CREE

C3M0120065J

Silicon Carbide Power MOSFET
C3M™ MOSFET Technology

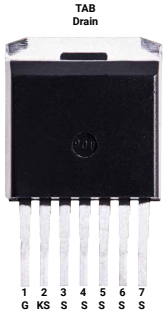
N-Channel Enhancement Mode

V_{DS}	650 V
$I_{D\ @\ 25^{\circ}C}$	21 A
$R_{DS(on)}$	120 mΩ

Features

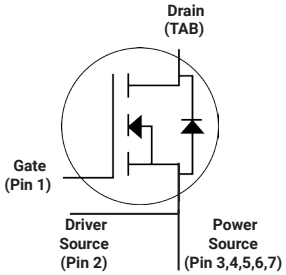
- 3rd Generation SiC MOSFET technology
- Low inductance package with driver source pin
- 7mm of creepage distance between drain and source
- High blocking voltage with low on-resistance
- High speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Qrr)
- Halogen free, RoHS compliant

Package



Halogen-Free

RoHS



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

- Solar inverters
- DC/DC converters
- Switch Mode Power Supplies
- EV battery chargers
- UPS

Part Number	Package	Marking
C3M0120065J	TO-263-7	C3M0120065J

Maximum Ratings

Symbol	Parameter	Value	Unit	Note
V_{DSS}	Drain - Source Voltage, T_C = 25 ˚C	650	V	
V_{GS}	Gate - Source voltage (Under transient events < 100 ns)	-8/+19	V	Fig. 28
I_D	Continuous Drain Current, V_{GS} = 15 V, T_C = 25˚C	21	A	Fig. 19
	Continuous Drain Current, V_{GS} = 15 V, T_C = 100˚C	15		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_P limited by T_{jmax}	51	A	
P_D	Power Dissipation, T_C=25˚C, T_J = 175 ˚C	86	W	Fig. 20
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	

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 = 1.86 mA	Fig. 11
			1.9		V	V_{DS} = V_{GS}, I_D = 1.86 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		120	157	mΩ	V_{GS} = 15 V, I_D = 6.76 A	Fig. 4, 5,6
			168			V_{GS} = 15 V, I_D = 6.76 A, T_J = 175ºC	
g_{fs}	Transconductance		5.0		S	V_{DS}= 20 V, I_{DS}= 6.76 A	Fig. 7
			4.9			V_{DS}= 20 V, I_{DS}= 6.76 A, T_J = 175ºC	
C_{iss}	Input Capacitance		640		pF	V_{GS} = 0 V, V_{DS} = 0V to 400 V F = 1 Mhz V_{AC} = 25 mV	Fig. 17, 18
C_{oss}	Output Capacitance		45				
C_{rss}	Reverse Transfer Capacitance		2.3				
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		57			V_{GS} = 0 V, V_{DS} = 0V to 400 V	Note: 1
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		79				Note: 1
E_{oss}	C_{oss} Stored Energy		4.3		µJ	V_{DS} = 400 V, F = 1 Mhz	Fig. 16
E_{ON}	Turn-On Switching Energy (Body Diode)		28		µJ	V_{DS} = 400 V, V_{GS} = -4 V/15 V, I_D = 6.76 A, $R_{G(ext)}$ = 10 Ω, L= 237 µH, T_J = 175ºC FWD = Internal Body Diode of MOSFET	Fig. 25
E_{OFF}	Turn Off Switching Energy (Body Diode)		6				
$t_{d(on)}$	Turn-On Delay Time		8		ns	V_{DD} = 400 V, V_{GS} = -4 V/15 V I_D = 6.76 A, $R_{G(ext)}$ = 10 Ω Timing relative to V_{DS} Inductive load	Fig. 26
t_r	Rise Time		9				
$t_{d(off)}$	Turn-Off Delay Time		18				
t_f	Fall Time		9				
$R_{G(int)}$	Internal Gate Resistance		6		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{gs}	Gate to Source Charge		8		nC	V_{DS} = 400 V, V_{GS} = -4 V/15 V I_D = 6.76 A Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		7				
Q_g	Total Gate Charge		26				

Note (1): $C_{o(er)}$, 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	4.5		V	V_{GS} = -4 V, I_{SD} = 3.4 A, T_J = 25 °C	Fig. 8, 9, 10
		4.0		V	V_{GS} = -4 V, I_{SD} = 3.4 A, T_J = 175 °C	
I_S	Continuous Diode Forward Current		15	A	V_{GS} = -4 V, T_C = 25˚C	
$I_{S,\ pulse}$	Diode pulse Current		51	A	V_{GS} = -4 V, pulse width t_P limited by T_{jmax}	
t_{rr}	Reverse Recover time	8		ns	V_{GS} = -4 V, I_{SD} = 6.76 A, V_R = 400 V dif/dt = 5470 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	78		nC		
I_{rrm}	Peak Reverse Recovery Current	16		A		
t_{rr}	Reverse Recover time	9		ns	V_{GS} = -4 V, I_{SD} = 6.76 A, V_R = 400 V dif/dt = 3650 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	41		nC		
I_{rrm}	Peak Reverse Recovery Current	7		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	1.73	°C/W		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			

