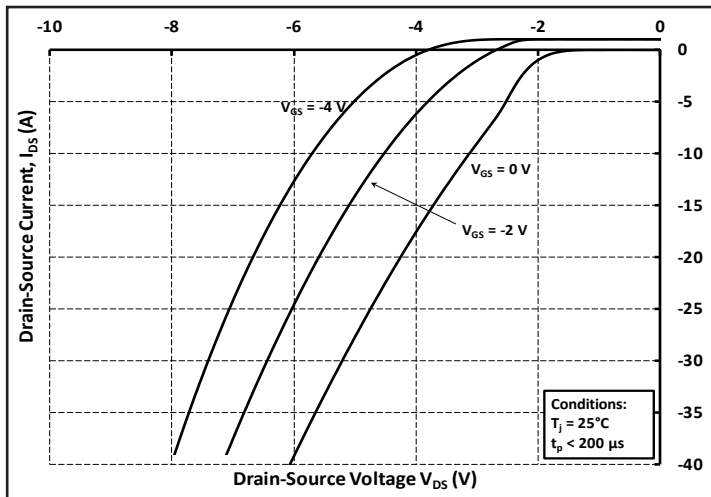


Figure 9. Body Diode Characteristic at 25 °C

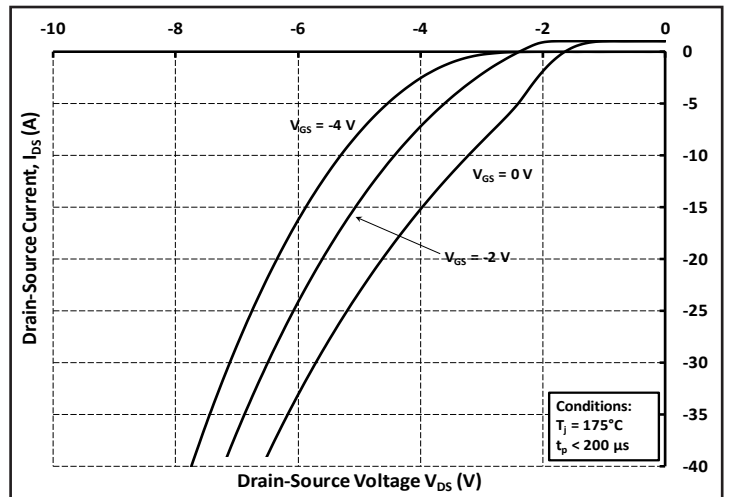


Figure 10. Body Diode Characteristic at 175 °C

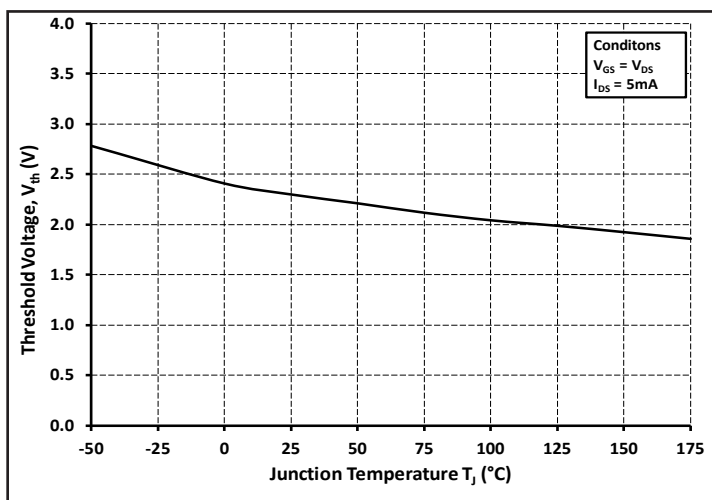


Figure 11. Threshold Voltage vs. Temperature

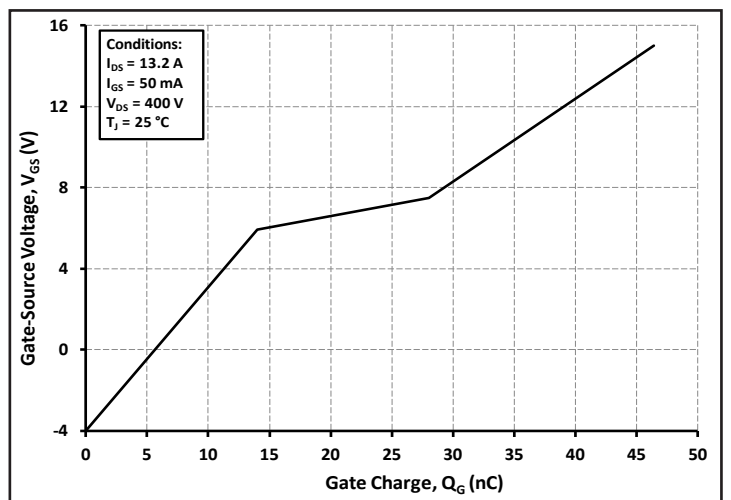


