CREE

C3M0025065K

V_{DS}	650 V
I_{D} @ 25°C	97 A
$R_{DS(on)}$	25 mΩ

Silicon Carbide Power MOSFET
C3M™ MOSFET Technology
N-Channel Enhancement Mode

Features

- C3M™ 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})
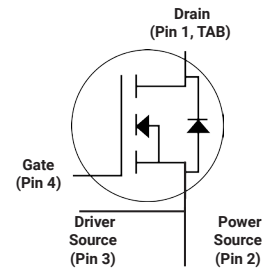- Halogen free, RoHS compliant

Benefits

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

Applications

- EV chargers
- UPS
- Solar inverters
- Industrial SMPS
- DC/DC converters

Package

Tab Drain

1 D 2 S 3 S 4 G

Halogen-Free

RoHS

Drain (Pin 1, TAB)

Gate (Pin 4)

Driver Source (Pin 3)

Power Source (Pin 2)

Part Number	Package	Marking
C3M0025065K	TO 247-4	C3M0025065K

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. 29
I_D	Continuous Drain Current, V_{GS} = 15 V, T_C = 25°C	97	A	Fig. 19
	Continuous Drain Current, V_{GS} = 15 V, T_C = 100°C	70		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_P limited by T_{jmax}	251	A	
P_D	Power Dissipation, T_C=25°C, T_J = 175 °C	326	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	
M_d	Mounting Torque, (M3 or 6-32 screw)	1 / 8.8	Nm / lbf-in	

CREE

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$_D$ = 9.22 mA	Fig. 11
			1.9		V	V$_{DS}$ = V$_{GS}$, I$_D$ = 9.22 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		25	34	mΩ	V$_{GS}$ = 15 V, I$_D$ = 33.5 A	Fig. 4, 5,6
			33			V$_{GS}$ = 15 V, I$_D$ = 33.5 A, T$_J$ = 175ºC	
g$_{fs}$	Transconductance		25		S	V$_{DS}$= 20 V, I$_{DS}$= 33.5 A	Fig. 7
			24			V$_{DS}$= 20 V, I$_{DS}$= 33.5 A, T$_J$ = 175ºC	
C$_{iss}$	Input Capacitance		2980		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		178				
C$_{rss}$	Reverse Transfer Capacitance		12				
C$_{o(er)}$	Effective Output Capacitance (Energy Related)		236			V$_{GS}$ = 0 V, V$_{DS}$ = 0V to 400 V	Note: 1
C$_{o(tr)}$	Effective Output Capacitance (Time Related)		340				Note: 1
E$_{oss}$	C$_{oss}$ Stored Energy		37		µJ	V$_{DS}$ = 600 V, F = 1 Mhz	Fig. 16
E$_{ON}$	Turn-On Switching Energy (Body Diode)		121		µJ	V$_{DS}$ = 400 V, V$_{GS}$ = -4 V/15 V, I$_D$ = 33.5 A, R$_{G(ext)}$ = 2.5 Ω, L= 59 µH, T$_J$ = 175ºC FWD = Internal Body Diode of MOSFET	Fig. 25
E$_{OFF}$	Turn Off Switching Energy (Body Diode)		53				
E$_{ON}$	Turn-On Switching Energy (External Diode)		73		µJ	V$_{DS}$ = 400 V, V$_{GS}$ = -4 V/15 V, I$_D$ = 33.5 A, R$_{G(ext)}$ = 2.5 Ω, L= 59 µH, T$_J$ = 175ºC FWD = External SiC DIODE	Fig. 25
E$_{OFF}$	Turn Off Switching Energy (External Diode)		82				
t$_{d(on)}$	Turn-On Delay Time		12		ns	V$_{DD}$ = 400 V, V$_{GS}$ = -4 V/15 V I$_D$ = 33.5 A, R$_{G(ext)}$ = 2.5 Ω Timing relative to V$_{DS}$ Inductive load	Fig. 26
t$_r$	Rise Time		18				
t$_{d(off)}$	Turn-Off Delay Time		25				
t$_f$	Fall Time		8				
R$_{G(int)}$	Internal Gate Resistance		1.3		Ω	f = 1 MHz, V$_{AC}$ = 25 mV	
Q$_{gs}$	Gate to Source Charge		34		nC	V$_{DS}$ = 400 V, V$_{GS}$ = -4 V/15 V I$_D$ = 33.5 A Per IEC60747-8-4 pg 21	Fig. 12
Q$_{gd}$	Gate to Drain Charge		33				
Q$_g$	Total Gate Charge		112				

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	5.0		V	V_{GS} = -4 V, I_{SD} = 16.8 A, T_J = 25 °C	Fig. 8, 9, 10
		4.5		V	V_{GS} = -4 V, I_{SD} = 16.8 A, T_J = 175 °C	
I_S	Continuous Diode Forward Current		52	A	V_{GS} = -4 V, T_C = 25˚C	
$I_{S, pulse}$	Diode pulse Current		251	A	V_{GS} = -4 V, pulse width t_P limited by T_{jmax}	
t_{rr}	Reverse Recover time	16		ns	V_{GS} = -4 V, I_{SD} = 33.5 A, V_R = 400 V dif/dt = 5560 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	453		nC		
I_{rrm}	Peak Reverse Recovery Current	54		A		
t_{rr}	Reverse Recover time	22		ns	V_{GS} = -4 V, I_{SD} = 33.5 A, V_R = 400 V dif/dt = 1575 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	293		nC		
I_{rrm}	Peak Reverse Recovery Current	22		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.46	°C/W		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			