Typical Performance

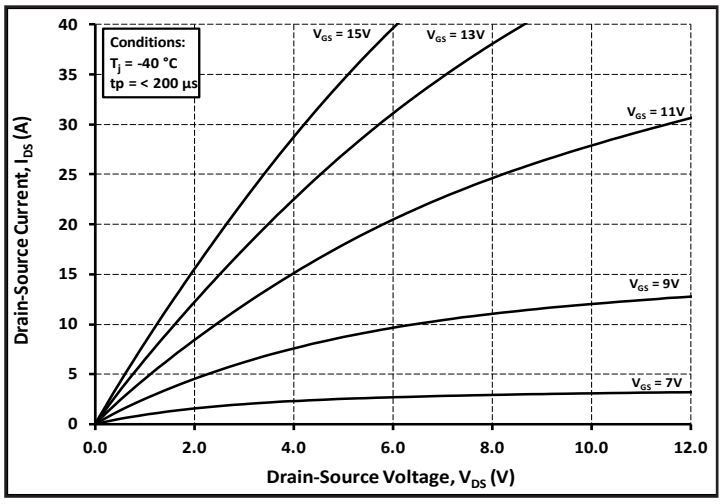


Figure 1. Output Characteristics T_J = -40 ºC

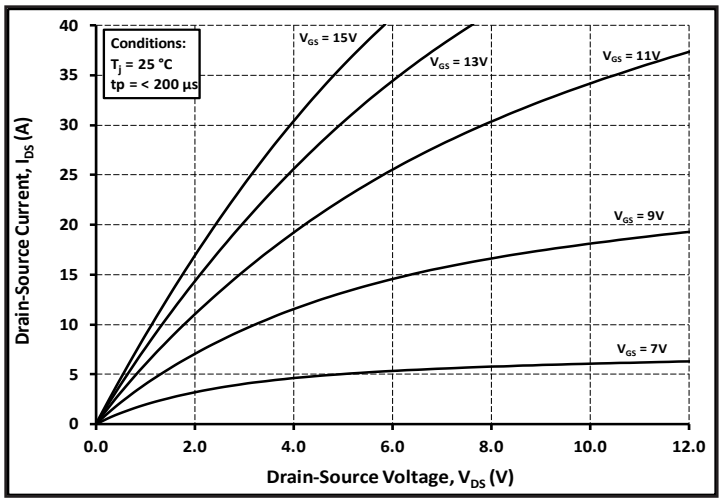


Figure 2. Output Characteristics T_J = 25 ºC

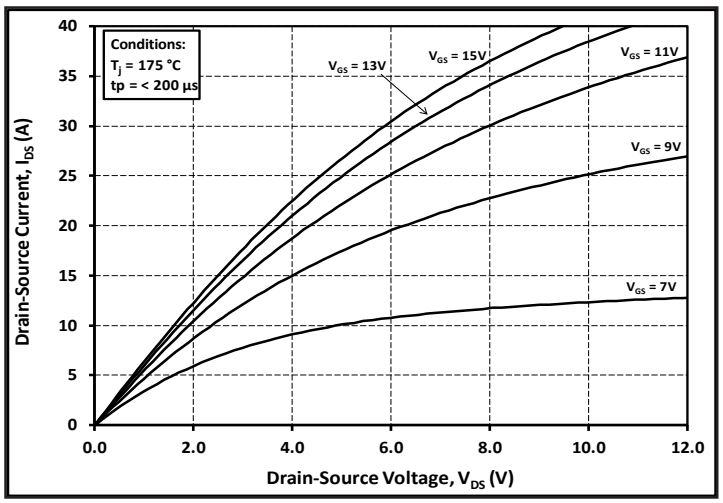


Figure 3. Output Characteristics T_J = 175 ºC

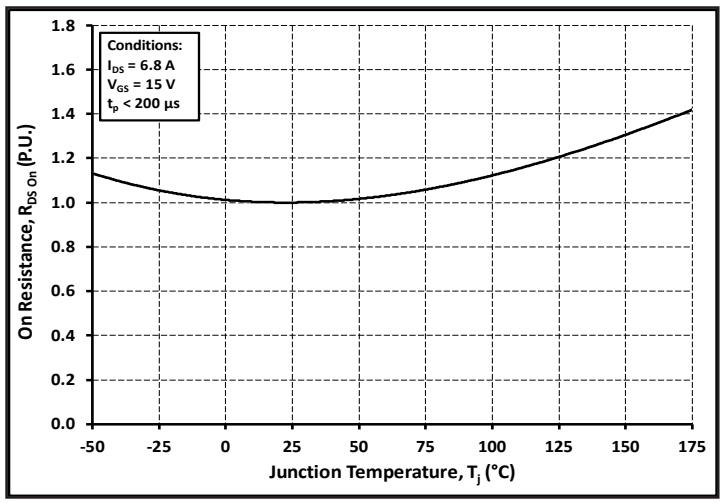


Figure 4. Normalized On-Resistance vs. Temperature

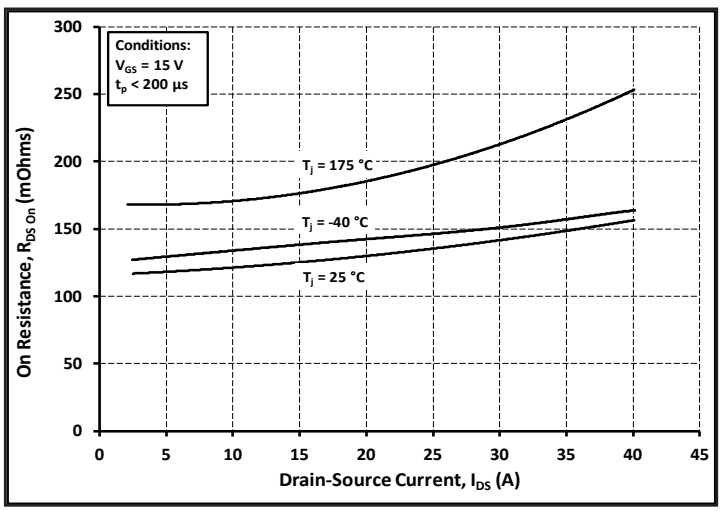


