

C3M0021120K1

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

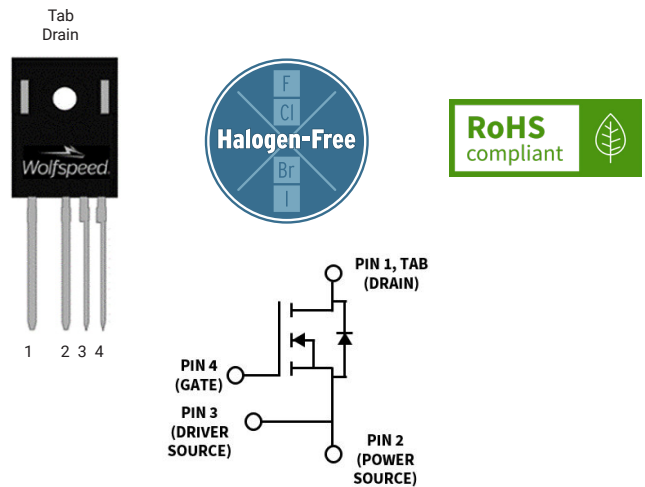
Benefits

- 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



Part Number	Package	Marking
C3M0021120K1	TO-247-4L LP	C3M0021120K1

Key Parameters

Parameter	Symbol	Min.	Typ.	Max	Unit	Conditions	Note
Drain - Source Voltage	V_{DS}			1200	V	$T_c = 25^\circ\text{C}$	
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			104	A	$V_{GS} = 15\text{ V}, T_c = 25^\circ\text{C}, T_J \leq 175^\circ\text{C}$	Fig. 19
				75		$V_{GS} = 15\text{ V}, T_c = 100^\circ\text{C}, T_J \leq 175^\circ\text{C}$	Note 2
Pulsed Drain Current	I_{DM}			248		t_{Pmax} limited by T_{Jmax} $V_{GS} = 15\text{ V}, T_c = 25^\circ\text{C}$	Fig. 22
Power Dissipation	P_D			405	W	$T_c = 25^\circ\text{C}, T_J = 175^\circ\text{C}$	Fig. 20
Operating Junction and Storage Temperature	T_J, T_{stg}			-55 to +175	$^\circ\text{C}$		
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 $\pm 5\%$ regulation tolerance, see Application Note PRD-04814 for additional details

Note (2): Verified by design


Electrical Characteristics ($T_c = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	1200			V	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.9	3.8	V	$V_{DS} = V_{GS}, I_D = 17.1\text{ mA}$	Fig. 11
			2.3		V	$V_{DS} = V_{GS}, I_D = 17.1\text{ mA}, T_J = 175^\circ\text{C}$	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	μA	$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$	
I_{GSS}	Gate-Source Leakage Current		10	250	nA	$V_{GS} = 15\text{ V}, V_{DS} = 0\text{ V}$	
$R_{DS(on)}$	Drain-Source On-State Resistance		21	29	m Ω	$V_{GS} = 15\text{ V}, I_D = 62.1\text{ A}$	Fig. 4, 5, 6
			35			$V_{GS} = 15\text{ V}, I_D = 62.1\text{ A}, T_J = 175^\circ\text{C}$	
g_{fs}	Transconductance		38		S	$V_{DS} = 20\text{ V}, I_{DS} = 62.1\text{ A}$	Fig. 7
			35			$V_{DS} = 20\text{ V}, I_{DS} = 62.1\text{ A}, T_J = 175^\circ\text{C}$	
C_{iss}	Input Capacitance		5100		pF	$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to }1000\text{ V}$ $F = 100\text{ kHz}$ $V_{AC} = 25\text{ mV}$	Fig. 17, 18
C_{oss}	Output Capacitance		174				
C_{rss}	Reverse Transfer Capacitance		11				
E_{oss}	C_{oss} Stored Energy		98		μJ		Fig. 16
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		210		pF	$V_{GS} = 0\text{ V}, V_{DS} = 0 \dots 800\text{ V}$	Note: 3
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		323		pF		
E_{ON}	Turn-On Switching Energy (External Diode)		0.96		mJ	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 62.12\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 59\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = External SiC DIODE	Fig. 26, 28
E_{OFF}	Turn Off Switching Energy (External Diode)		0.45				
E_{ON}	Turn-On Switching Energy (Body Diode FWD)		1.99		mJ	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 62.12\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 59\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = Internal Body Diode	Fig. 26, 28
E_{OFF}	Turn-Off Switching Energy (Body Diode FWD)		0.43				
$t_{d(on)}$	Turn-On Delay Time		17		ns	$V_{DD} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 62.12\text{ A}, R_{G(ext)} = 2.5\text{ }\Omega,$ Timing relative to V_{DS} Inductive load	Fig. 27, 28
t_r	Rise Time		39				
$t_{d(off)}$	Turn-Off Delay Time		54				
t_f	Fall Time		13				
$R_{G(int)}$	Internal Gate Resistance		3		Ω	$f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$	
Q_{gs}	Gate to Source Charge		59		nC	$V_{DS} = 800\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 62.12\text{ A}$ Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		53				
Q_g	Total Gate Charge		177				

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as C_{oss} while V_{ds} is rising from 0 to 800V
 $C_{o(tr)}$, a lumped capacitance that gives same charging time as C_{oss} while V_{ds} is rising from 0 to 800V

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} = 31.1 A, T _J = 25 °C	Fig. 8, 9, 10
		4.4		V	V _{GS} = -4 V, I _{SD} = 31.1 A, T _J = 175 °C	
I _S	Continuous Diode Forward Current		73	A	V _{GS} = -4 V, T _c = 25°C	
I _{SM}	Diode pulse Current		248	A	V _{GS} = -4 V, pulse width t _p limited by T _{Jmax}	
t _{rr}	Reverse Recover time	30		ns	V _{GS} = -4 V, I _{SD} = 62.1 A, V _R = 800 V dif/dt = 4845 A/μs, T _J = 175 °C	
Q _{rr}	Reverse Recovery Charge	1264		nC		
I _{rrm}	Peak Reverse Recovery Current	64		A		
t _{rr}	Reverse Recover time	45		ns	V _{GS} = -4 V, I _{SD} = 62.1 A, V _R = 800 V dif/dt = 2415 A/μs, T _J = 175 °C	
Q _{rr}	Reverse Recovery Charge	1050		nC		
I _{rrm}	Peak Reverse Recovery Current	13		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
R _{θJC}	Thermal Resistance from Junction to Case	0.28	°C/W		Fig. 21



