C3M0016120K1

Silicon Carbide Power MOSFET
N-Channel Enhancement Mode

Features

- Optimized package with separate driver source pin
- Lower profile TO-247-4 package body
- 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

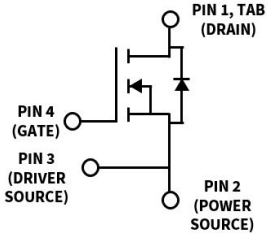
Typical Applications

- Motor Control
- EV Battery Chargers
- High Voltage DC/DC Converters
- Solar/ESS
- UPS
- Enterprise PSU

Package

Halogen-Free

RoHS compliant



Part Number	Package	Marking
C3M0016120K1	TO-247-4L LP	C3M0016120K1

Key Parameters

Parameter	Symbol	Min.	Typ.	Max	Unit	Conditions	Note
Drain - Source Voltage	V_{DS}			1200	v	T_C = 25°C	
Maximum Gate - Source Voltage	$V_{GS(max)}$	-8		+19		Transient	
Operational Gate-Source Voltage	$V_{GS\ op}$		-4/15			Static	Note 1
DC Continuous Drain Current	I_D			125	A	V_{GS} = 15 V, T_C = 25 °C, T_J ≤175 °C	Fig. 19 Note 2
				90		V_{GS} = 15 V, T_C = 100 °C, T_J ≤175 °C	
Pulsed Drain Current	I_{DM}			321		t_{Pmax} limited by T_{jmax} V_{GS} = 15V, T_C = 25 °C	Fig. 22
Power Dissipation	P_D			483	W	T_C = 25 °C, T_J = 175 °C	Fig. 20
Operating Junction and Storage Temperature	T_J, T_{stg}			-55 to +175	°C		
Solder Temperature	T_L			260		According to JEDEC J-STD-020	
Mounting Torque	M_D			1 8.8	Nm lbf-in	M3 or 6-32 screw	

Note (1): Recommended turn-on gate voltage is 15V with ±5% regulation tolerance, see Application Note PRD-04814 for additional details
Note (2): Verified by design

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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	1200			V	V_{GS} = 0 V, I_D = 100 µA	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.5	3.8	V	V_{DS} = V_{GS}, I_D = 22.08 mA	Fig. 11
			2.1		V	V_{DS} = V_{GS}, I_D = 22.08 mA, T_J = 175ºC	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	µA	V_{DS} = 1200 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		16	22	mΩ	V_{GS} = 15 V, I_D = 80.28 A	Fig. 4, 5, 6
			29			V_{GS} = 15 V, I_D = 80.28 A, T_J = 175ºC	
g_{fs}	Transconductance		54		S	V_{DS}= 20 V, I_{DS}= 80.28 A	Fig. 7
			49			V_{DS}= 20 V, I_{DS}= 80.28 A, T_J = 175ºC	
C_{iss}	Input Capacitance		6922		pF	V_{GS} = 0 V, V_{DS} = 0V to 1000 V F = 100 kHz V_{AC} = 25 mV	Fig. 17, 18
C_{oss}	Output Capacitance		231				
C_{rss}	Reverse Transfer Capacitance		13				
E_{oss}	C_{oss} Stored Energy		127		µJ		Fig. 16
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		268		pF	V_{GS} = 0 V, V_{DS} = 0... 800V	Note: 3
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		404		pF		
E_{ON}	Turn-On Switching Energy (External Diode)		1287		µJ	V_{DS}= 800 V, V_{GS}= -4 V/15 V, I_D= 80.28 A, $R_{G(ext)}$ = 2.5 Ω, L= 59 µH, T_J = 175ºC FWD = External SiC DIODE	Fig. 26, 28
E_{OFF}	Turn Off Switching Energy (External Diode)		805				
E_{ON}	Turn-On Switching Energy (Body Diode FWD)		2552		µJ	V_{DS}= 800 V, V_{GS}= -4 V/15 V, I_D= 80.28 A, $R_{G(ext)}$ = 2.5 Ω, L= 59 µH, T_J = 175ºC FWD = Internal Body Diode	Fig. 26, 28
E_{OFF}	Turn-Off Switching Energy (Body Diode FWD)		788				
$t_{d(on)}$	Turn-On Delay Time		19		ns	V_{DD} = 800 V, V_{GS} = -4 V/15 V I_D = 80.28 A, $R_{G(ext)}$ = 2.5 Ω, Timing relative to V_{DS} Inductive load	Fig. 27, 28
t_r	Rise Time		40				
$t_{d(off)}$	Turn-Off Delay Time		62				
t_f	Fall Time		13				
$R_{G(int)}$	Internal Gate Resistance		2.6		Ω	f = 1 MHz, V_{AC} = 25 mV	
Q_{gs}	Gate to Source Charge		70		nC	V_{DS} = 800 V, V_{GS} = -4 V/15 V I_D = 80.28 A Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		65				
Q_g	Total Gate Charge		223				

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as Coss while Vds is rising from 0 to 500V
$C_{o(tr)}$, a lumped capacitance that gives same charging time as Coss while Vds is rising from 0 to 500V

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

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage	4.9		V	V_{GS} = -4 V, I_{SD} = 40.14 A, T_J = 25 °C	Fig. 8, 9, 10
		4.4		V	V_{GS} = -4 V, I_{SD} = 40.14 A, T_J = 175 °C	
I_S	Continuous Diode Forward Current		88	A	V_{GS} = -4 V, T_C = 25˚C	
I_{SM}	Diode pulse Current		321	A	V_{GS} = -4 V, pulse width t_P limited by T_{jmax}	
t_{rr}	Reverse Recover time	32		ns	V_{GS} = -4 V, I_{SD} = 80.28 A, V_R = 800 V dif/dt = 5180 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	1665		nC		
I_{rrm}	Peak Reverse Recovery Current	82		A		
t_{rr}	Reverse Recover time	46		ns	V_{GS} = -4 V, I_{SD} = 80.28 A, V_R = 800 V dif/dt = 2760 A/µs, T_J = 175 °C	
Q_{rr}	Reverse Recovery Charge	1365		nC		
I_{rrm}	Peak Reverse Recovery Current	45		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.23	°C/W		Fig. 21