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

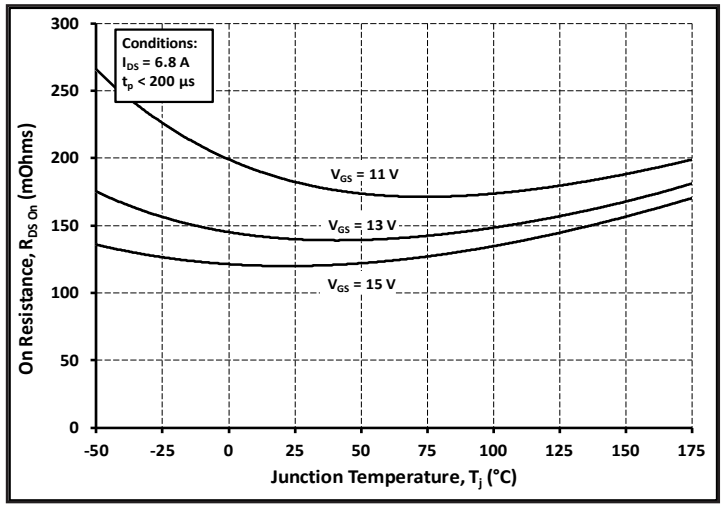


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

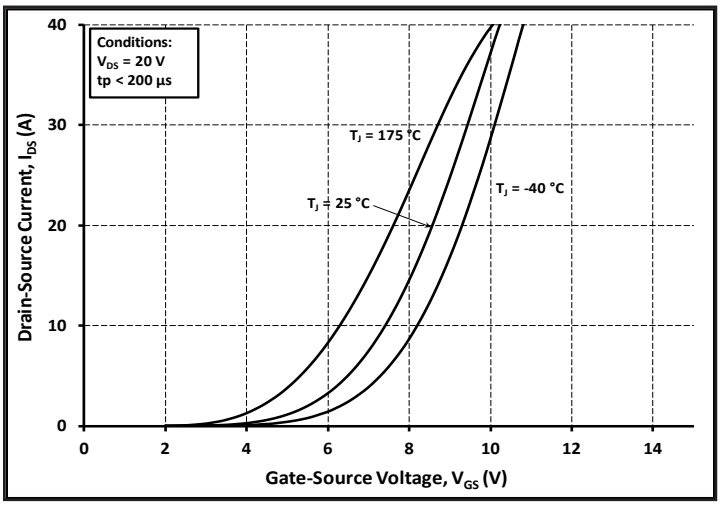


Figure 7. Transfer Characteristic for Various Junction Temperatures

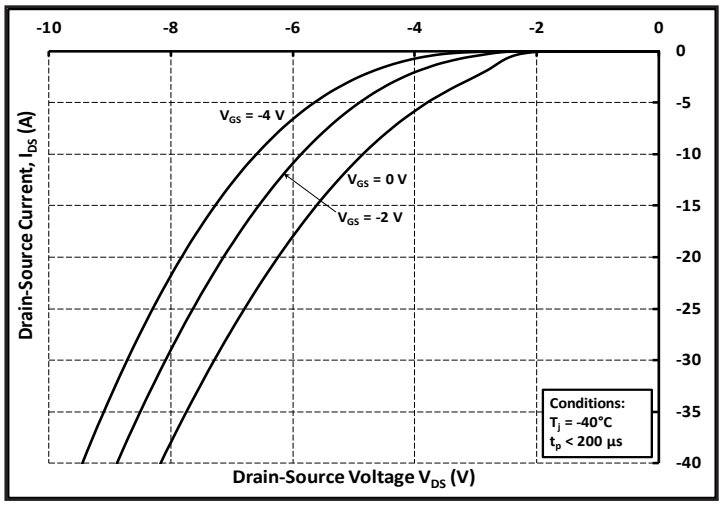


Figure 8. Body Diode Characteristic at -40 °C

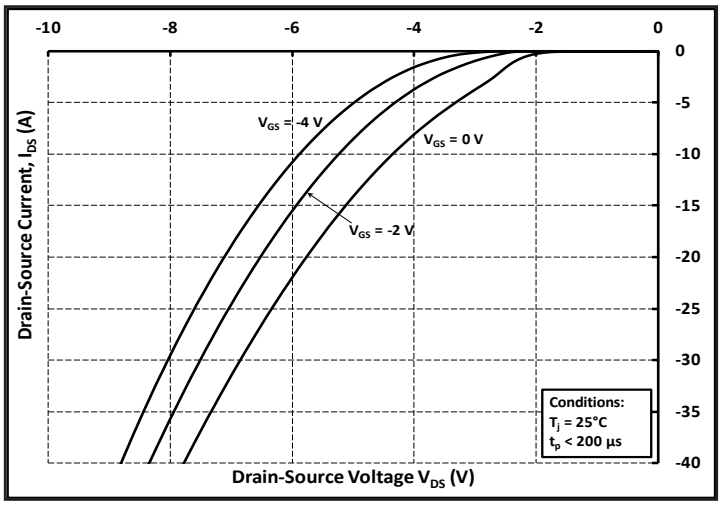