Figure 12. Gate Charge Characteristics



MDDG2C065R060K3

650V N-Channel SiC Power MOSFET

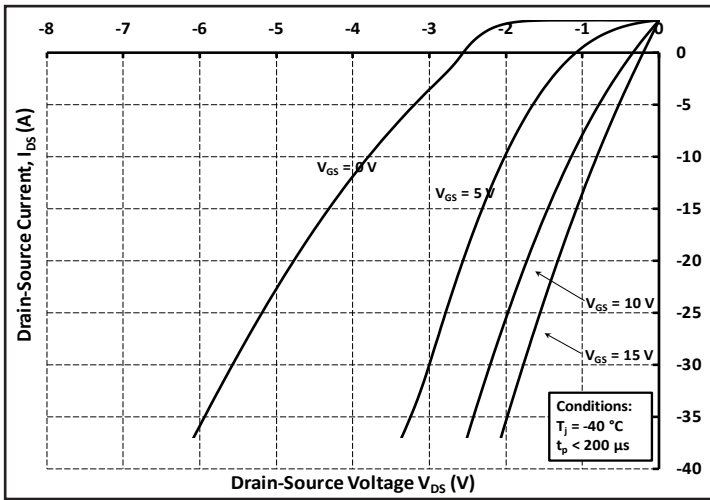


Figure 13. 3rd Quadrant Characteristic at -40 °C

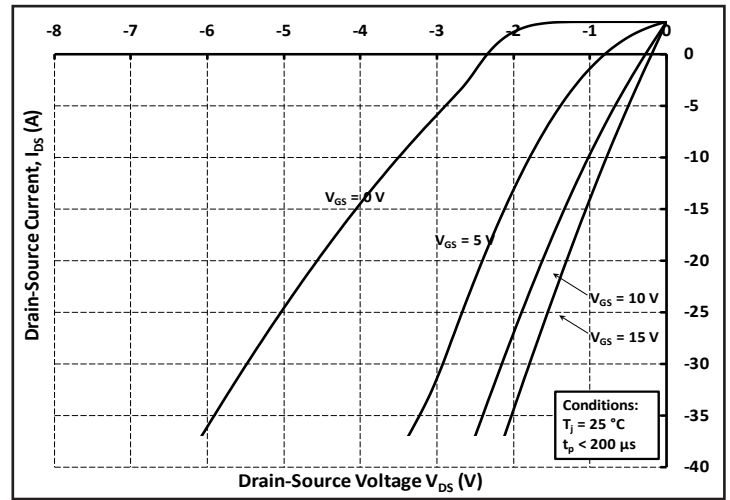


Figure 14. 3rd Quadrant Characteristic at 25 °C

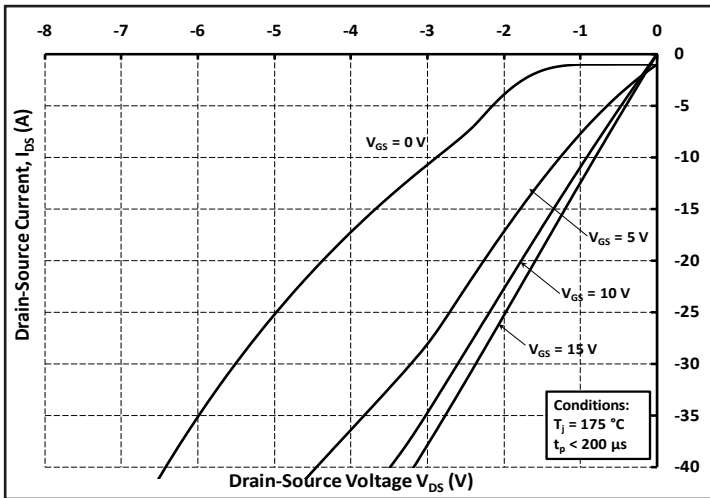