Typical Performance
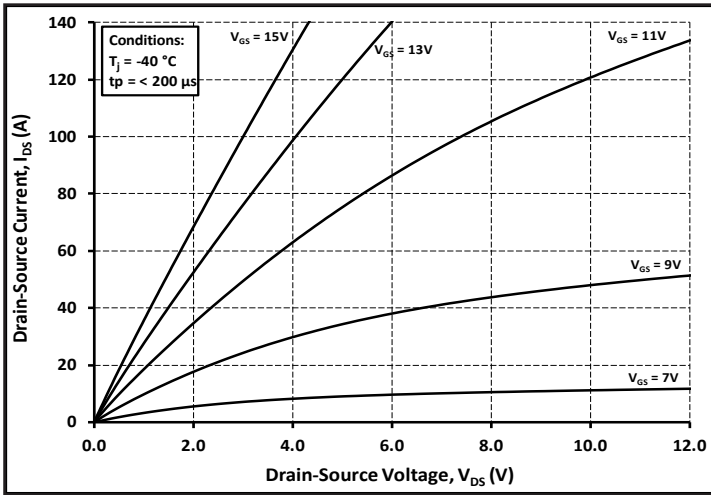
Figure 1. Output Characteristics T$_J$ = -40 °C
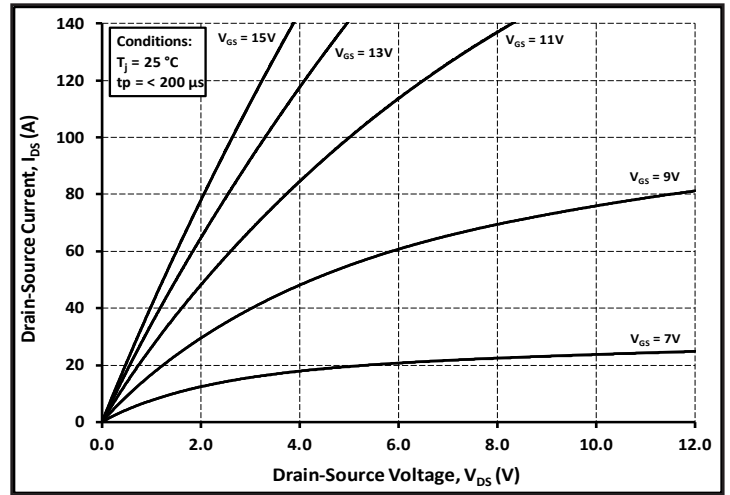
Figure 2. Output Characteristics T$_J$ = 25 °C
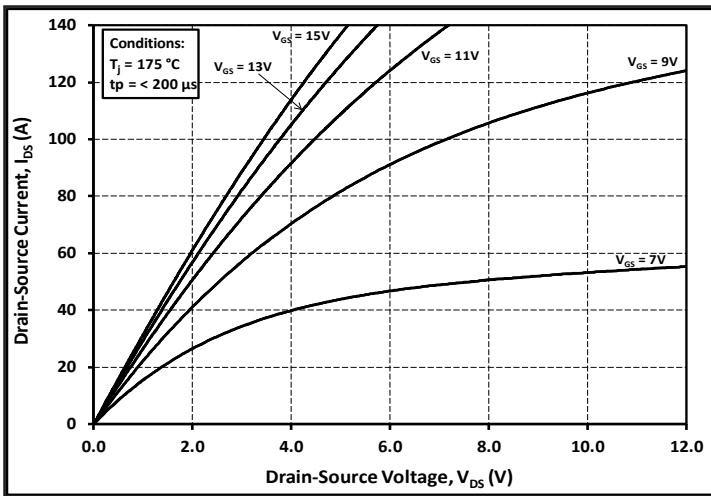
Figure 3. Output Characteristics T$_J$ = 175 °C
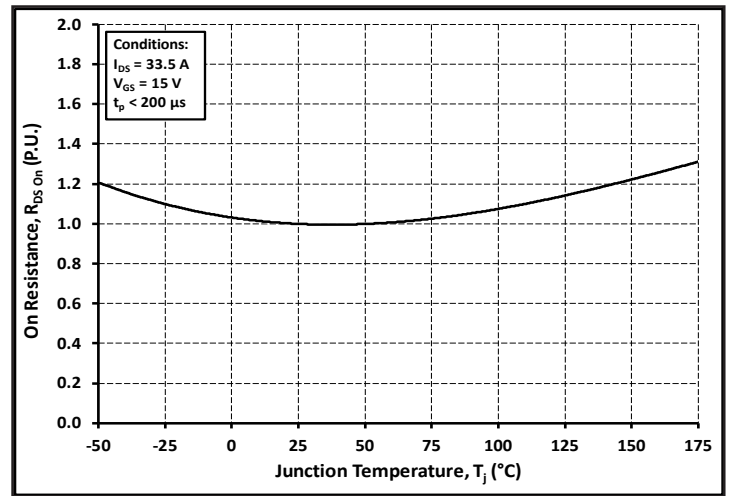
Figure 4. Normalized On-Resistance vs. Temperature
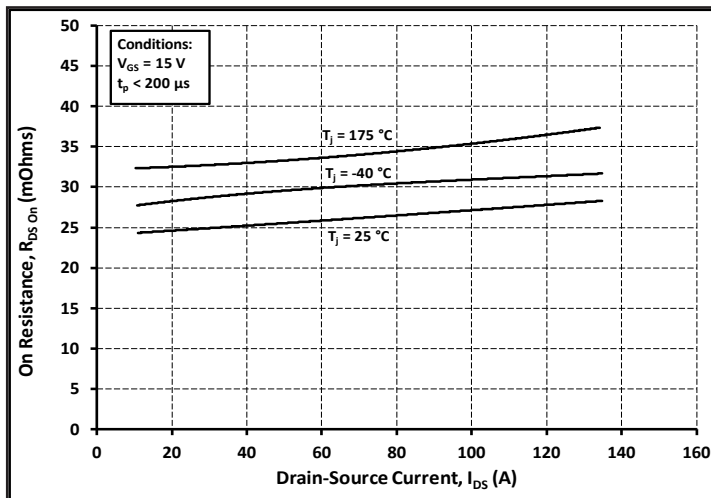
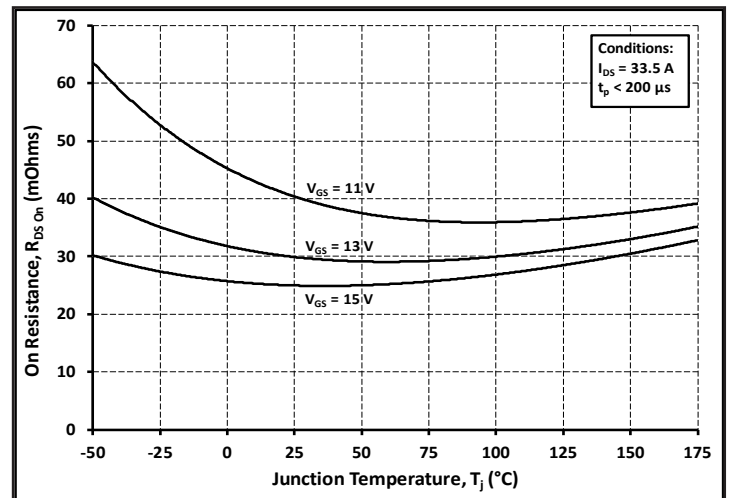Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