Figure 9. Body Diode Characteristic at 25 °C

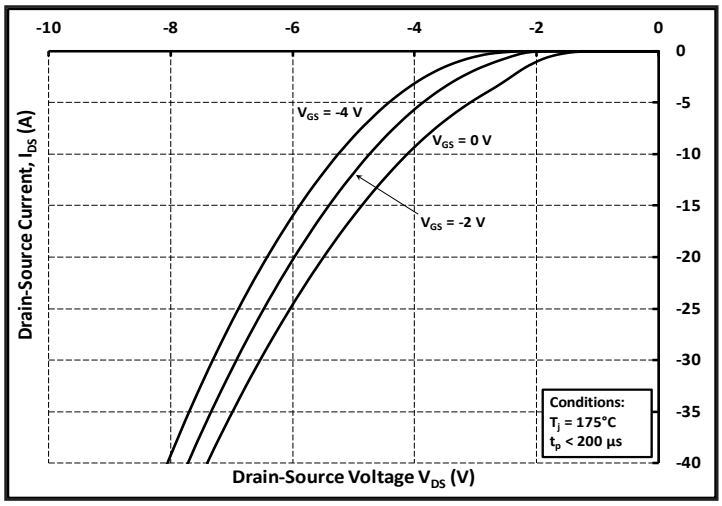


Figure 10. Body Diode Characteristic at 175 °C

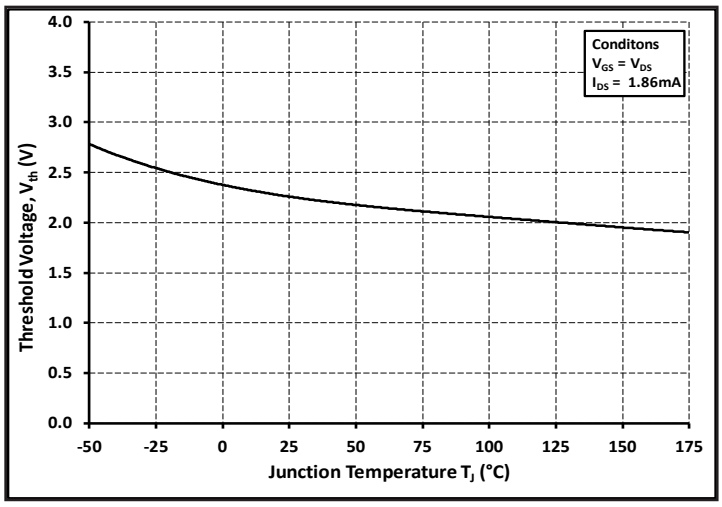


Figure 11. Threshold Voltage vs. Temperature

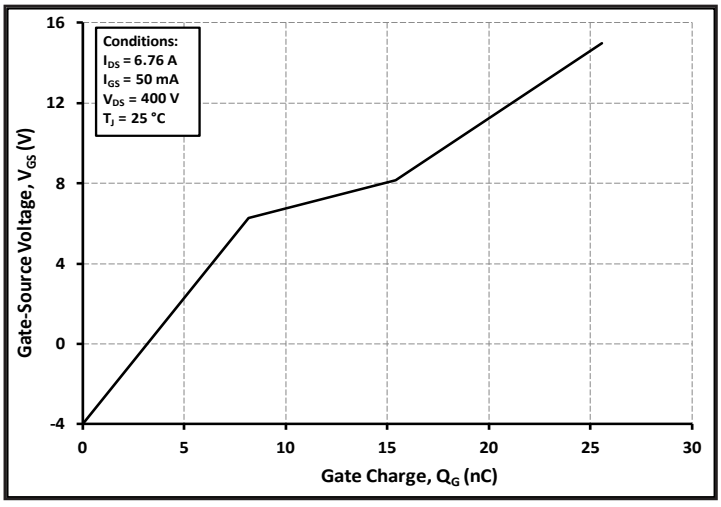


Figure 12. Gate Charge Characteristics

Typical Performance

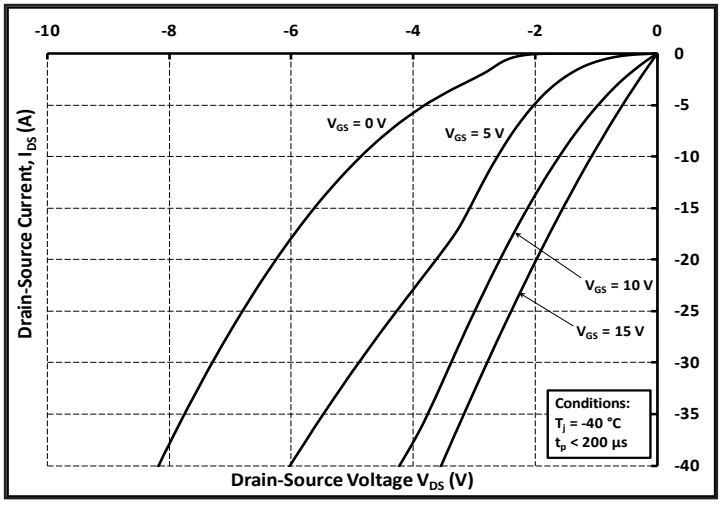


Figure 13. 3rd Quadrant Characteristic at -40 °C