Typical Performance

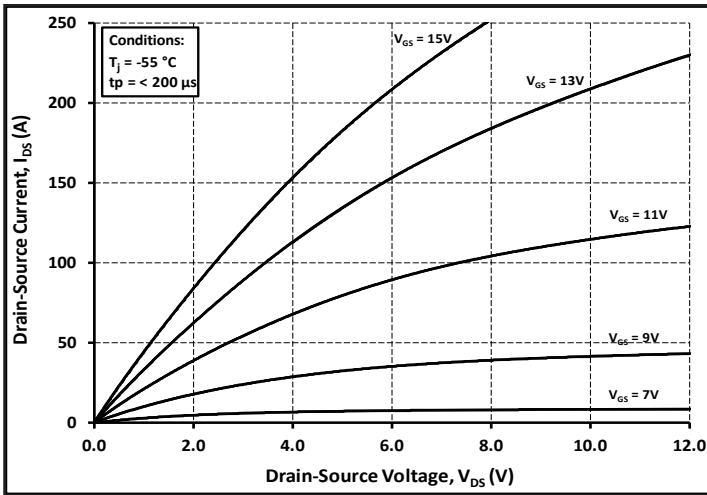


Figure 1. Output Characteristics $T_J = -55\text{ }^{\circ}\text{C}$

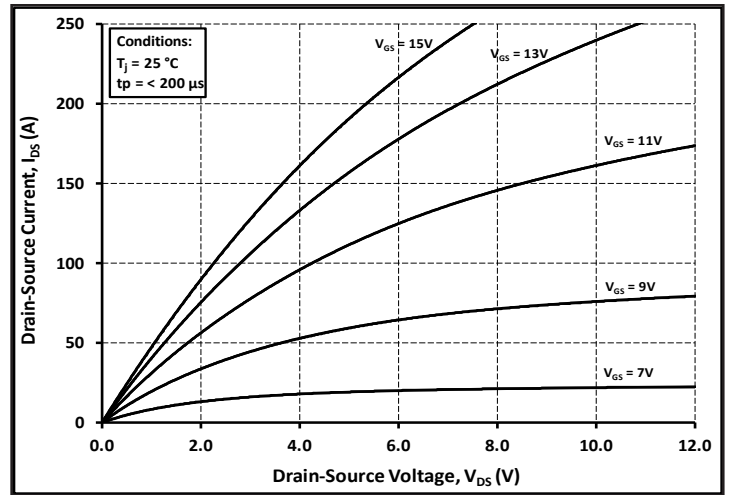


Figure 2. Output Characteristics $T_J = 25\text{ }^{\circ}\text{C}$

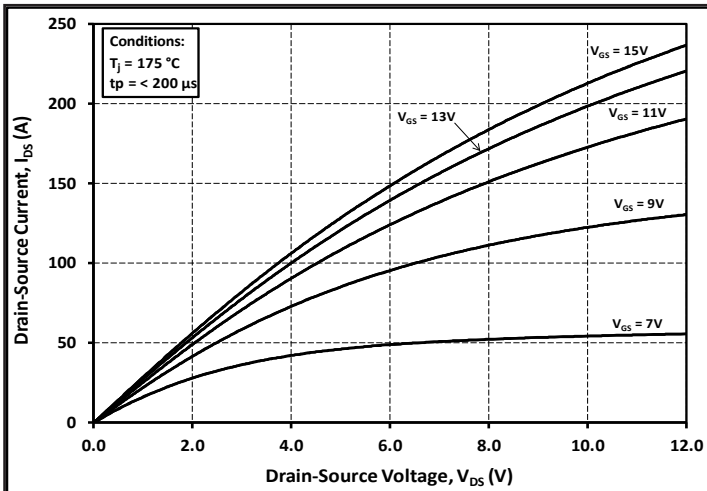


Figure 3. Output Characteristics $T_J = 175\text{ }^{\circ}\text{C}$

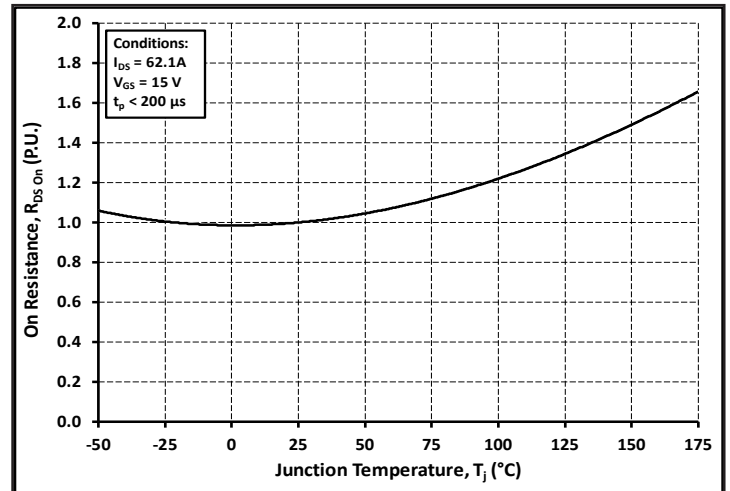


Figure 4. Normalized On-Resistance vs. Temperature

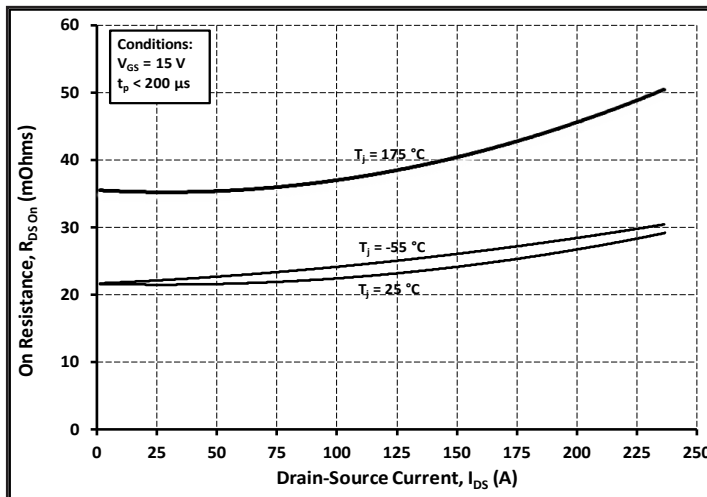


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