Typical Performance

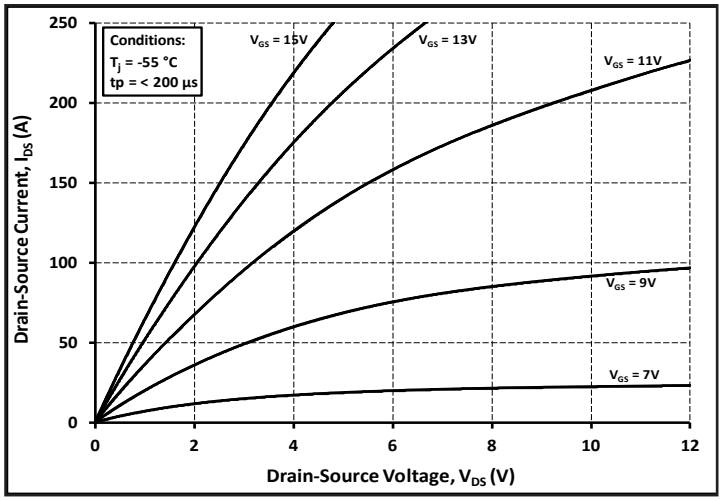


Figure 1. Output Characteristics T_J = -55 ºC

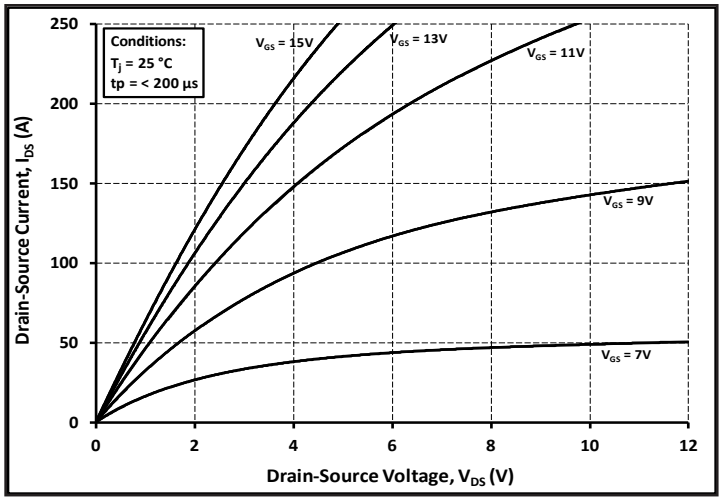


Figure 2. Output Characteristics T_J = 25 ºC

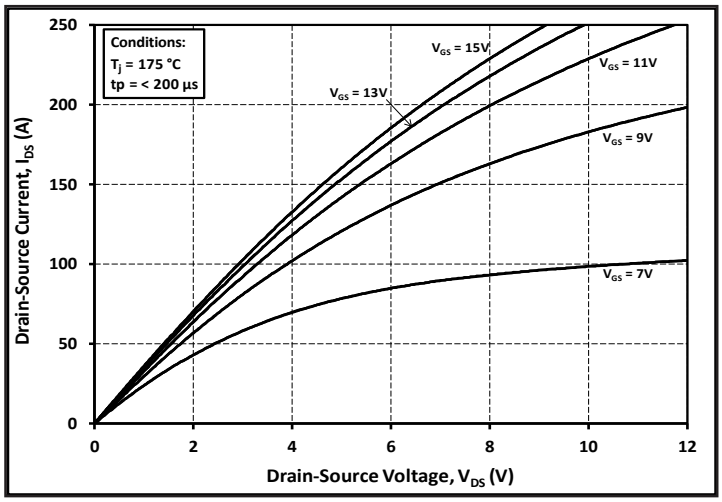


Figure 3. Output Characteristics T_J = 175 ºC

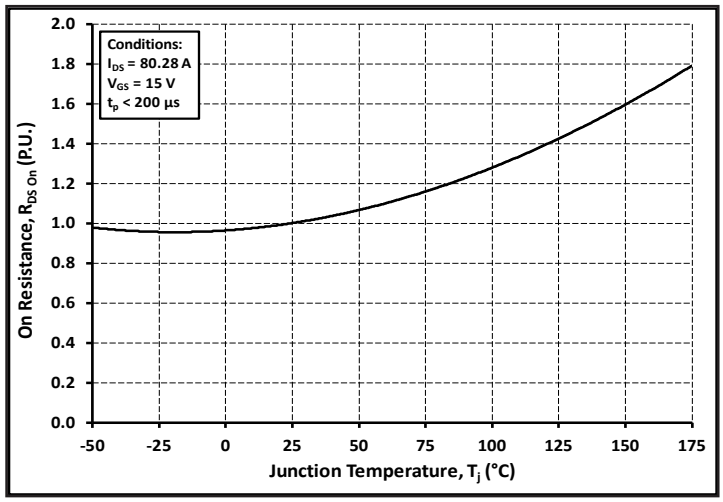


Figure 4. Normalized On-Resistance vs. Temperature

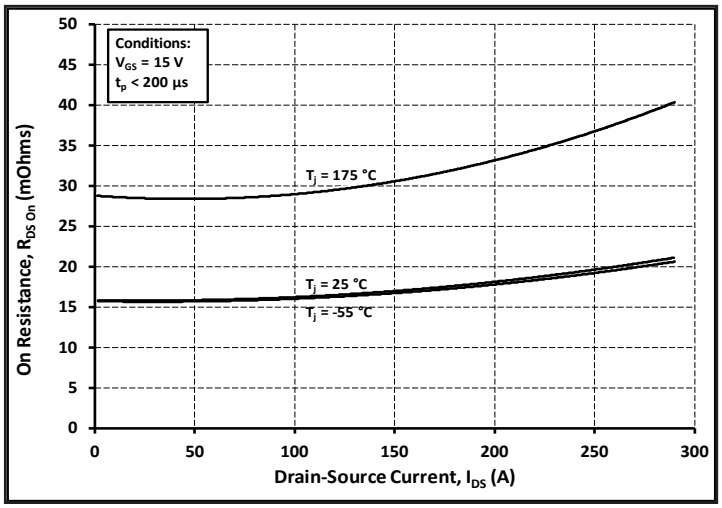


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

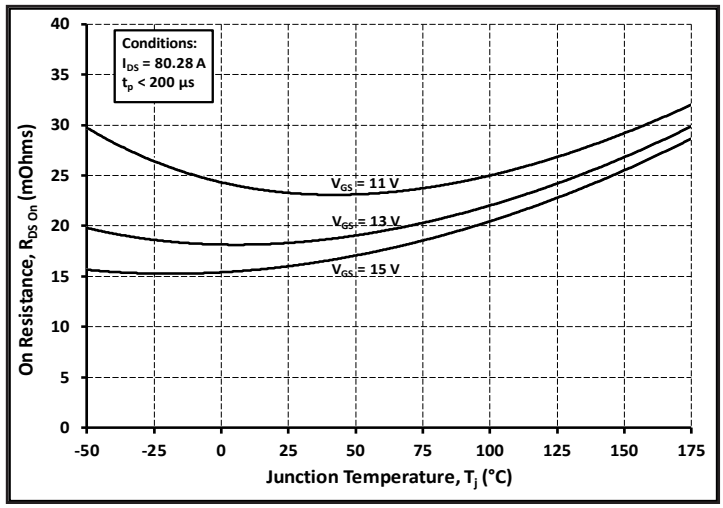


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