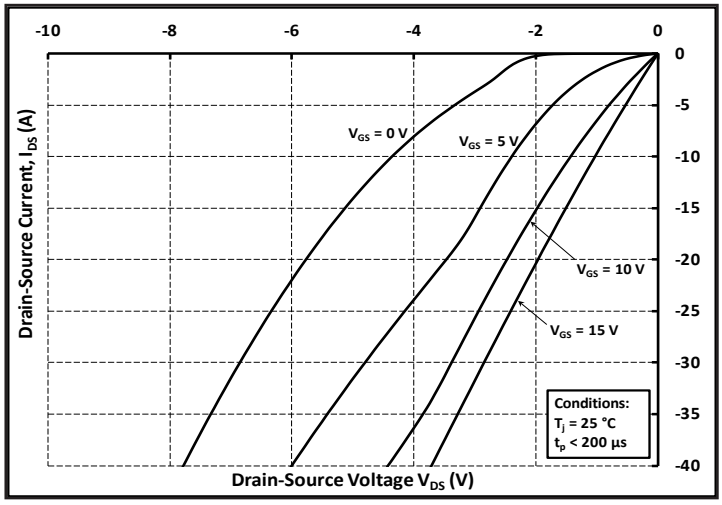


Figure 14. 3rd Quadrant Characteristic at 25 °C

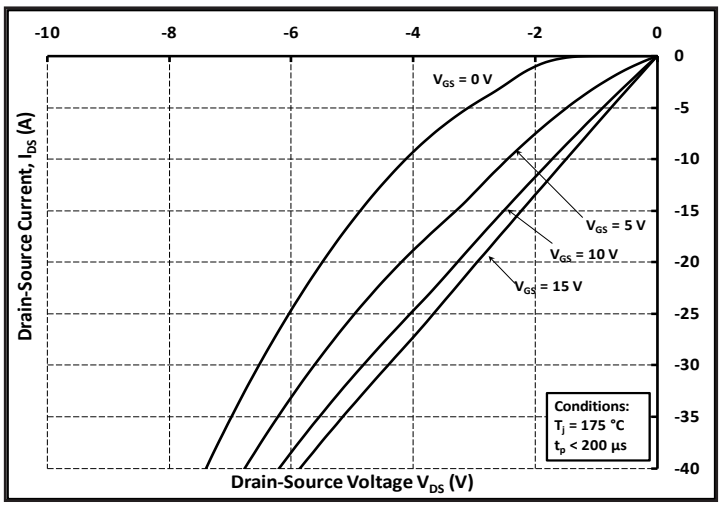


Figure 15. 3rd Quadrant Characteristic at 175 °C

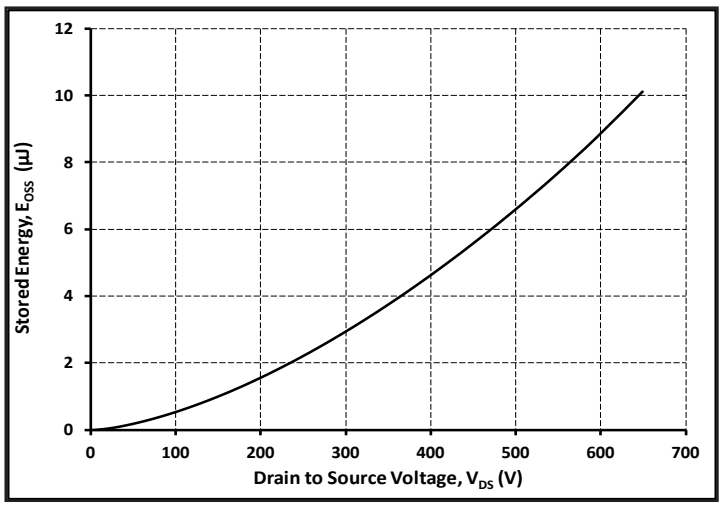


Figure 16. Output Capacitor Stored Energy

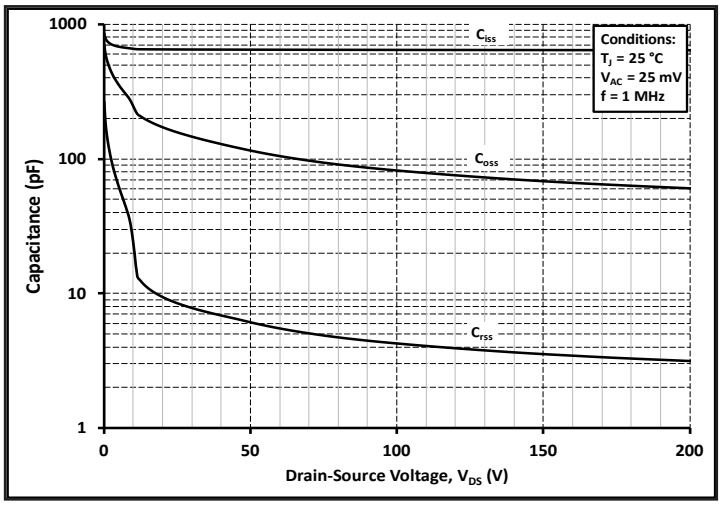


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

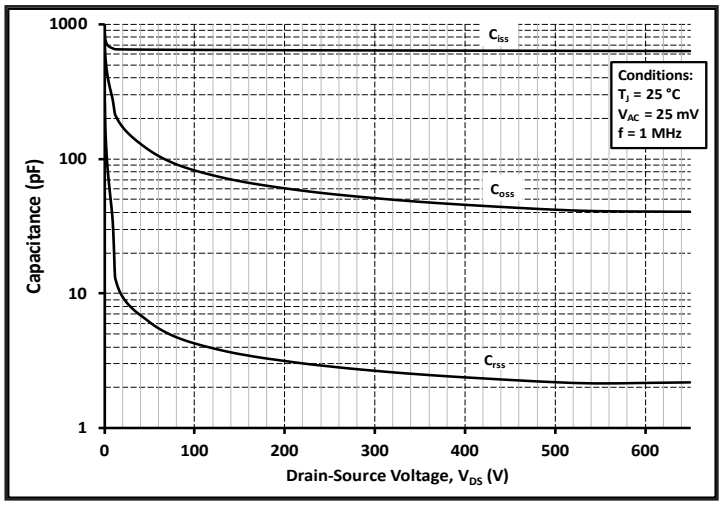