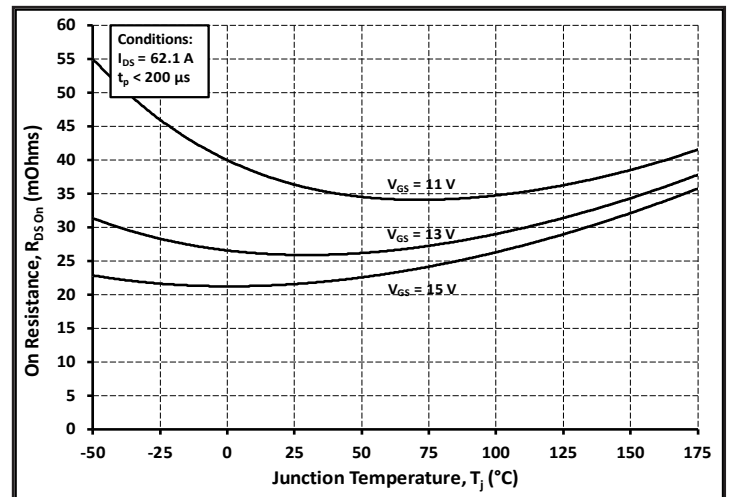


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

Typical Performance

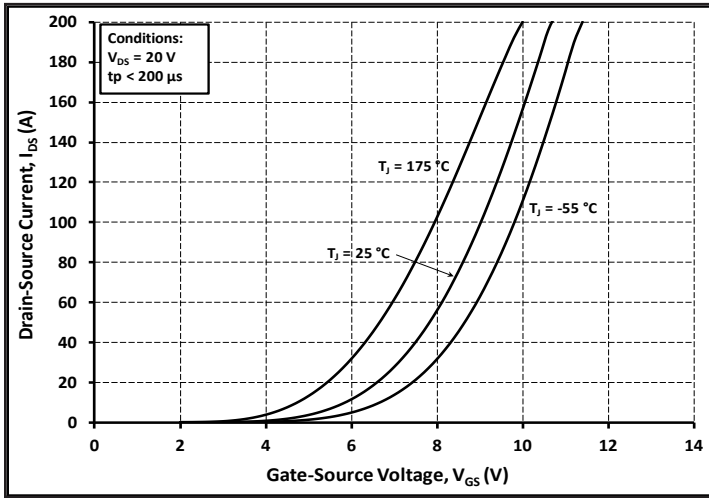


Figure 7. Transfer Characteristic for Various Junction Temperatures

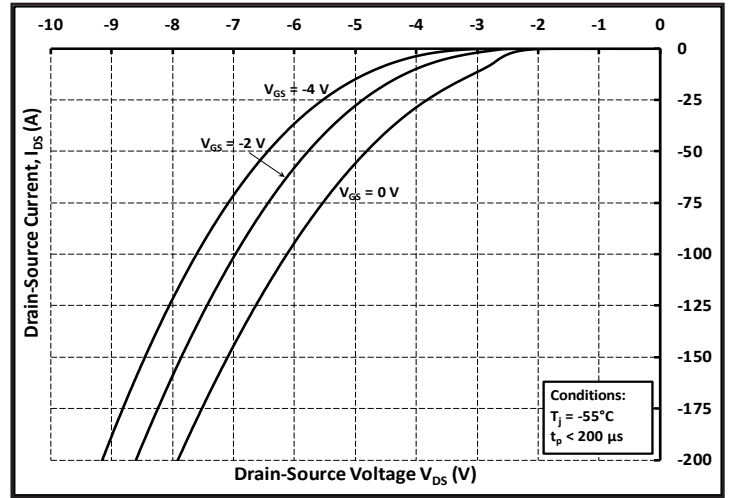
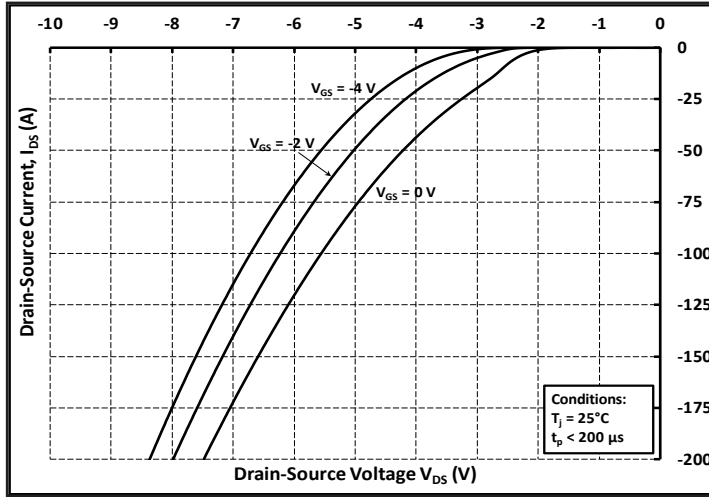
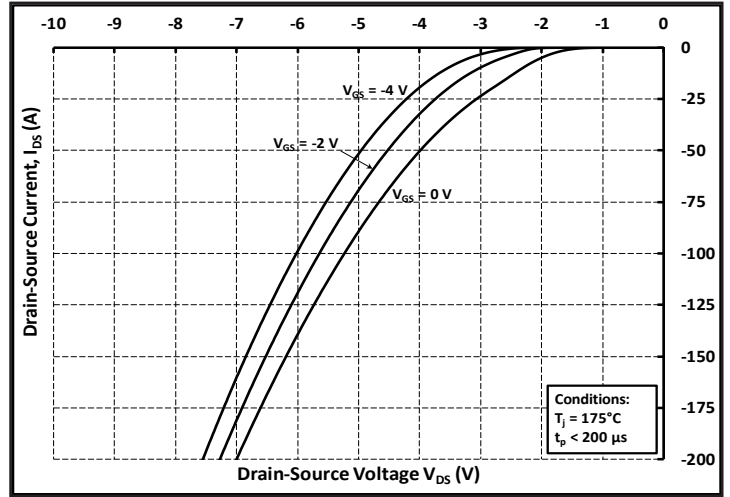
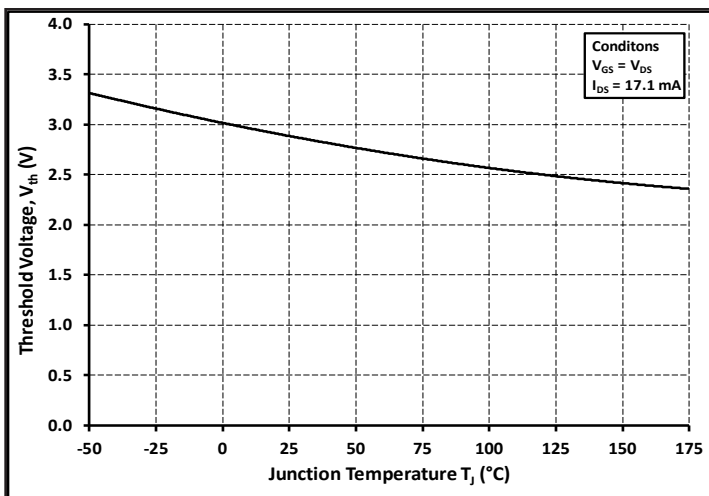
Figure 8. Body Diode Characteristic at -55°C Figure 9. Body Diode Characteristic at 25°C Figure 10. Body Diode Characteristic at 175°C 