Figure 15. 3rd Quadrant Characteristic at 175 °C

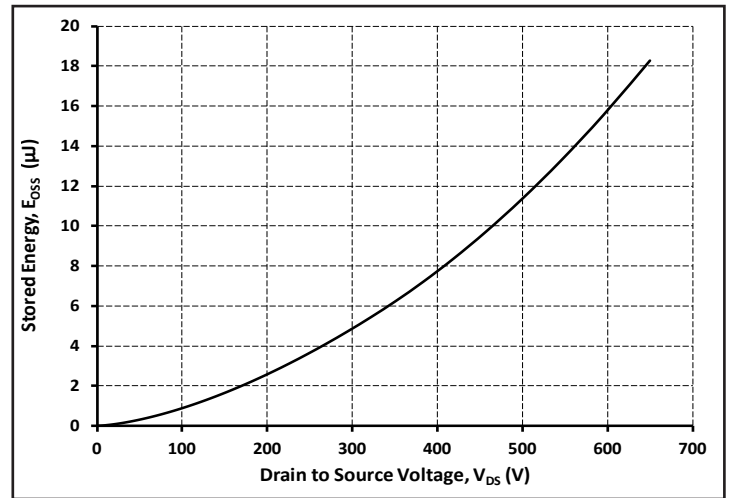


Figure 16. Output Capacitor Stored Energy

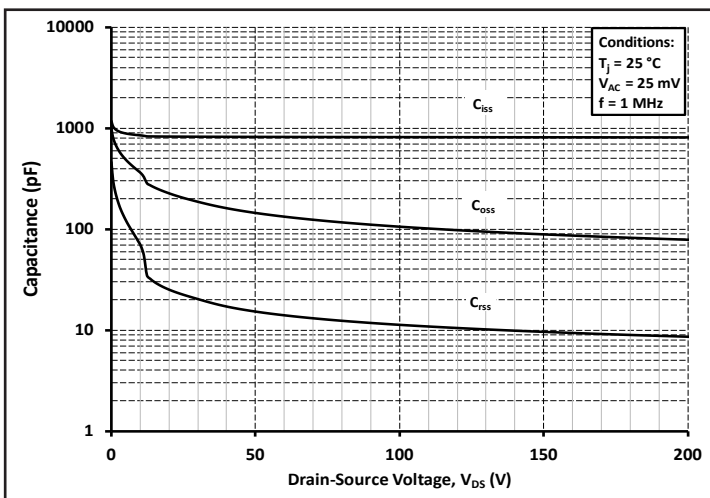


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

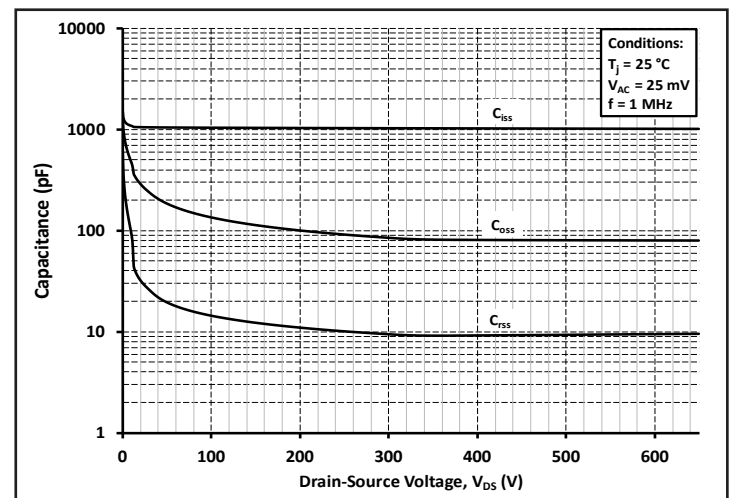


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)