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)

Typical Performance

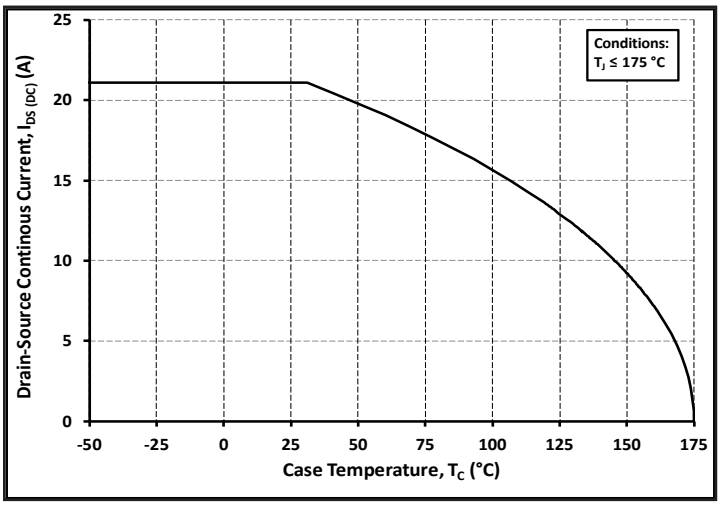


Figure 19. Continuous Drain Current Derating vs. Case Temperature

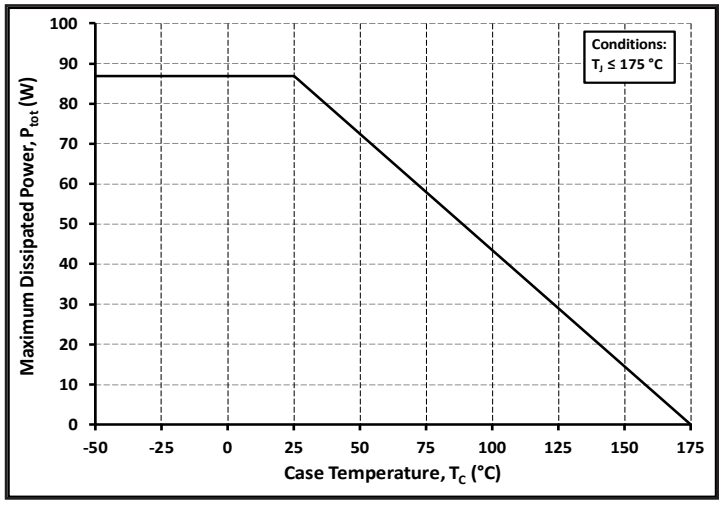


Figure 20. Maximum Power Dissipation Derating Vs Case Temperature

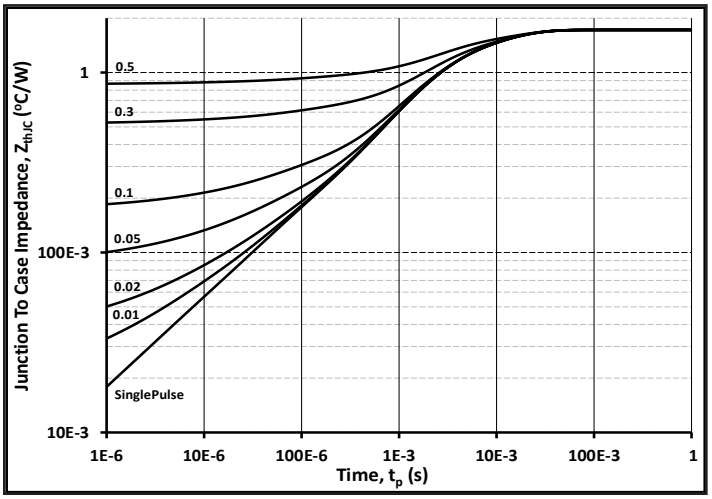


Figure 21. Transient Thermal Impedance (Junction - Case)