Figure 11. Threshold Voltage vs. Temperature

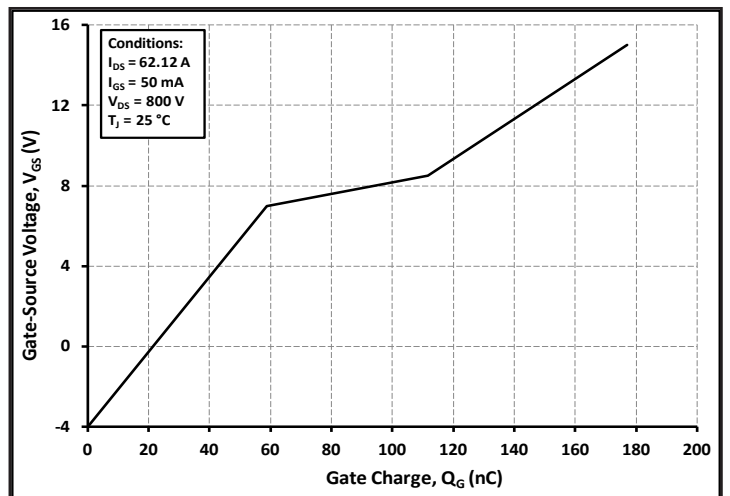


Figure 12. Gate Charge Characteristics

Typical Performance

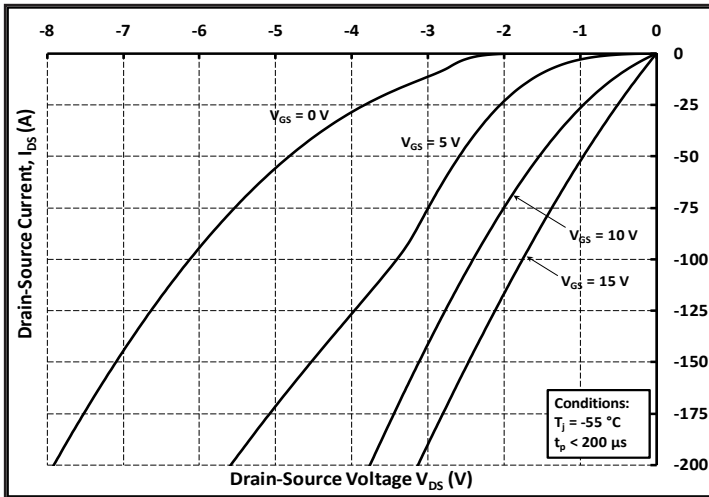
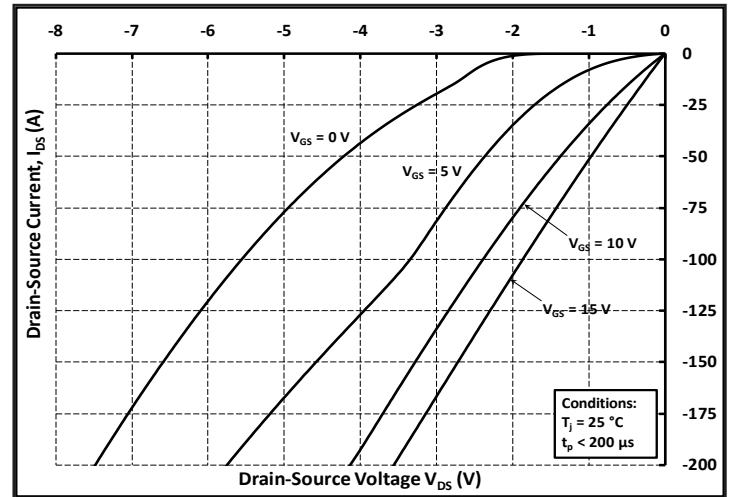
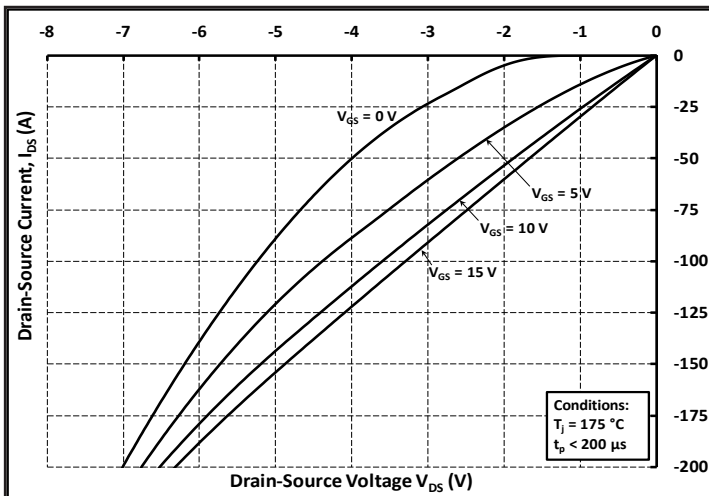
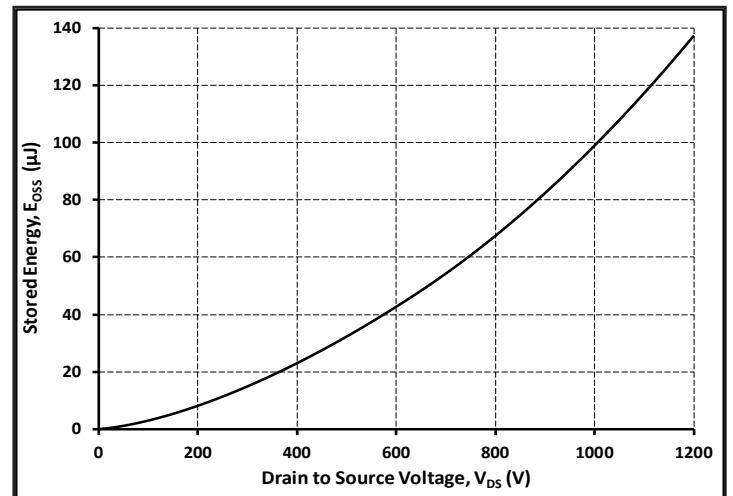
Figure 13. 3rd Quadrant Characteristic at $-55\text{ }^{\circ}\text{C}$ Figure 14. 