MDDG2C065R060K3

650V N-Channel SiC Power MOSFET

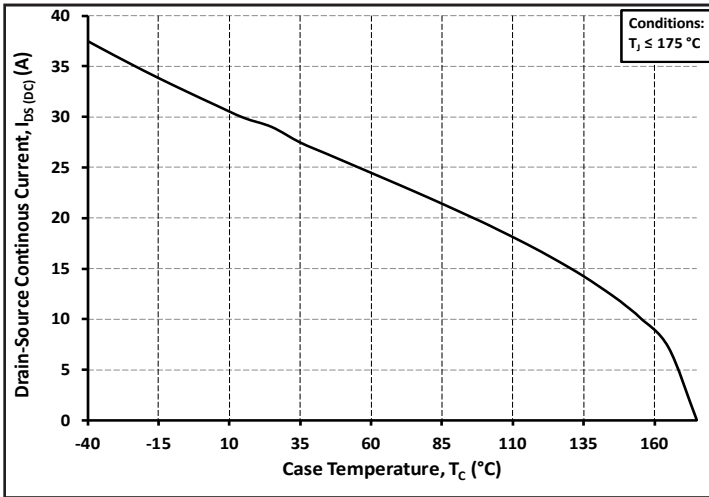


Figure 19. Continuous Drain Current Derating vs. Case Temperature

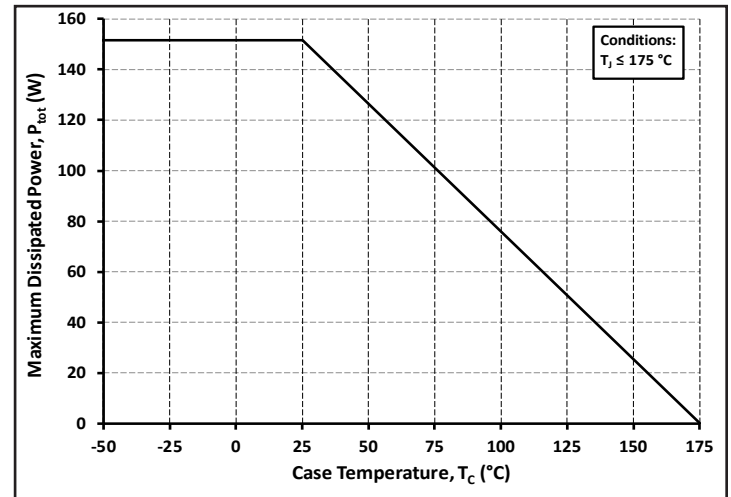


Figure 20. Maximum Power Dissipation Derating Vs Case Temperature

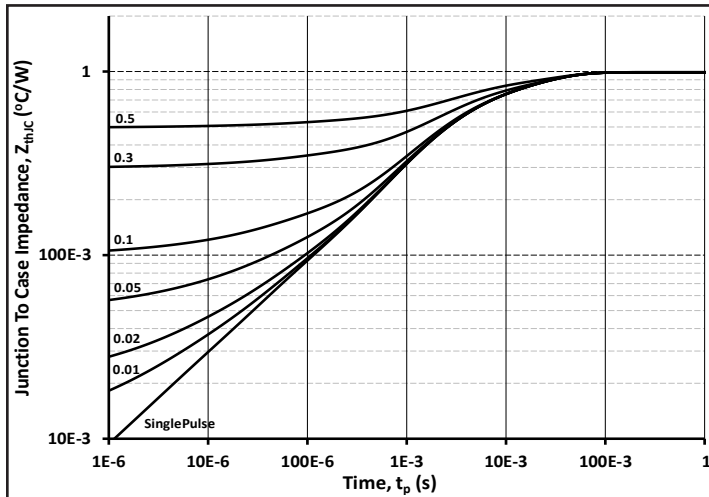


Figure 21. Transient Thermal Impedance (Junction - Case)