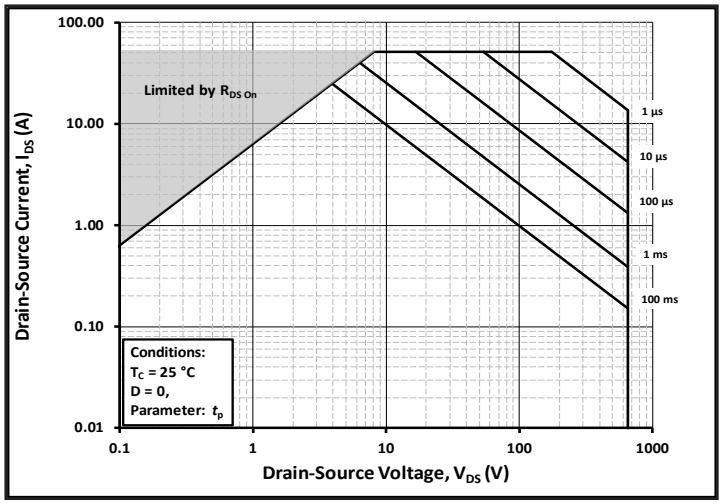


Figure 22. Safe Operating Area

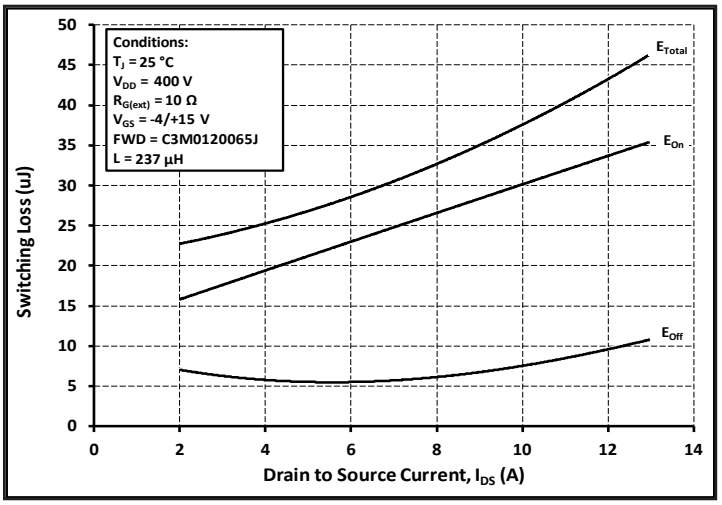


Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 400V)