3rd Quadrant Characteristic at $25\text{ }^{\circ}\text{C}$ Figure 15. 3rd Quadrant Characteristic at $175\text{ }^{\circ}\text{C}$ 

Figure 16. Output Capacitor Stored Energy

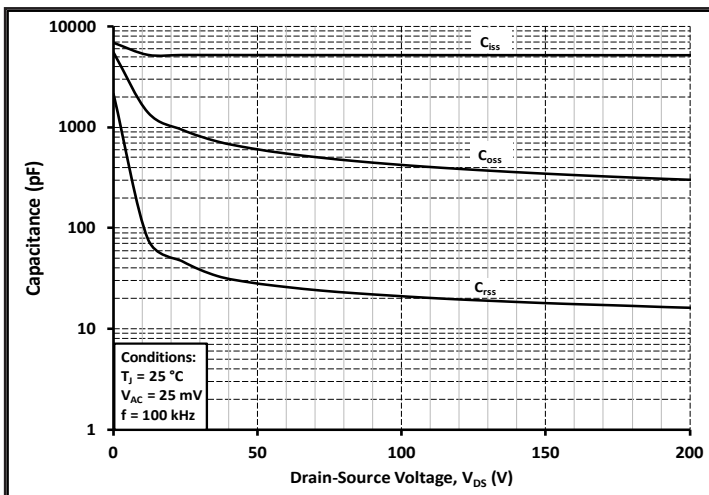


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

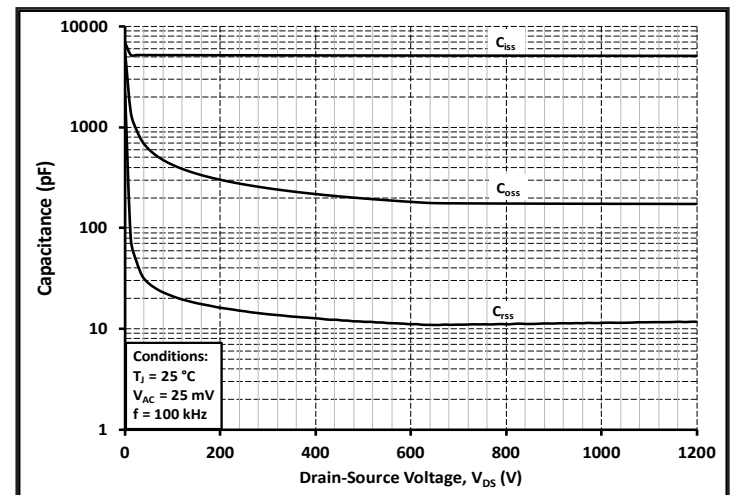


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)