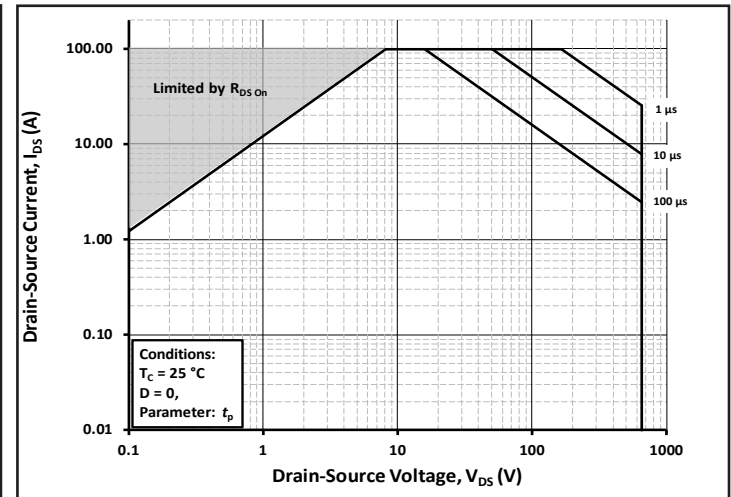


Figure 22. Safe Operating Area

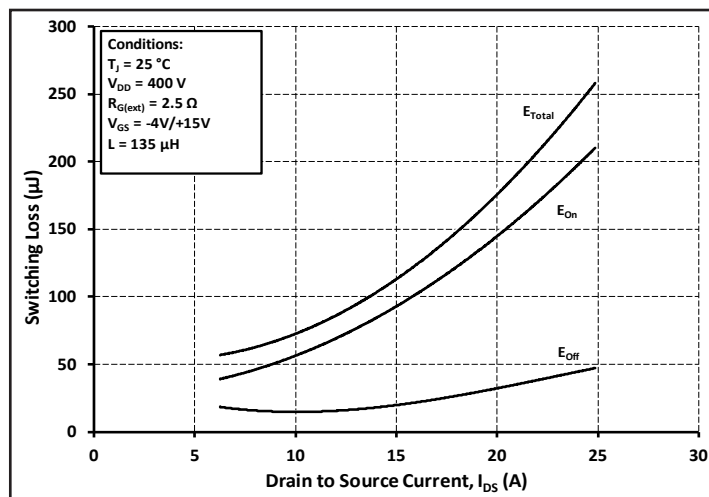


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 400V$)