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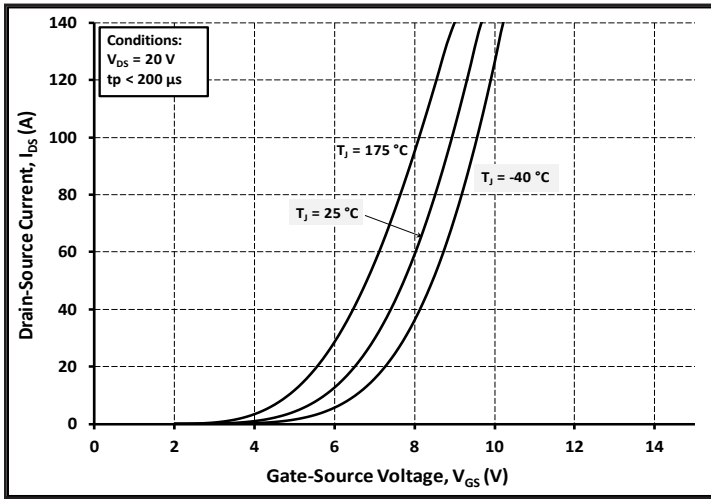For Various Gate Voltage

Typical Performance

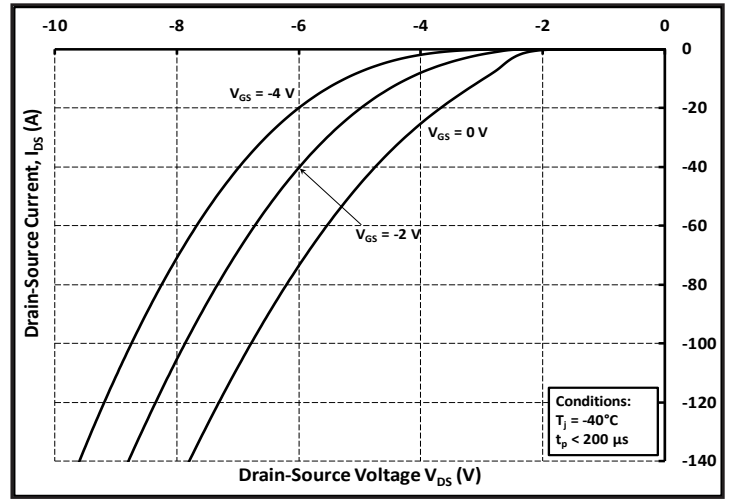Figure 7. Transfer Characteristic for
Various Junction Temperatures

Figure 8. Body Diode Characteristic at -40 ºC
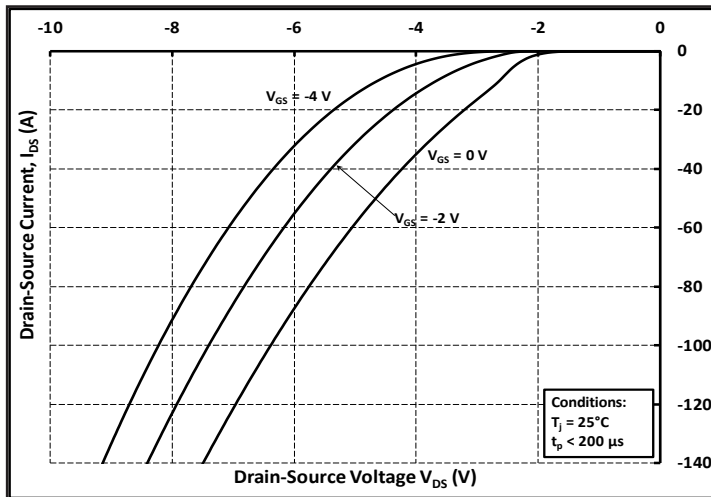
Figure 9. Body Diode Characteristic at 25 ºC
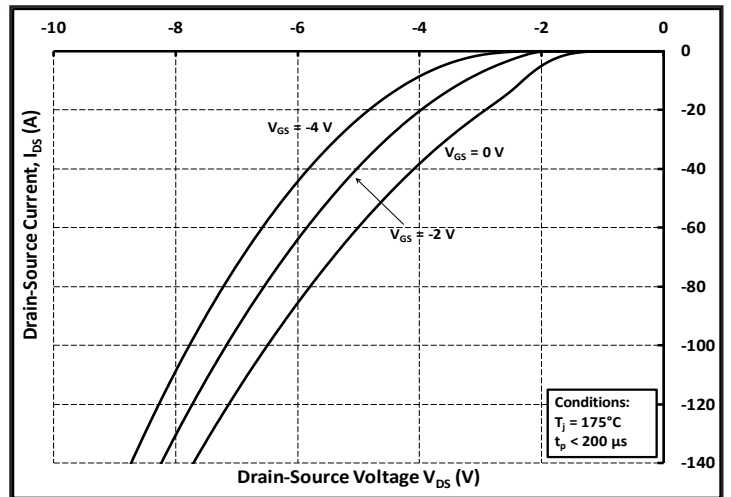
Figure 10. Body Diode Characteristic at 175 ºC
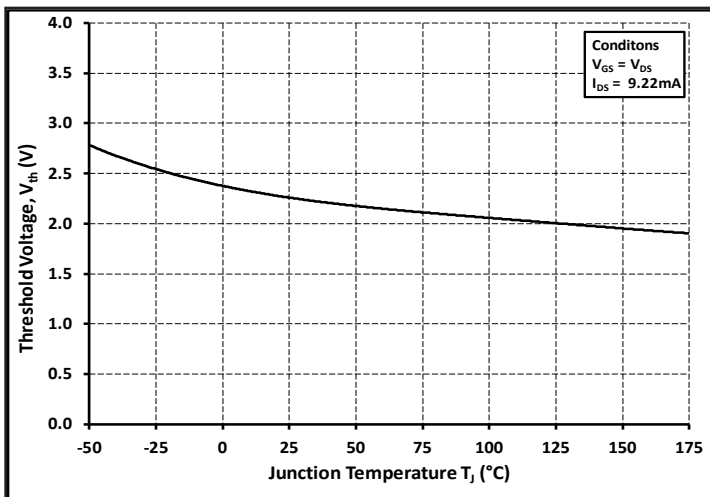
Figure 11. Threshold Voltage vs. Temperature
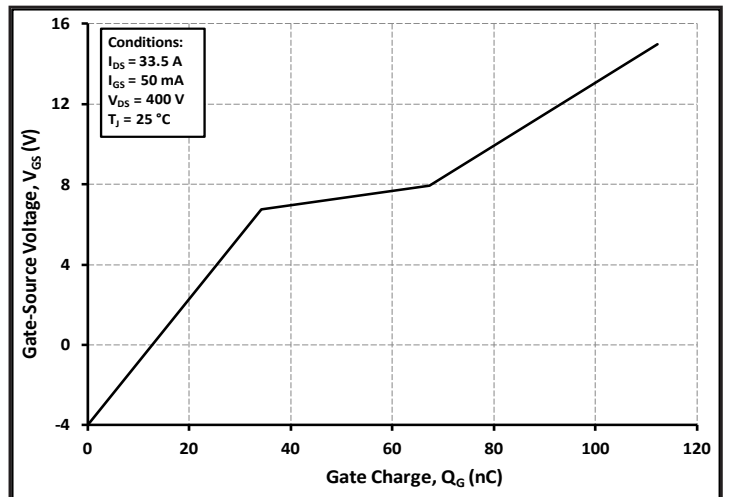
Figure 12. Gate Charge Characteristics