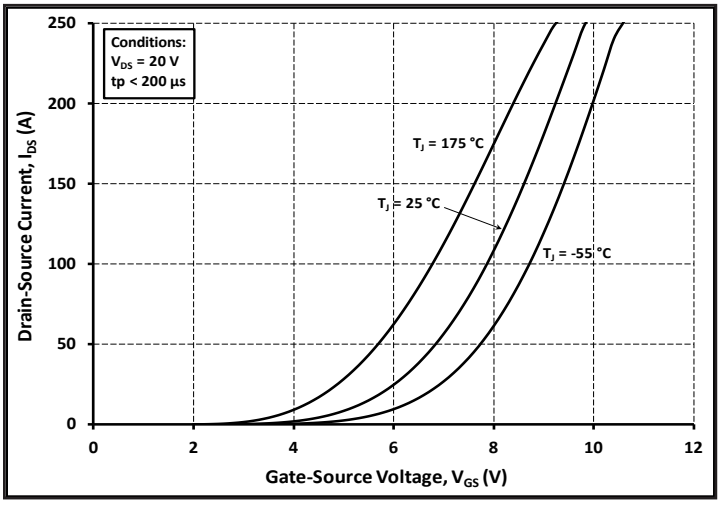


Figure 7. Transfer Characteristic for Various Junction Temperatures

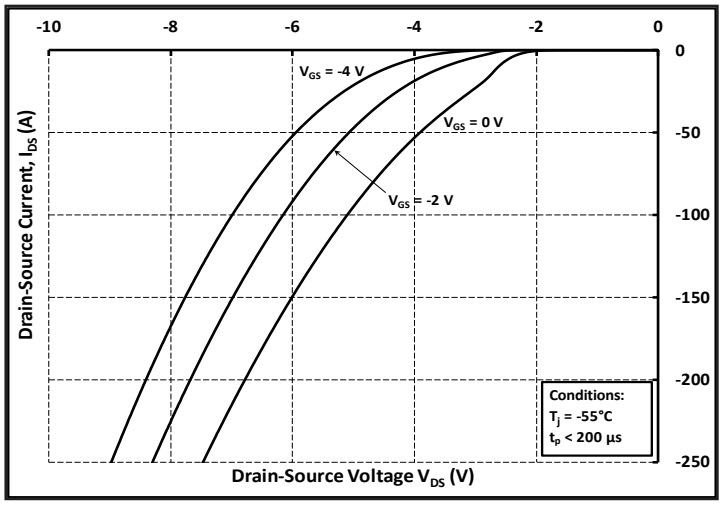


Figure 8. Body Diode Characteristic at -55 ºC

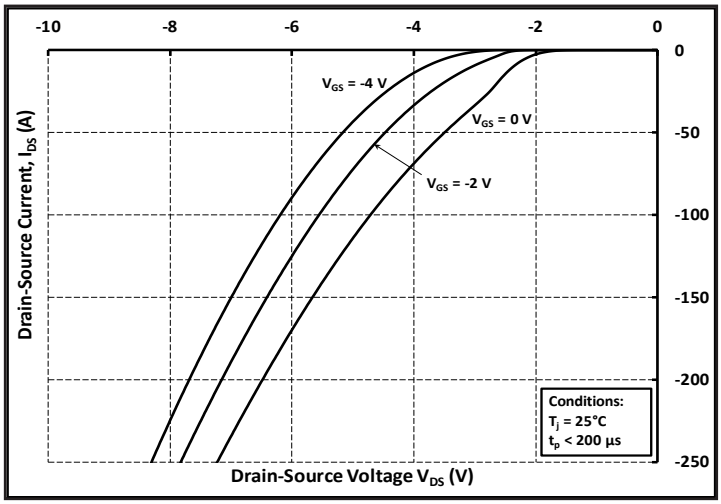


Figure 9. Body Diode Characteristic at 25 ºC

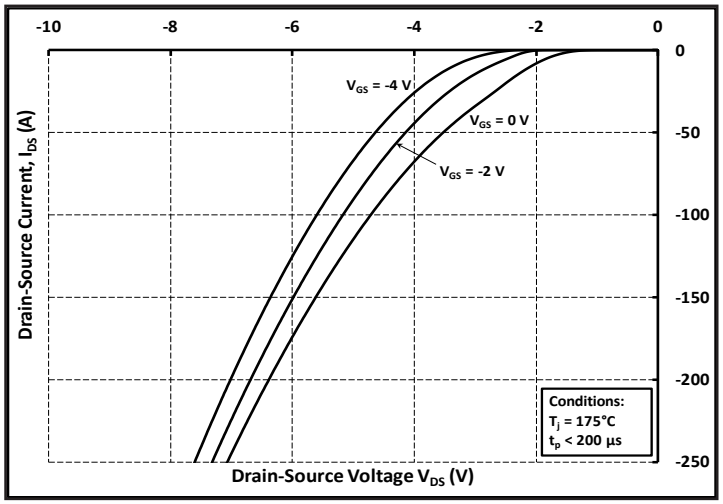


Figure 10. Body Diode Characteristic at 175 ºC

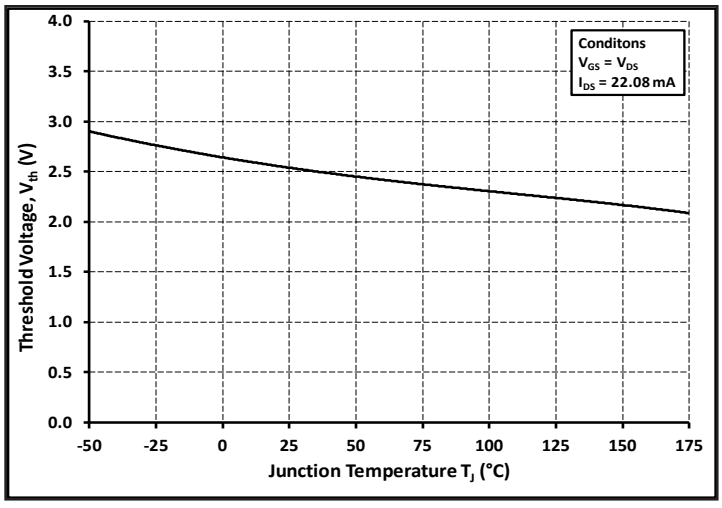


Figure 11. Threshold Voltage vs. Temperature

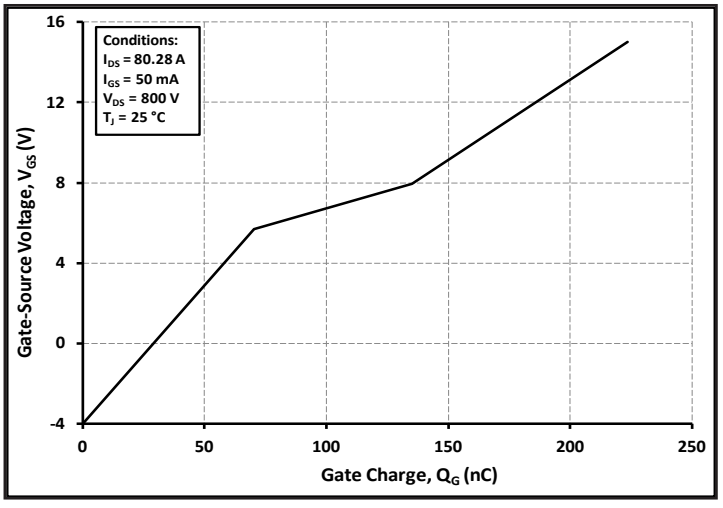


Figure 12. Gate Charge Characteristics