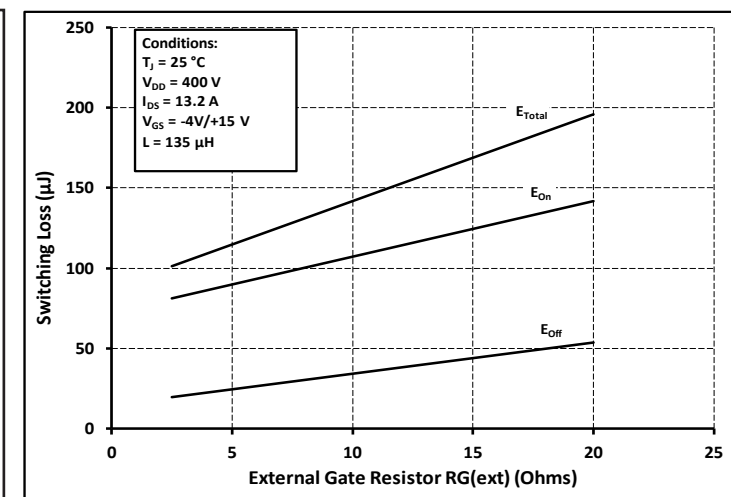


Figure 24. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

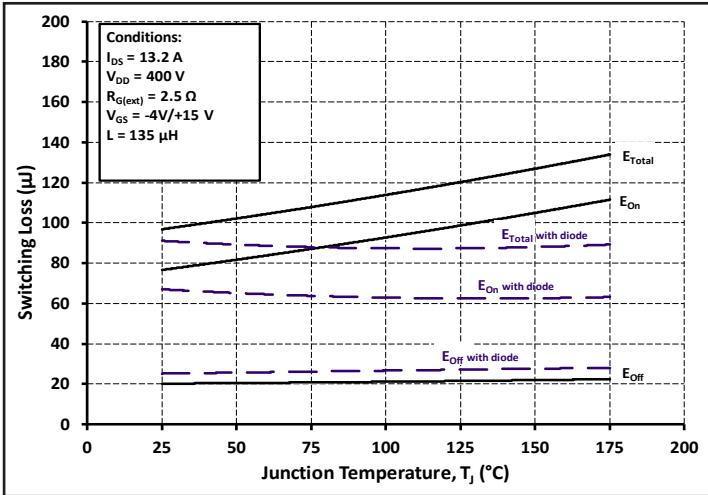


Figure 25. Clamped Inductive Switching Energy vs. Temperature

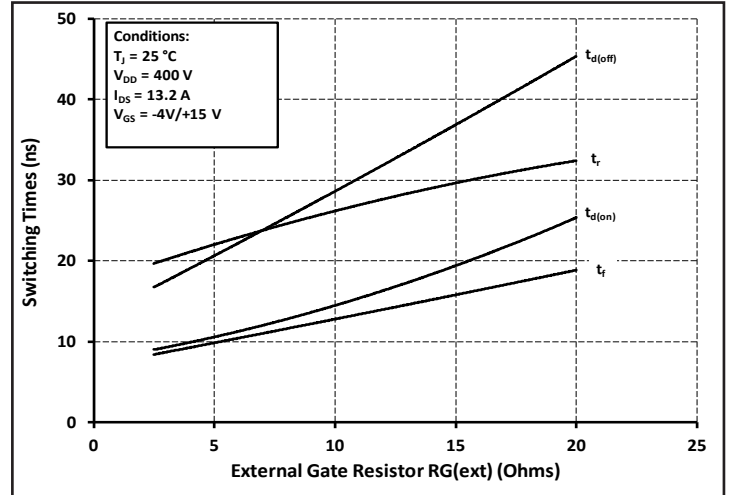


Figure 26. Switching Times vs. $R_{G(ext)}$

Test Circuit Schematic

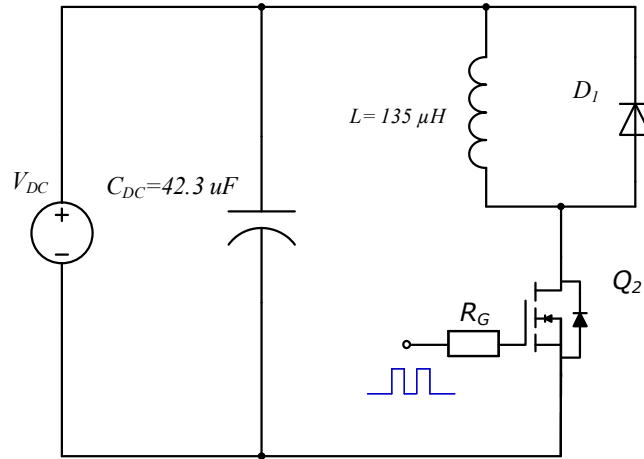


Figure 27. Clamped Inductive Switching Waveform Test Circuit

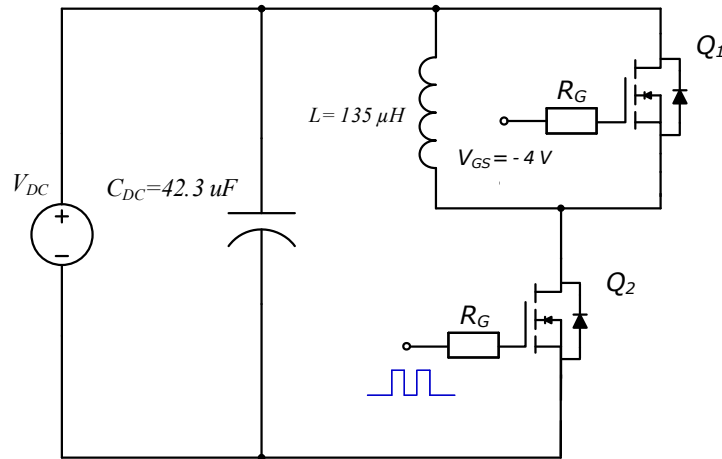


Figure 28. Body Diode Recovery Test Circuit

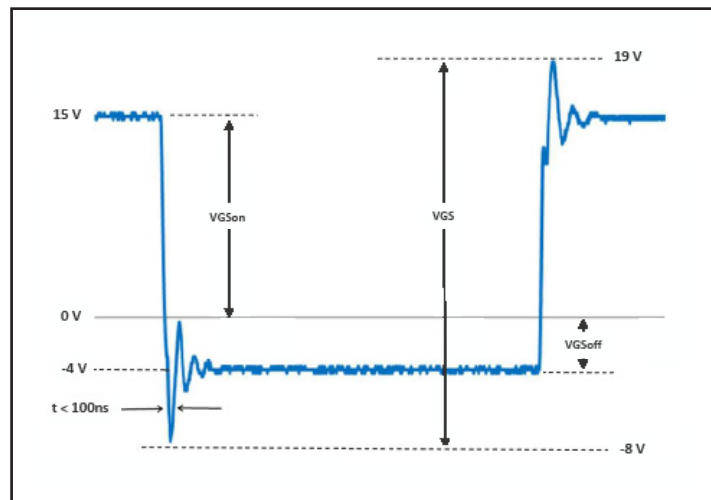


Figure 29. V_{GS} Waveform Example

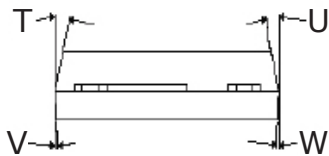
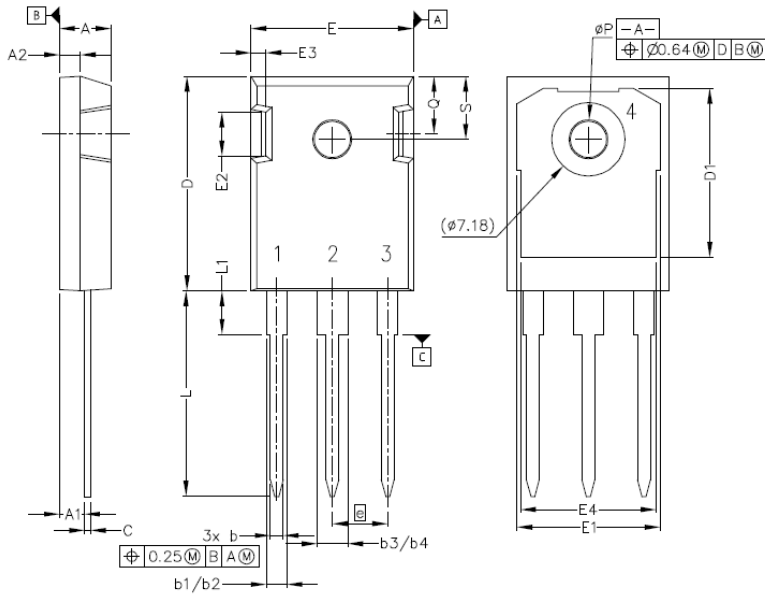


MDDG2C065R060K3

650V N-Channel SiC Power MOSFET

Package Dimensions

Package TO-247-3