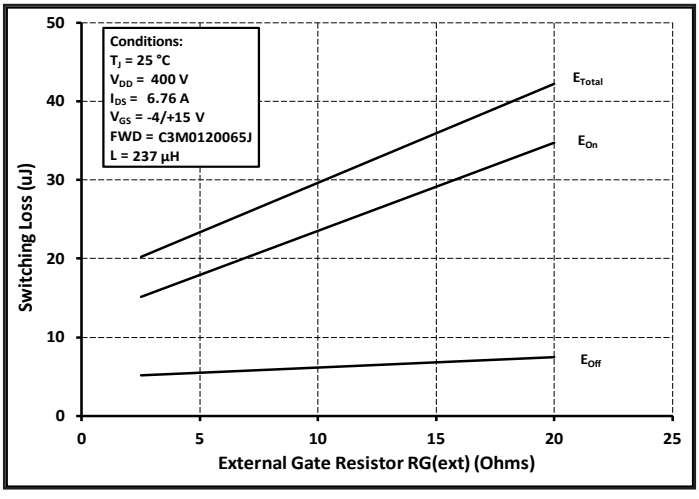


Figure 24. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

Typical Performance

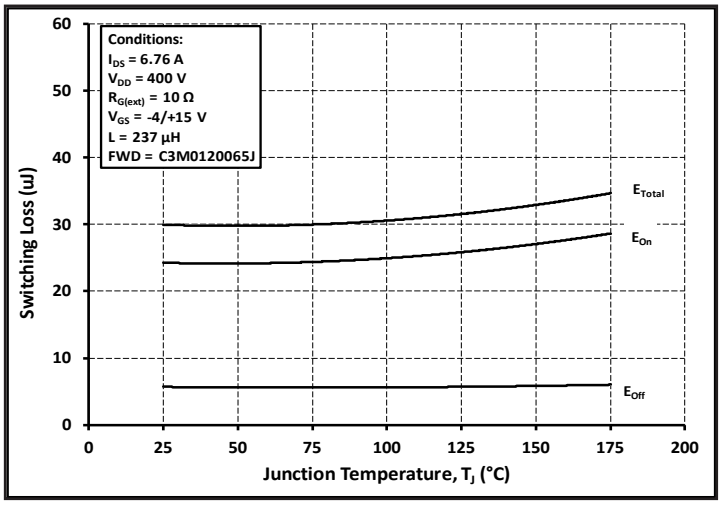


Figure 25. Clamped Inductive Switching Energy vs. Temperature

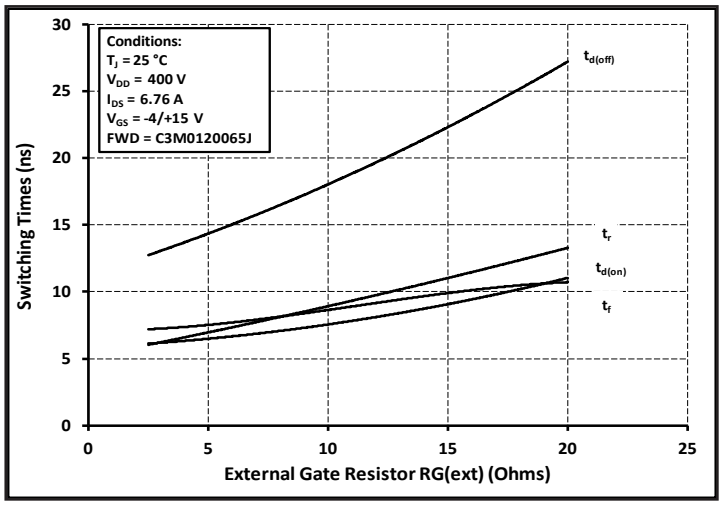


Figure 26. Switching Times vs. $R_{G(ext)}$

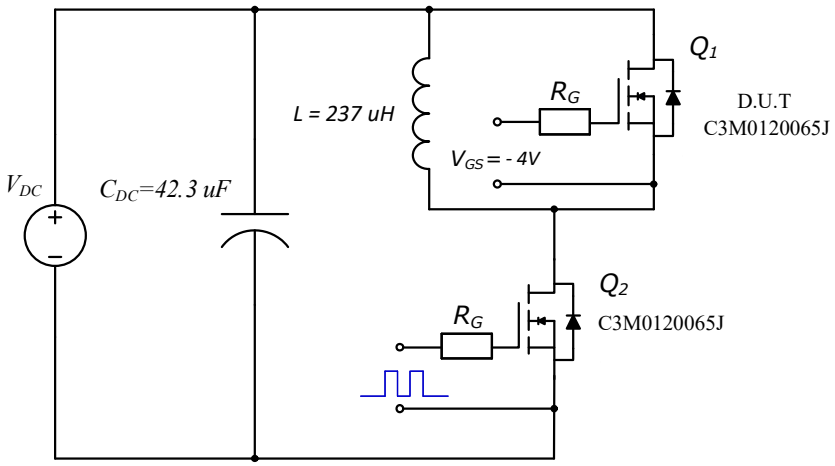


Figure 27. Clamped Inductive Switching Waveform Test Circuit

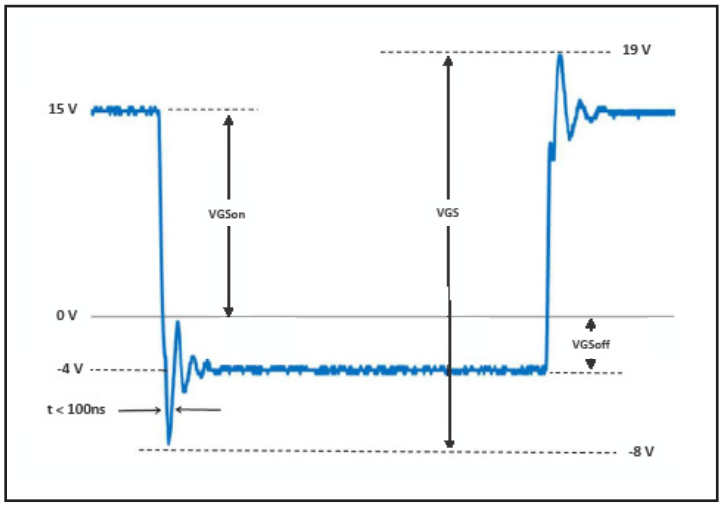
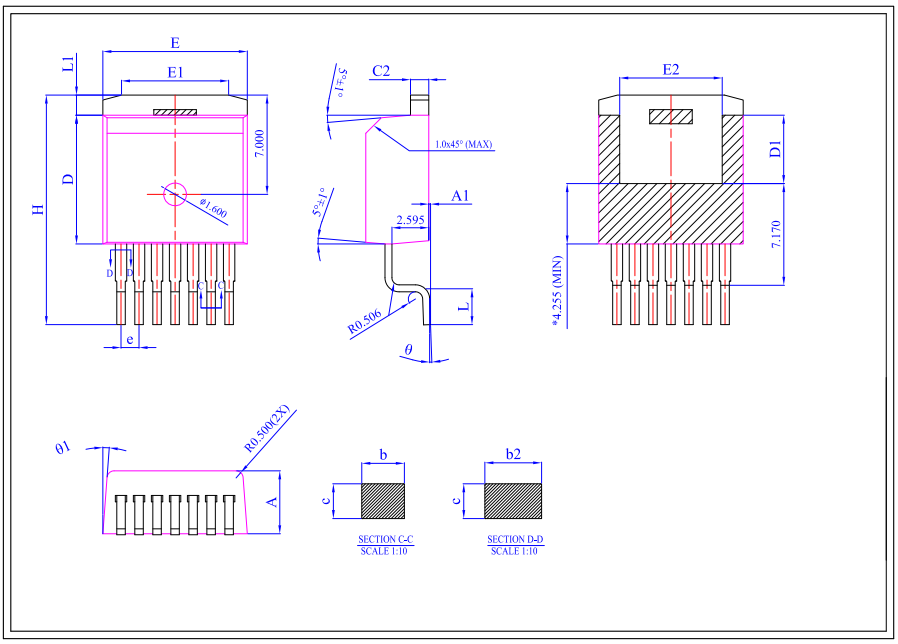


Figure 28. V_{GS} Waveform Example

Package Dimensions

Package 7L D2PAK



Dim	All Dimensions in Millimeters		
	Min	typ	Max
A	4.300	4.435	4.570
A1	0.00	0.125	0.25
b	0.500	0.600	0.700
b2	0.600	0.800	1.000
c	0.330	0.490	0.650
C2	1.170	1.285	1.400
D	9.025	9.075	9.125
D1	4.700	4.800	4.900
E	10.130	10.180	10.230
E1	6.500	7.550	8.600
E2	6.778	7.223	7.665
e		1.27	
H	15.043	16.178	17.313
L	2.324	2.512	2.700
L1	0.968	1.418	1.868
Ø	0°	4°	8°
Ø1	4.5°	5°	5.5°