Typical Performance
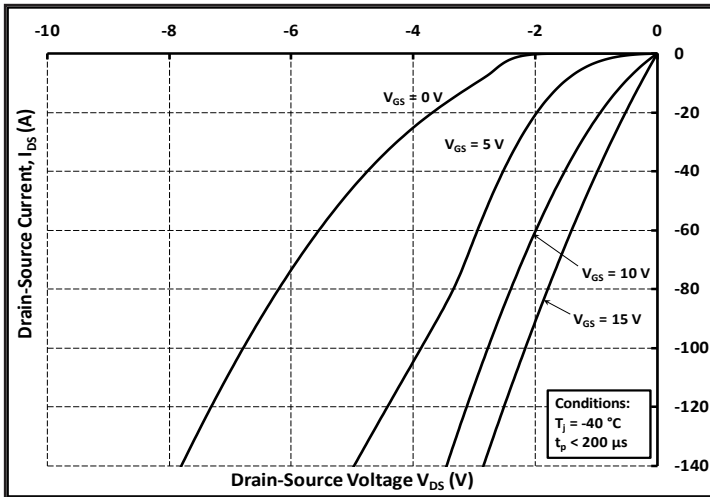
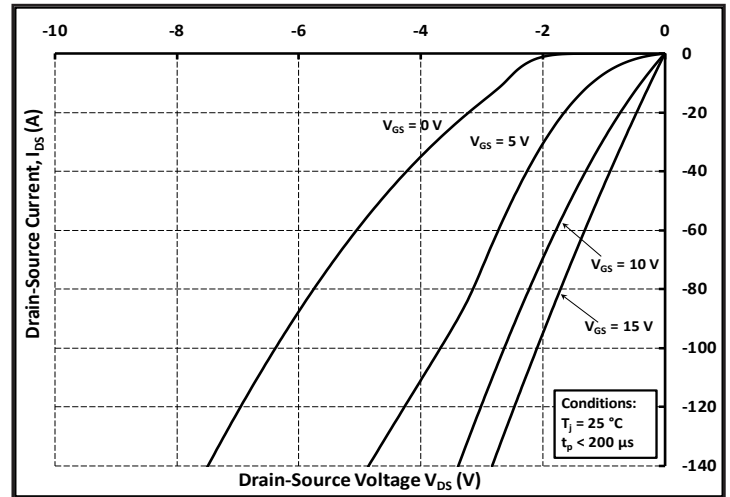Figure 13. 3rd Quadrant Characteristic at -40 ºC
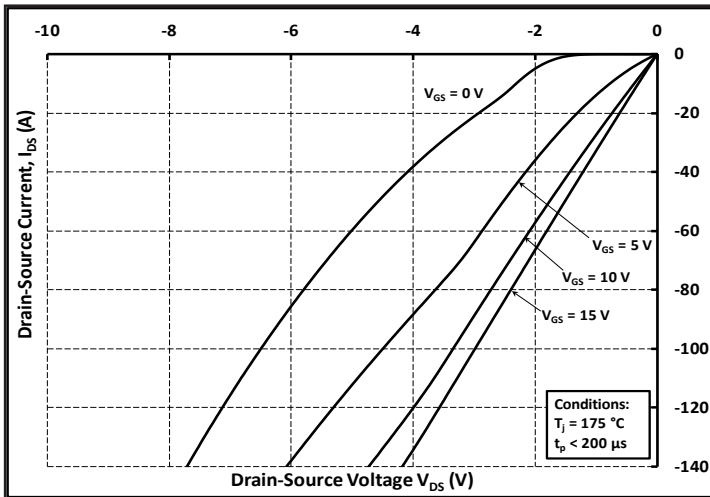