Typical Performance

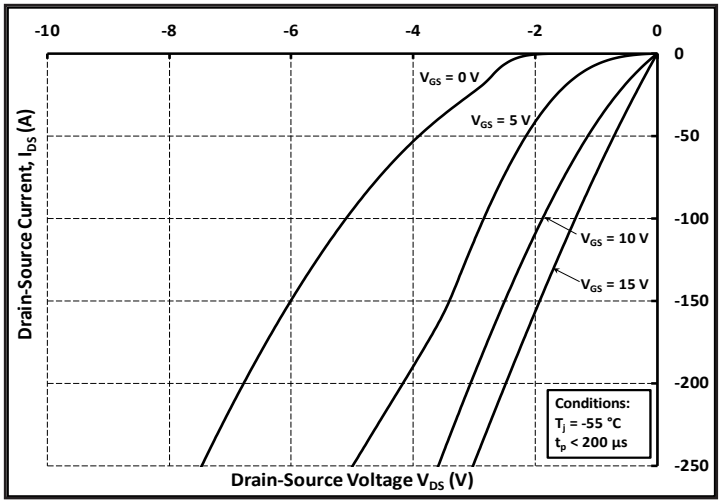


Figure 13. 3rd Quadrant Characteristic at -55 ºC

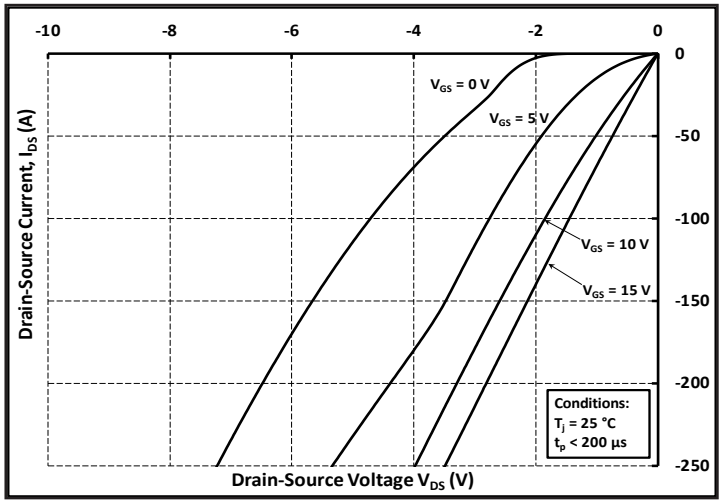


Figure 14. 3rd Quadrant Characteristic at 25 ºC

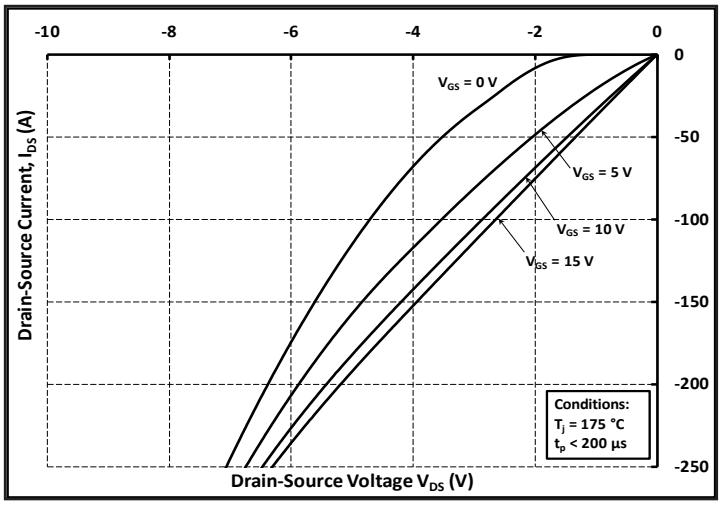


Figure 15. 3rd Quadrant Characteristic at 175 ºC

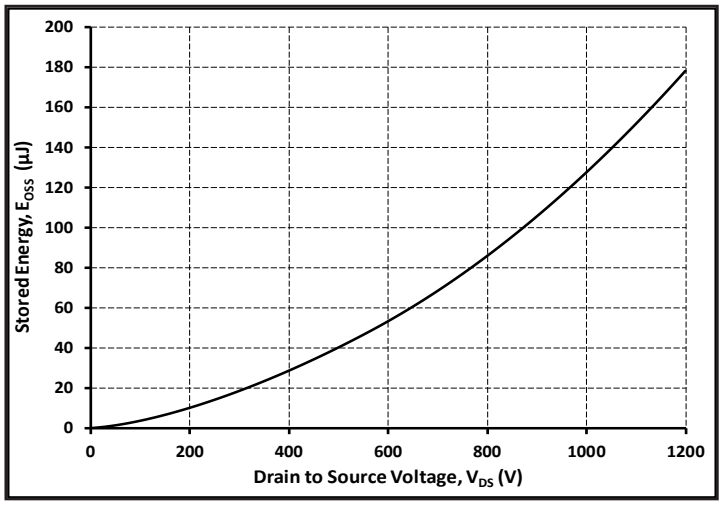


Figure 16. Output Capacitor Stored Energy

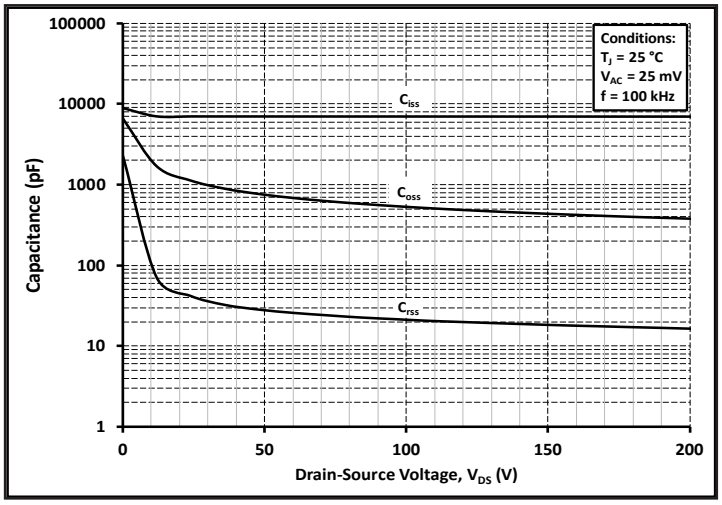


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

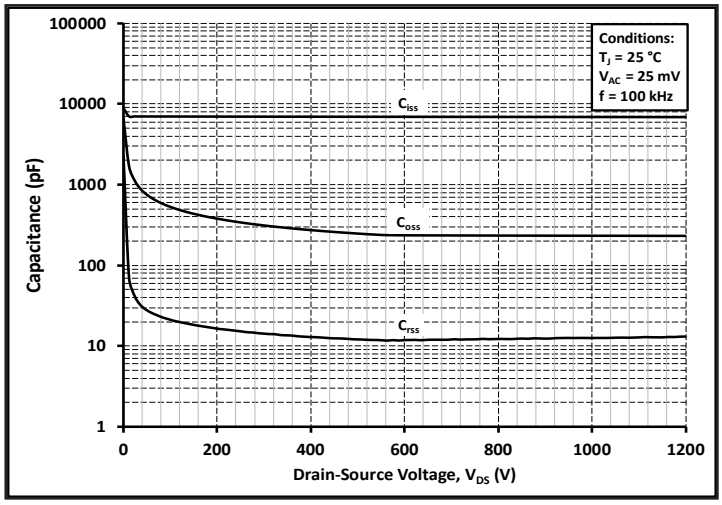


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)