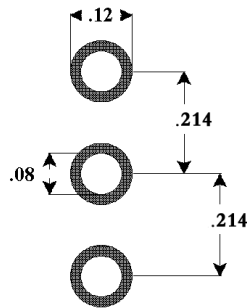


Pinout Information:

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

POS	Inches		Millimeters	
	Min	Max	Min	Max
A	.190	.205	4.83	5.21
A1	.090	.100	2.29	2.54
A2	.075	.085	1.91	2.16
b	.042	.052	1.07	1.33
b1	.075	.095	1.91	2.41
b2	.075	.085	1.91	2.16
b3	.113	.133	2.87	3.38
b4	.113	.123	2.87	3.13
c	.022	.027	0.55	0.68
D	.819	.831	20.80	21.10
D1	.640	.695	16.25	17.65
D2	.037	.049	0.95	1.25
E	.620	.635	15.75	16.13
E1	.516	.557	13.10	14.15
E2	.145	.201	3.68	5.10
E3	.039	.075	1.00	1.90
E4	.487	.529	12.38	13.43
e	.214 BSC		5.44 BSC	
N	3		3	
L	.780	.800	19.81	20.32
L1	.161	.173	4.10	4.40
ØP	.138	.144	3.51	3.65
Q	.216	.236	5.49	6.00
S	.238	.248	6.04	6.30
T	9°	11°	9°	11°
U	9°	11°	9°	11°
V	2°	8°	2°	8°
W	2°	8°	2°	8°

Recommended Solder Pad Layout



TO-247-3