Figure 14. 3rd Quadrant Characteristic at 25 ºC

Figure 15. 3rd Quadrant Characteristic at 175 ºC
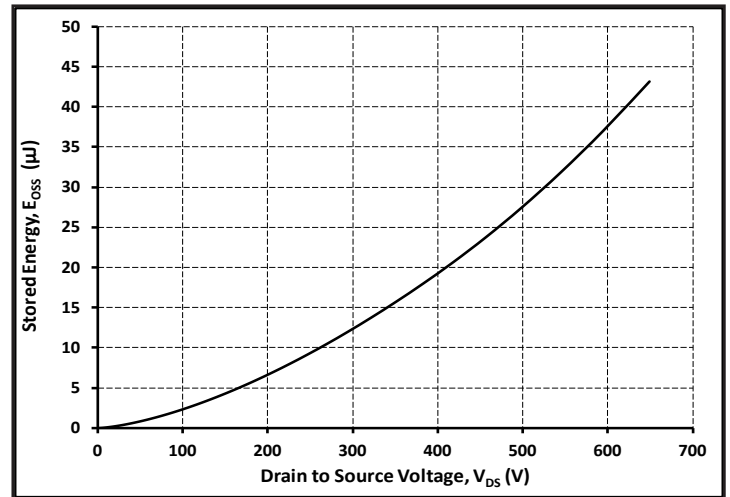
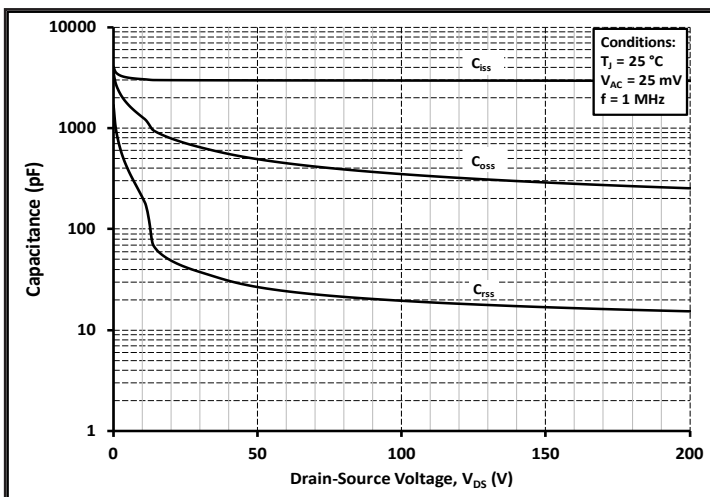Figure 16. Output Capacitor Stored Energy

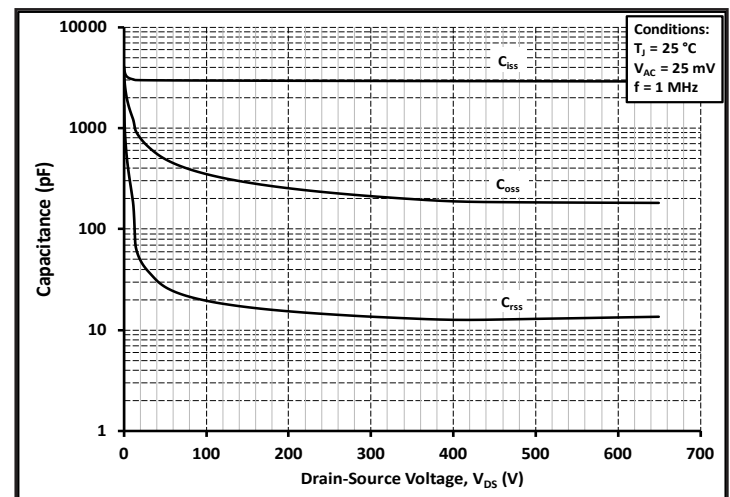Figure 17. Capacitances vs. Drain-Source
Voltage (0 - 200V)

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

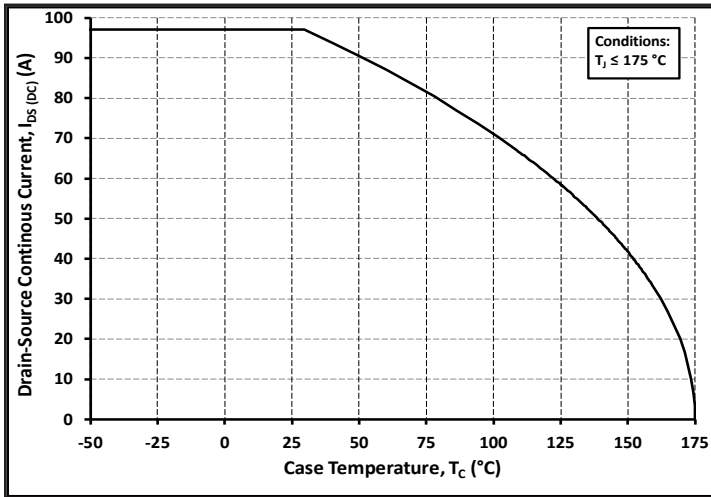## Typical Performance

Figure 19. Continuous Drain Current Derating vs. Case Temperature
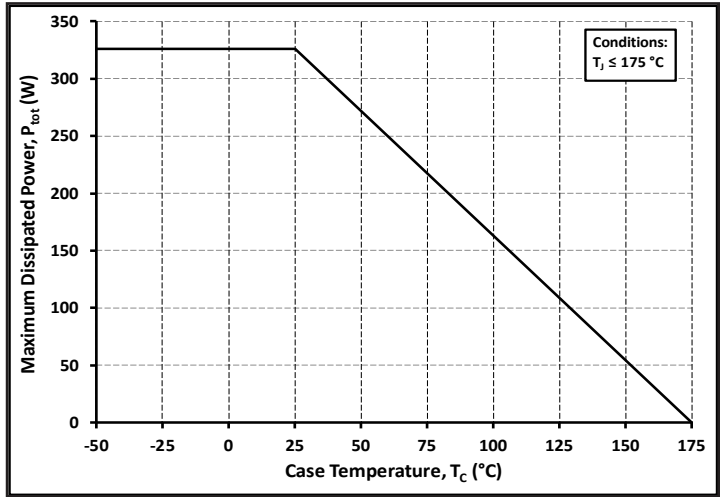