Typical Performance

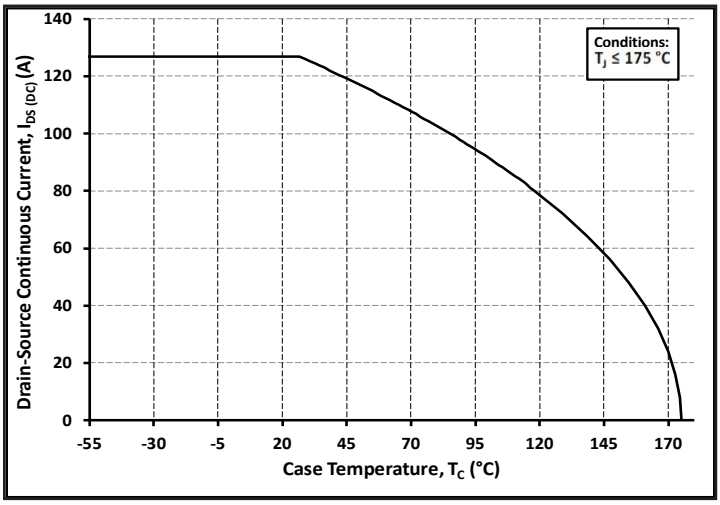


Figure 19. Continuous Drain Current Derating vs. Case Temperature

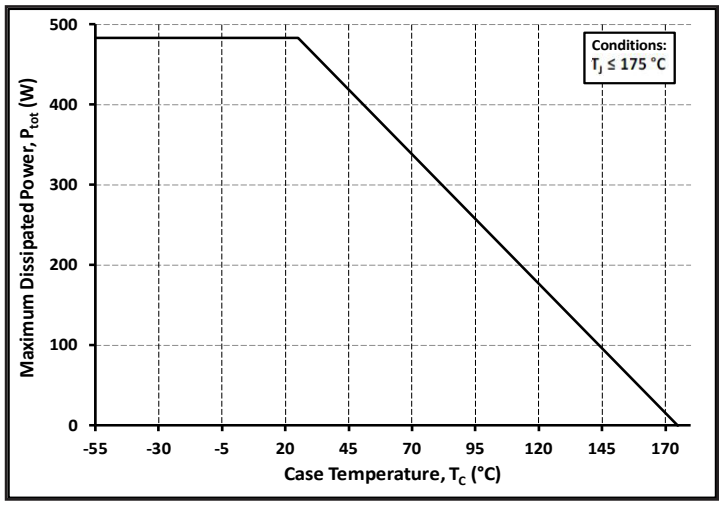


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

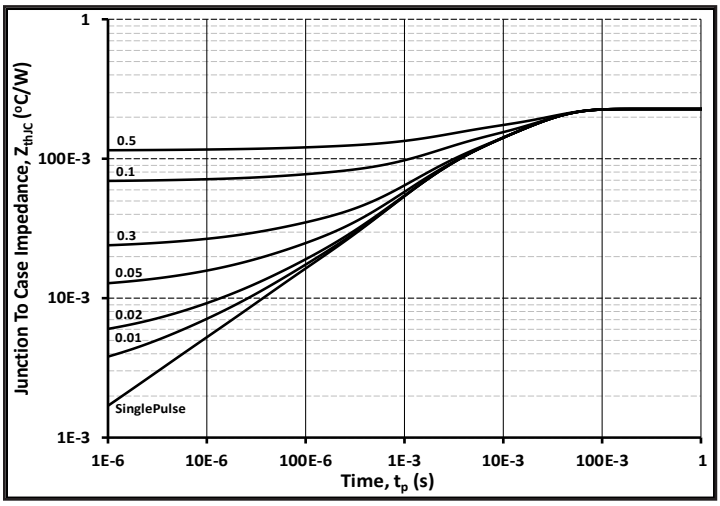


Figure 21. Transient Thermal Impedance (Junction - Case)

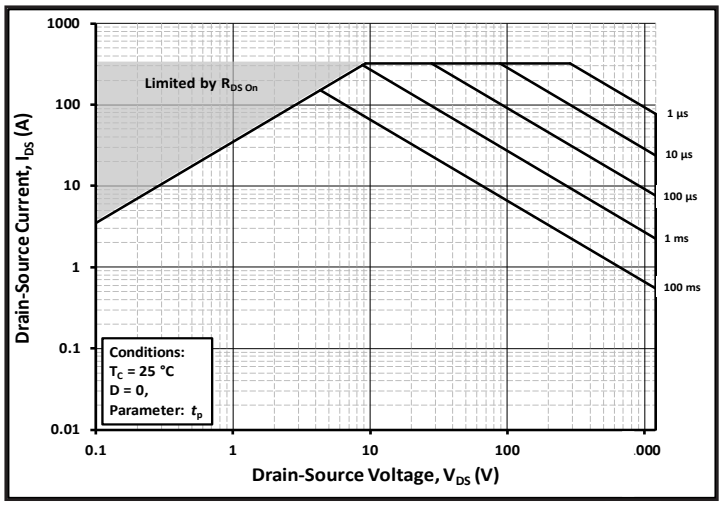


Figure 22. Safe Operating Area

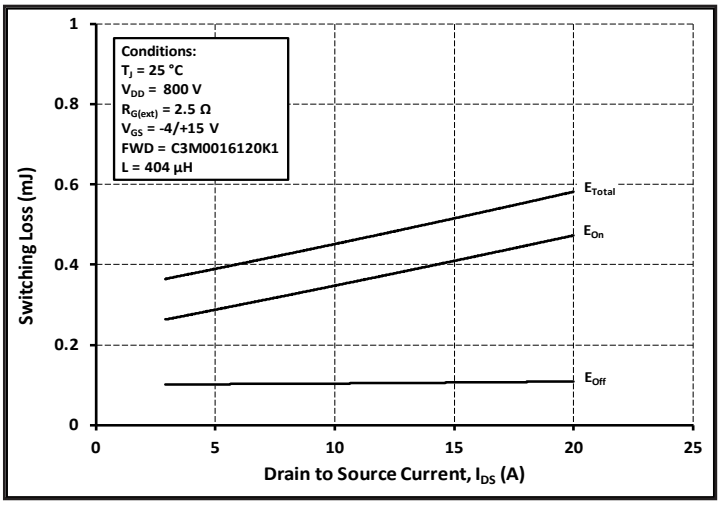


Figure 23. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 800V)