Typical Performance

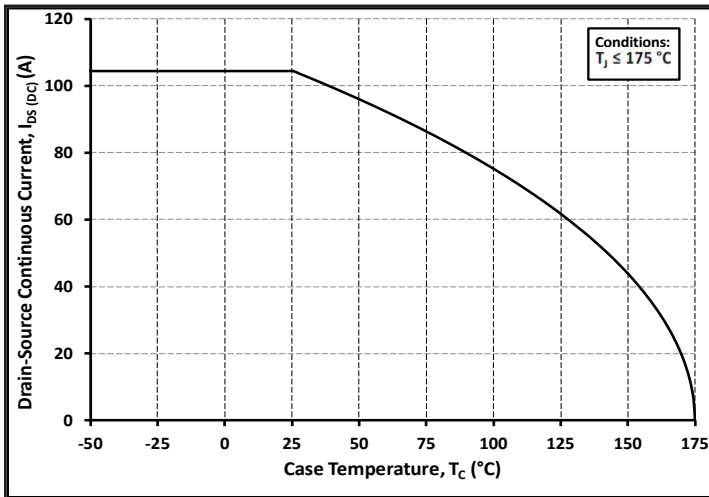


Figure 19. Continuous Drain Current Derating vs. Case Temperature

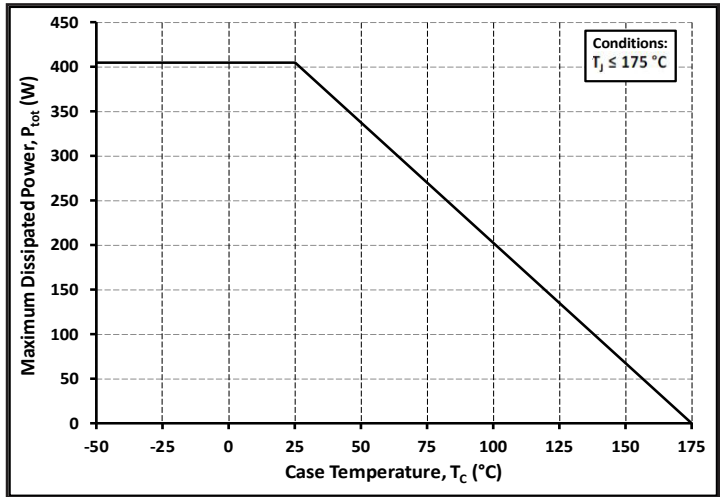


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

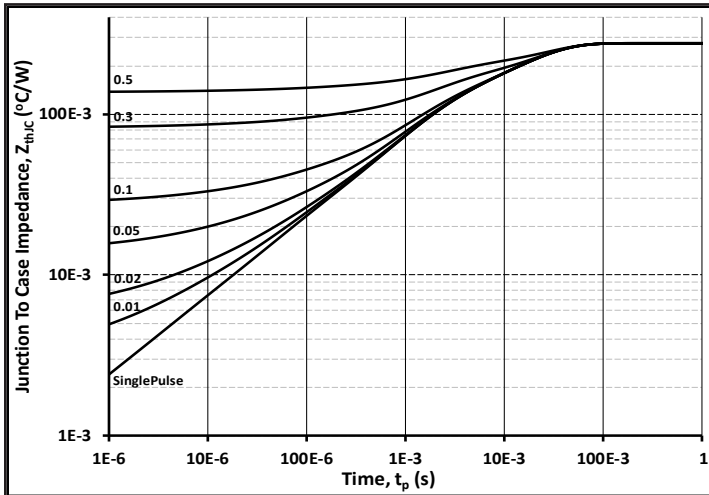


Figure 21. Transient Thermal Impedance (Junction - Case)

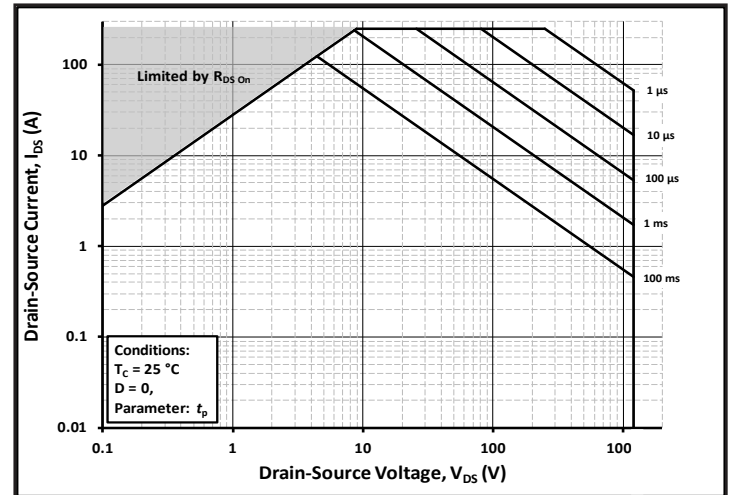
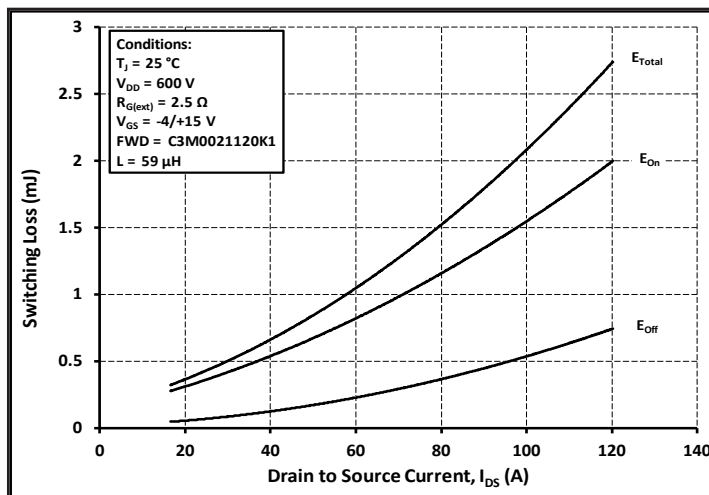
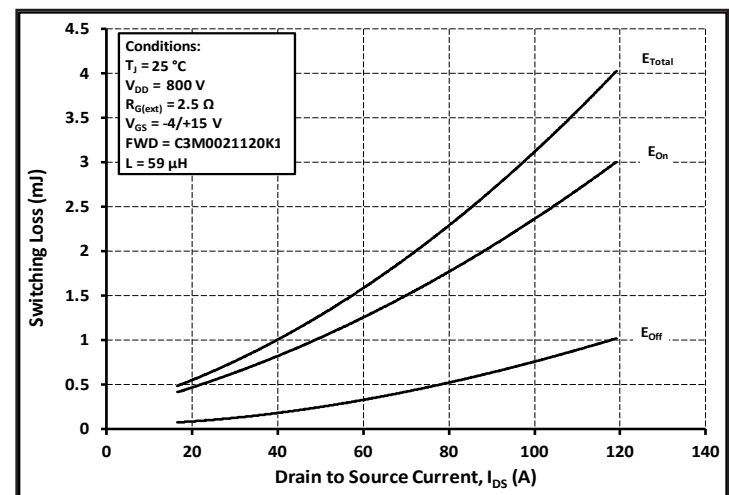