Figure 20. Maximum Power Dissipation Derating vs. Case Temperature
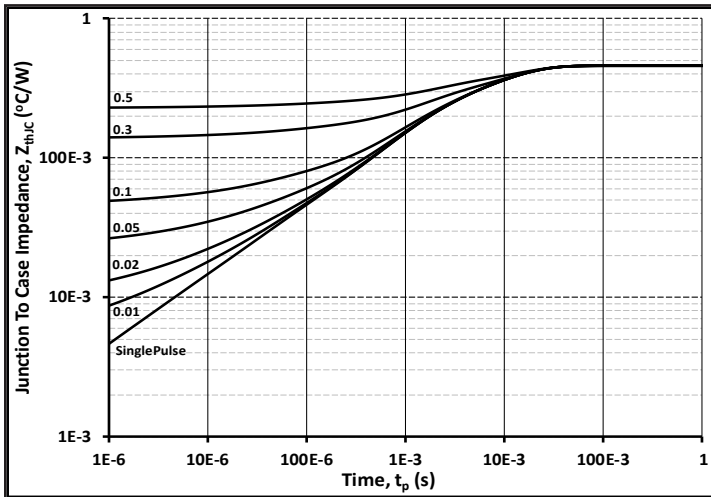

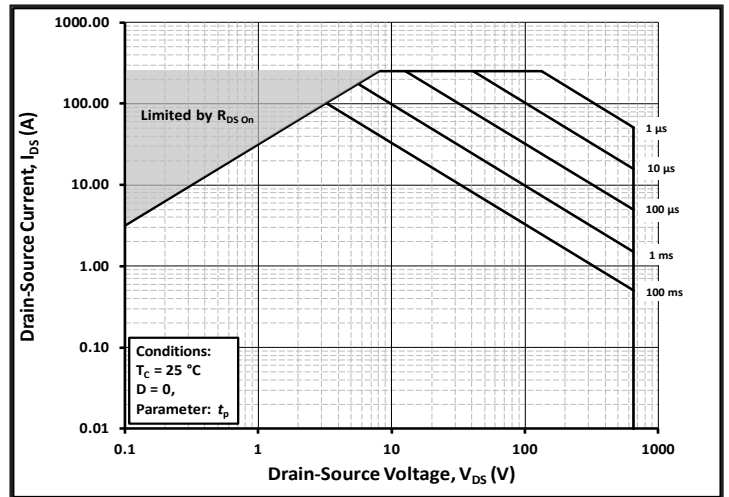Figure 21. Transient Thermal Impedance (Junction - Case)
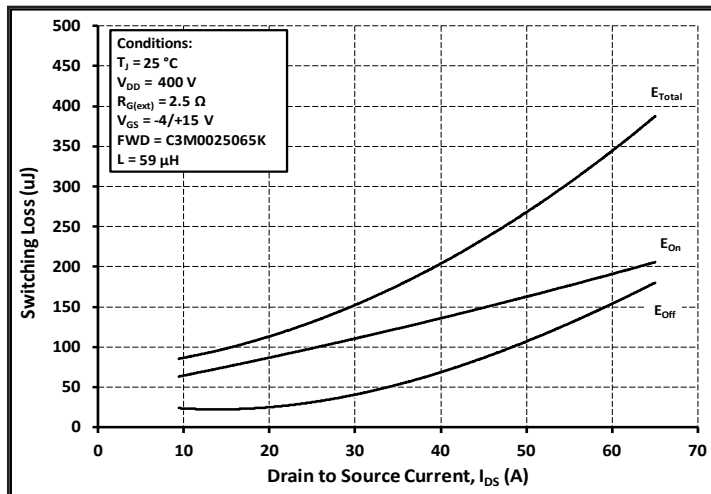

Figure 22. Safe Operating Area

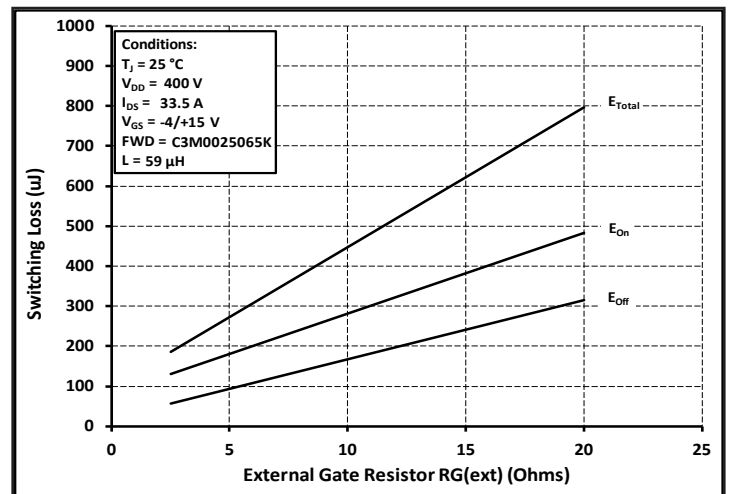Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 400V)

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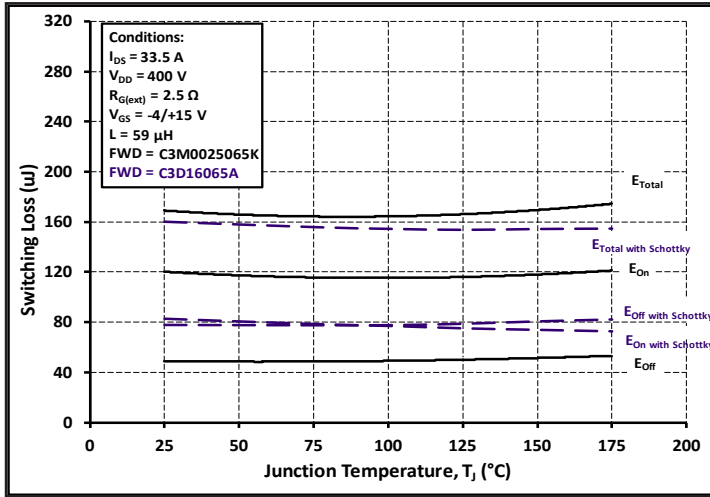
Typical Performance