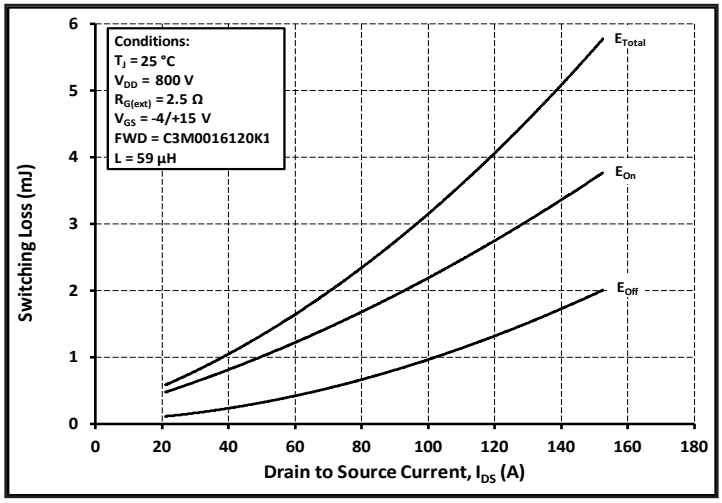


Figure 24. Clamped Inductive Switching Energy vs. Drain Current (V_{DD} = 800V)