Figure 22. Safe Operating Area

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

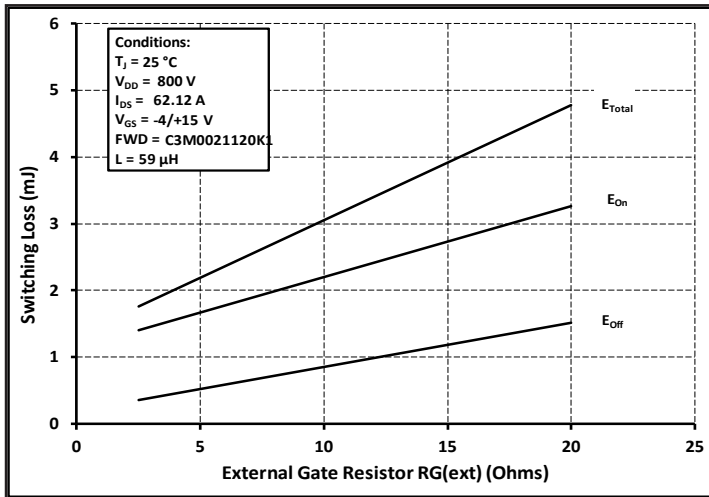
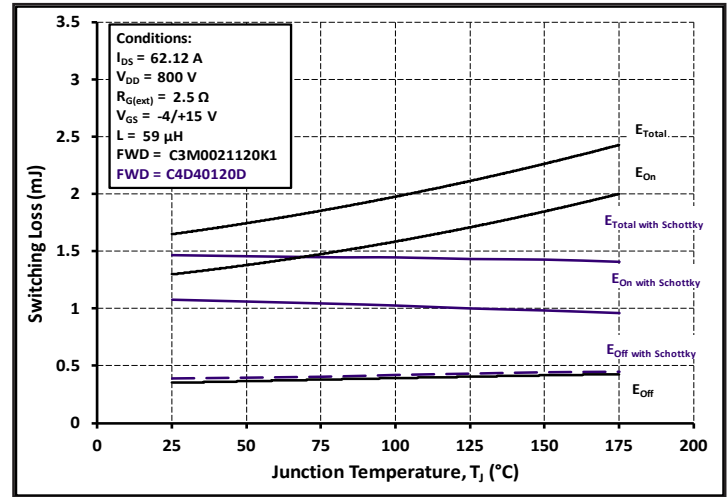
Figure 25. Clamped Inductive Switching Energy vs. $R_{G(\text{ext})}$ 

Figure 26. Clamped Inductive Switching Energy vs. Temperature

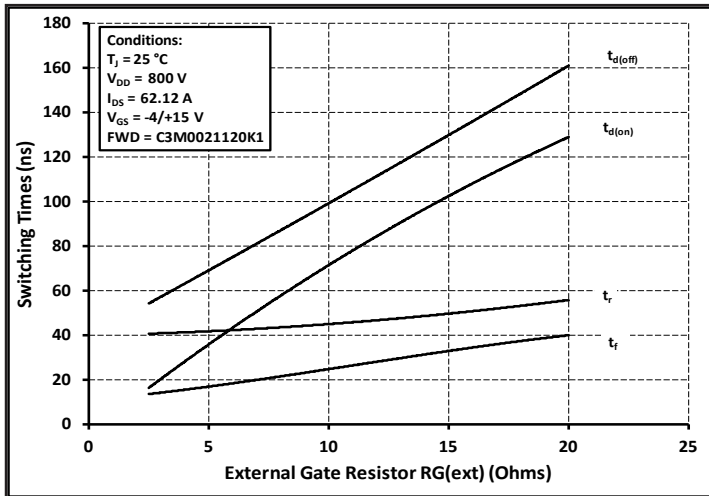
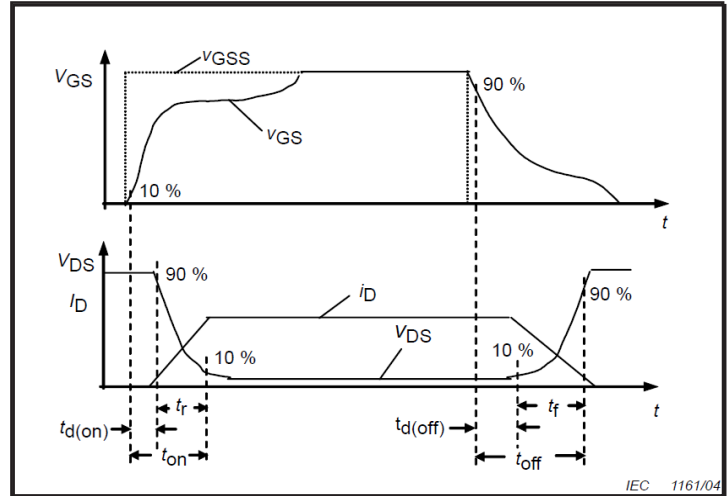
Figure 27. Switching Times vs. $R_{G(\text{ext})}$ 