Figure 25. Clamped Inductive Switching Energy vs. Temperature
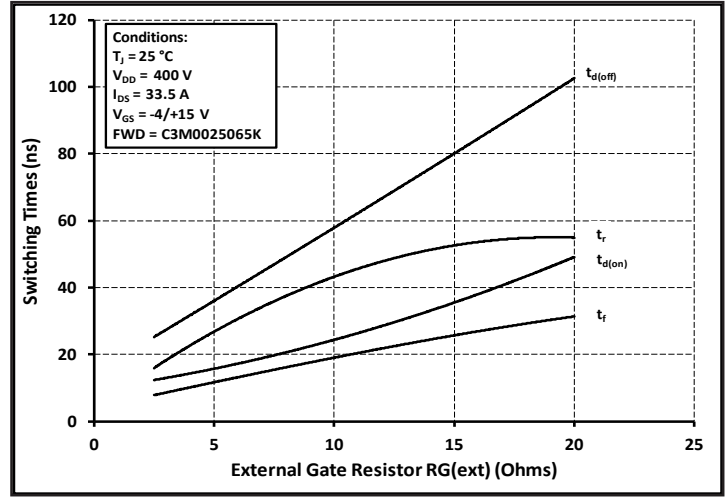

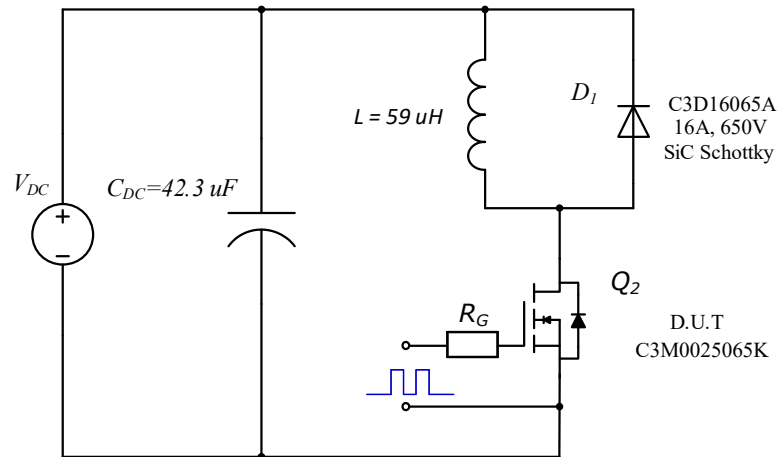Figure 26. Switching Times vs. $R_{G(ext)}$

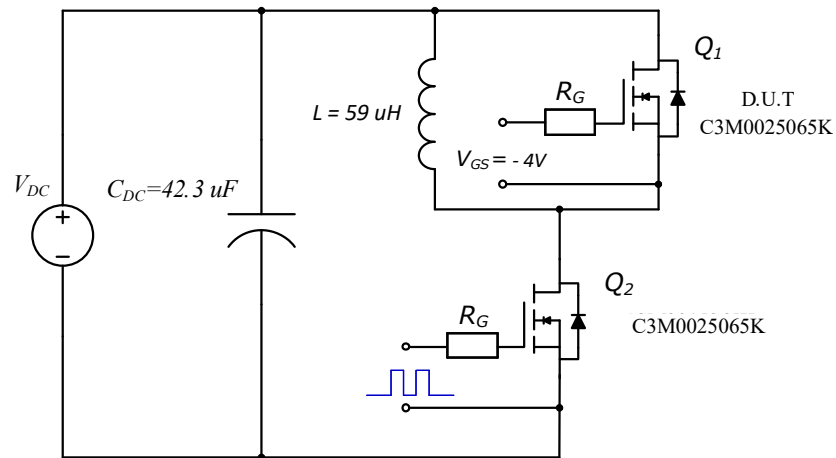Figure 27. Clamped Inductive Switching
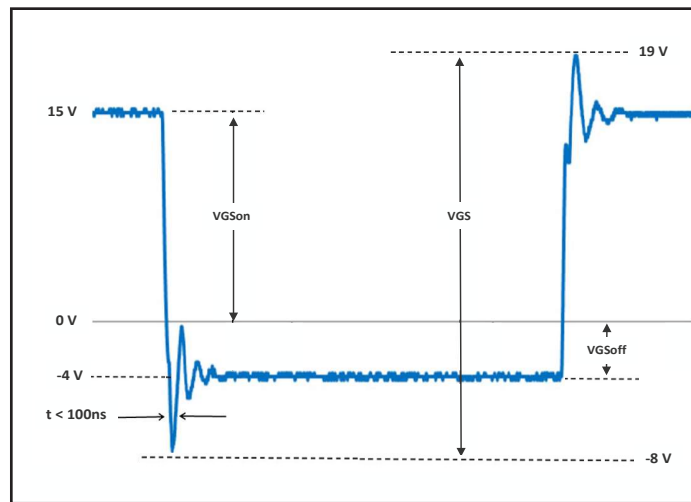Waveform Test Circuit