Typical Performance

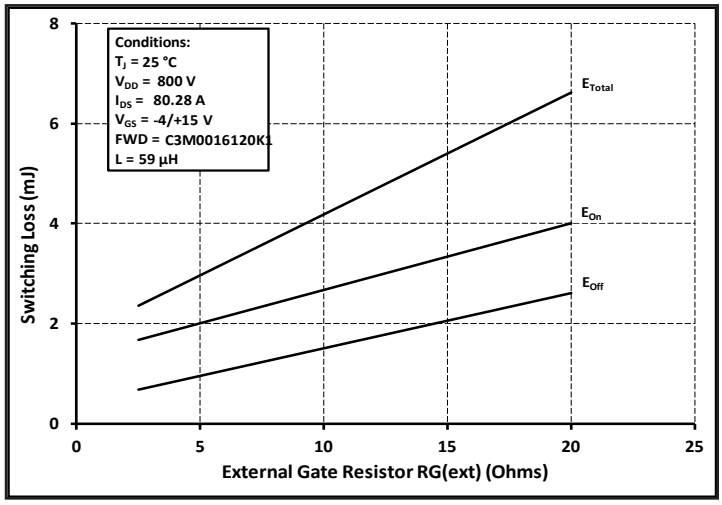


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

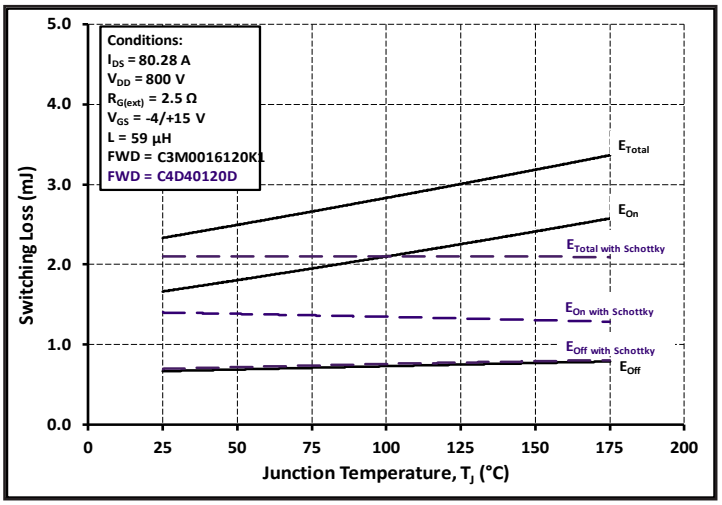


Figure 26. Clamped Inductive Switching Energy vs. Temperature

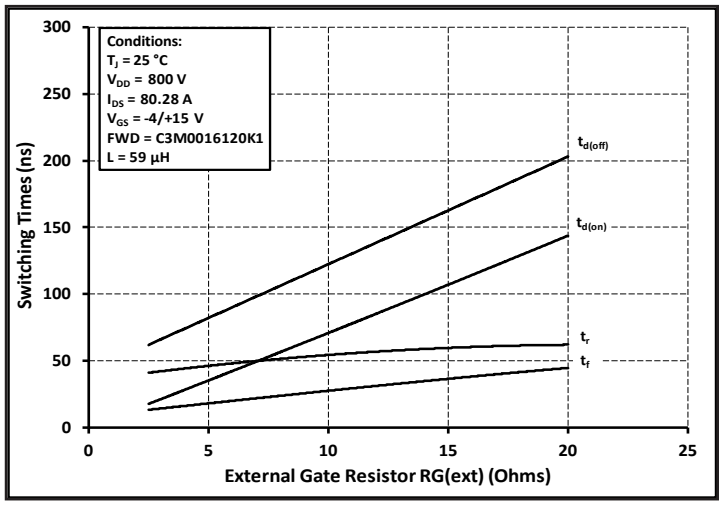


Figure 27. Switching Times vs. $R_{G(ext)}$

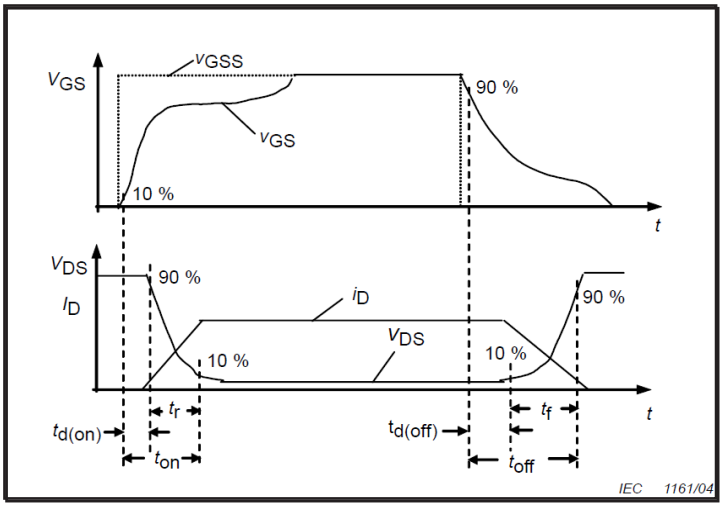


Figure 28. Switching Times Definition

Test Circuit Schematic

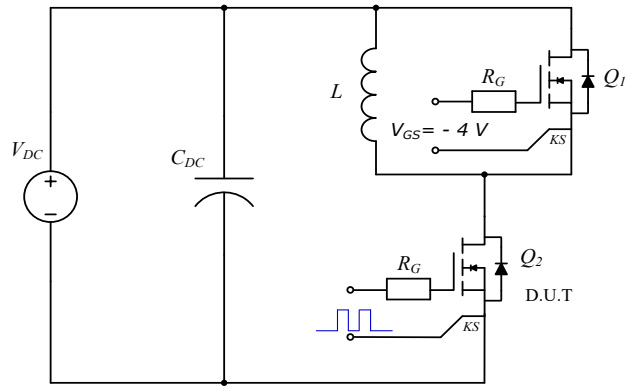
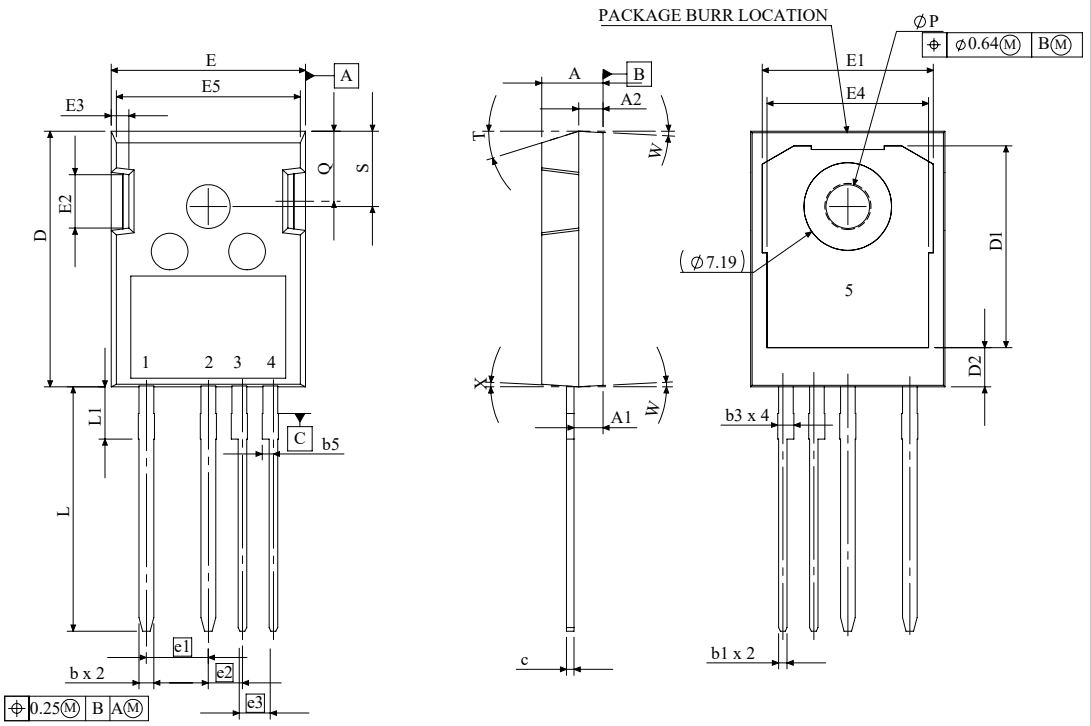


Figure 29. Clamped Inductive Switching Waveform Test Circuit

Package Dimensions



SYMBOL	MIN (mm)	MAX (mm)
A	4.83	5.21
A1	2.22	2.6
A2	1.91	2.16
b	1.10	1.30
b1	0.65	0.79
b3	1.34	1.44
b5	0.74	1.14
c	0.55	0.68
D	20.76	21.14
D1	16.25	17.65
D2	2.95	3.35