Figure 28. Switching Times Definition

Test Circuit Schematic

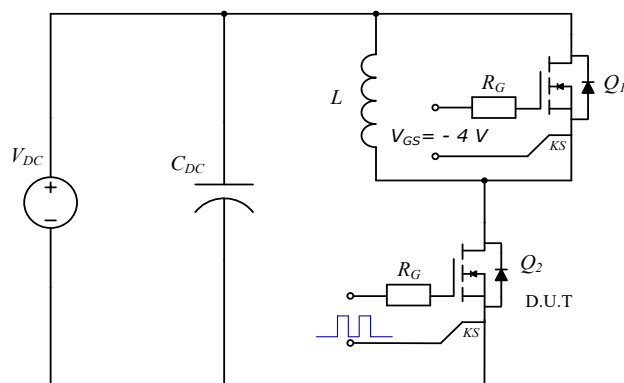
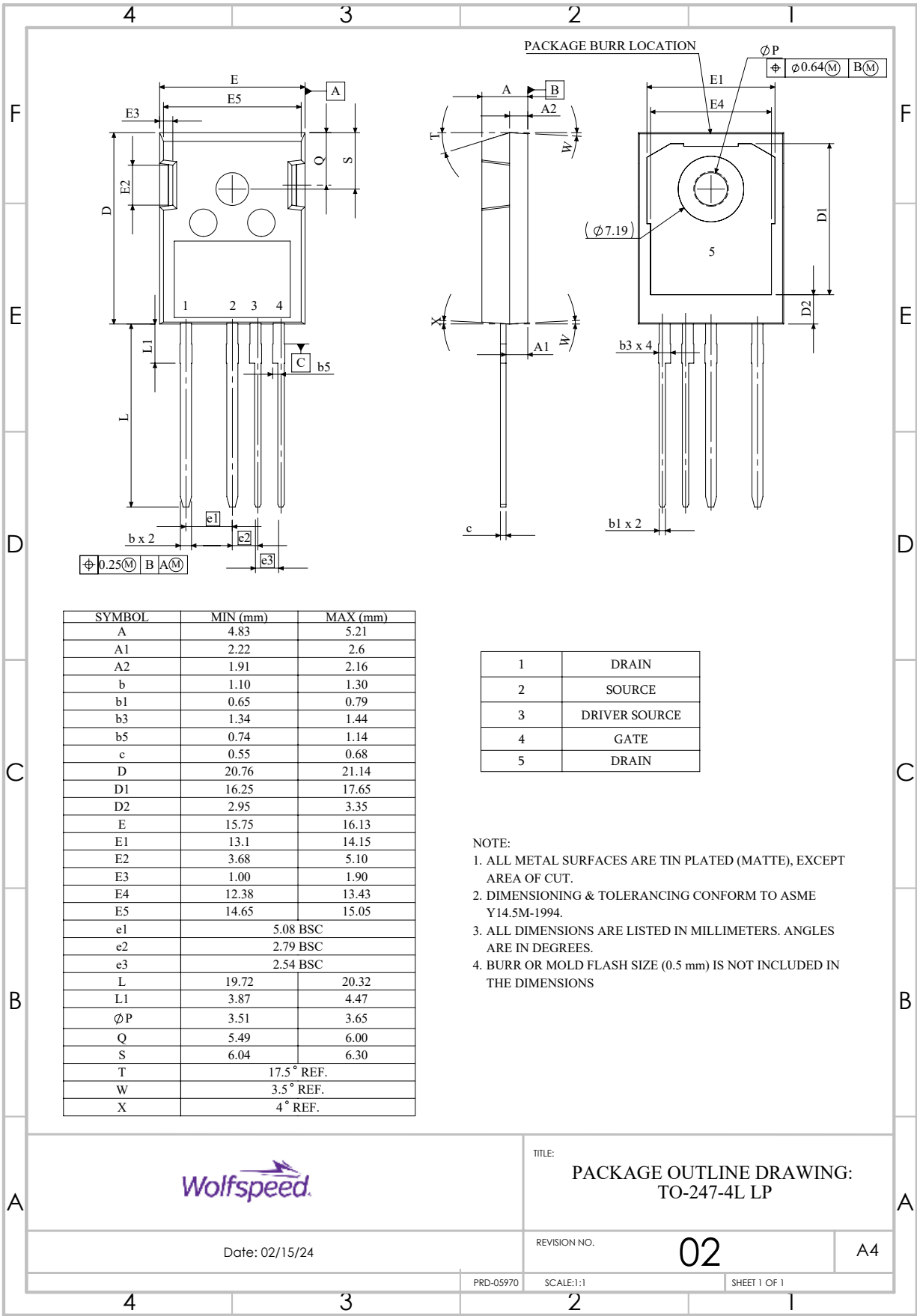


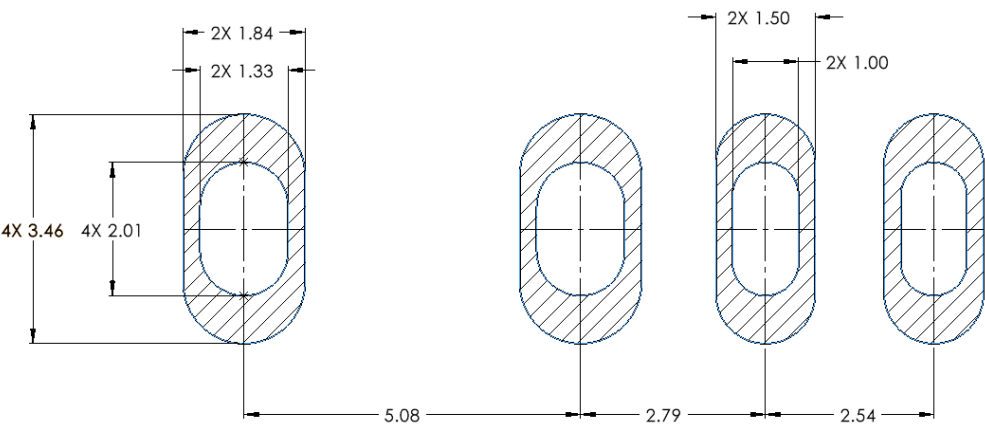
Figure 29. Clamped Inductive Switching
Waveform Test Circuit

Package Dimensions



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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