Figure 28. Body Diode Recovery Test Circuit

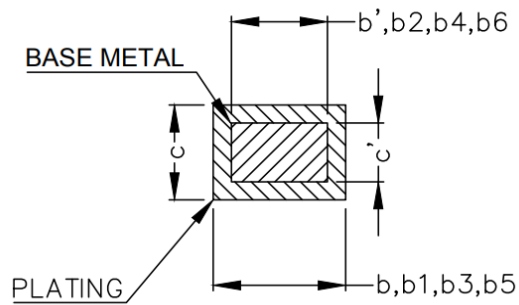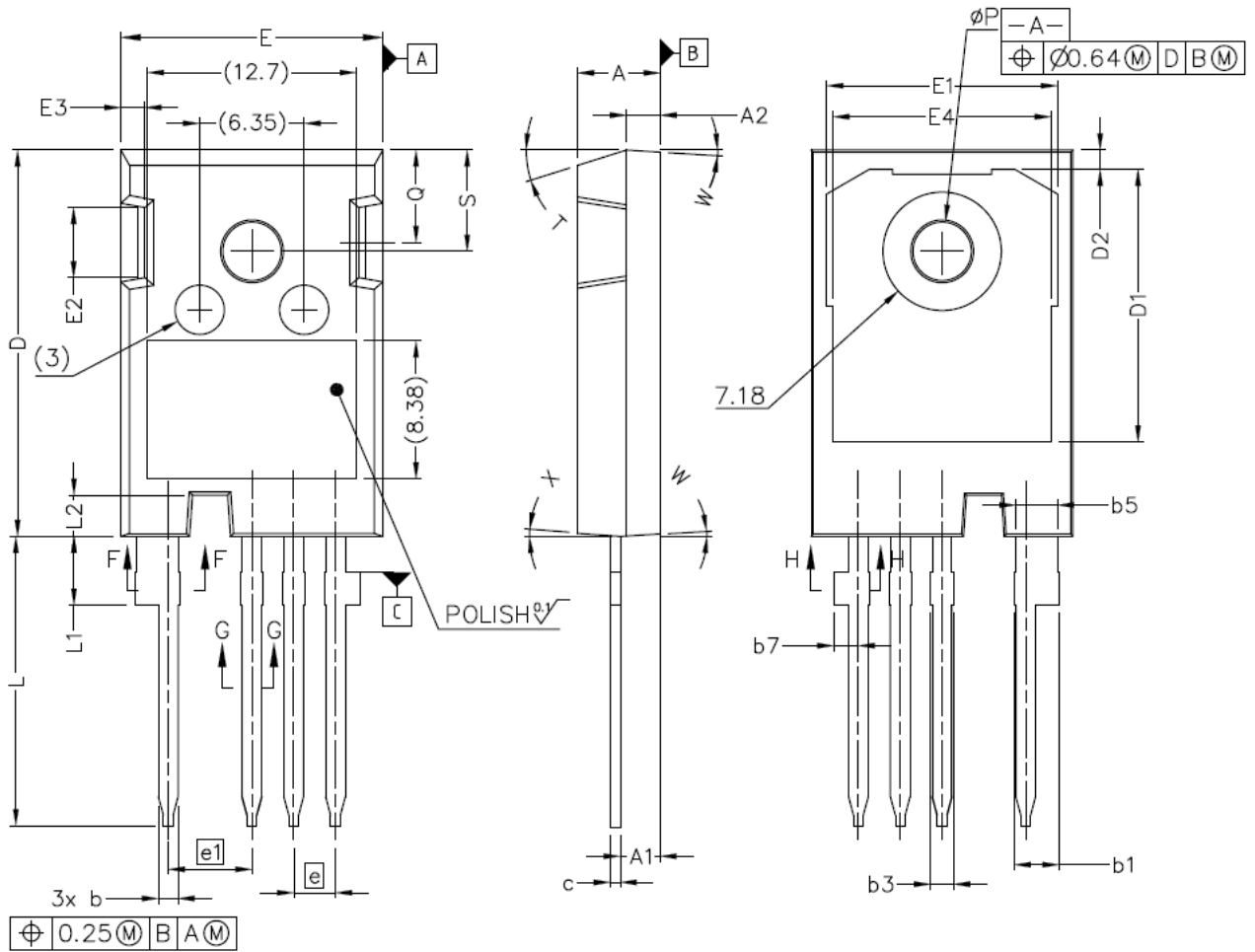

Figure 29. V_{GS} Waveform Example

Package Dimensions

Package TO-247-4L

SECTION "F-F", "G-G" AND "H-H"
SCALE: NONE

Package Dimensions
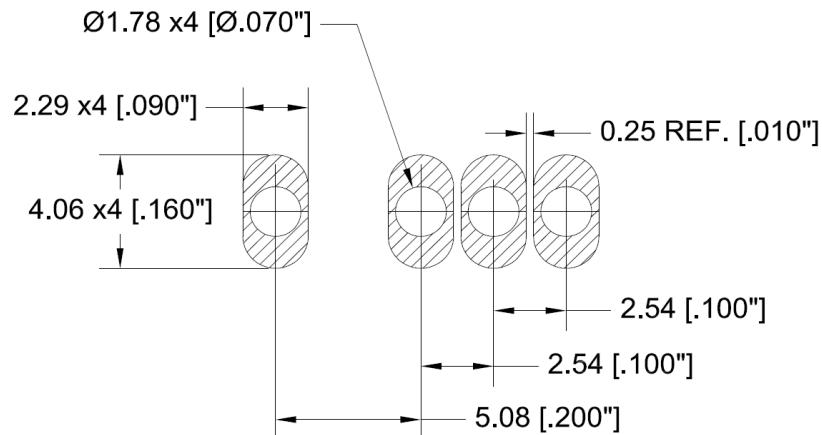
Package TO-247-4L

NOTE ;
1. ALL METAL SURFACES: TIN PLATED, EXCEPT AREA OF CUT
2. DIMENSIONING & TOLERANCEING CONFIRM TO
   ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS.
   ANGLES ARE IN DEGREES.
4. 'N' IS THE NUMBER OF TERMINAL POSITIONS

SYM	MILLIMETERS MIN	MILLIMETERS MAX
A	4.83	5.21
A1	2.29	2.54
A2	1.91	2.16
b`	1.07	1.28
b	1.07	1.33
b1	2.39	2.94
b2	2.39	2.84
b3	1.07	1.60
b4	1.07	1.50
b5	2.39	2.69
b6	2.39	2.64
b7	1.30	1.70
c`	0.55	0.65
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

SYM	MILLIMETERS MIN	MILLIMETERS MAX
E1	13.10	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	
N*	4	
L	17.31	17.82
L1	3.97	4.37
L2	2.35	2.65
Ø 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.	

Ø1.78 x4 [Ø.070"]
2.29 x4 [.090"]
4.06 x4 [.160"]
0.25 REF. [.010"]
2.54 [.100"]
2.54 [.100"]
5.08 [.200"]

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**