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
E5	14.65	15.05
e1	5.08 BSC	
e2	2.79 BSC	
e3	2.54 BSC	
L	19.72	20.32
L1	3.87	4.47
ϕP	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

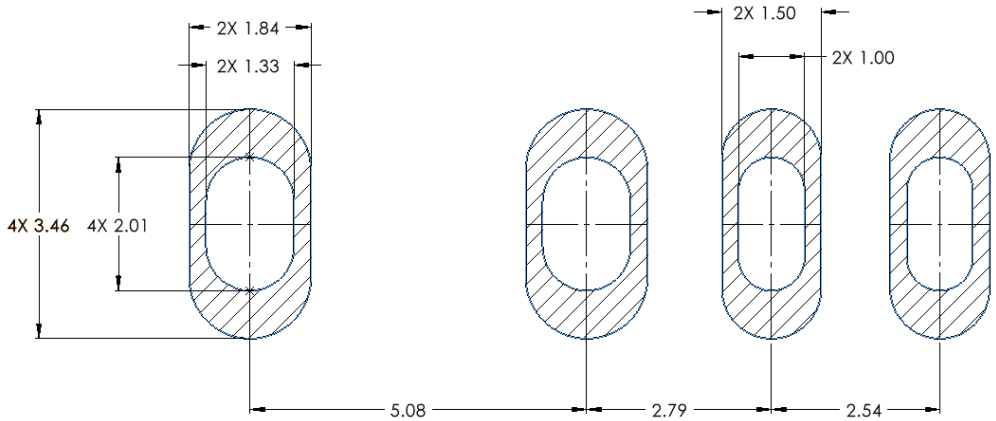
TITLE: PACKAGE OUTLINE DRAWING: TO-247-4L LP

Date: 02/15/24 | REVISION NO. 02 | A4

PRD-05970 | SCALE:1:1 | SHEET 1 OF 1

Recommended Solder Pad Layout

All dimensions in mm



Revision history

Document Version	Date of release	Descriptiion of changes
1.0	April-2024	Initial datasheet
2.0	October - 2024	Legal Disclaimer

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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.SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

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