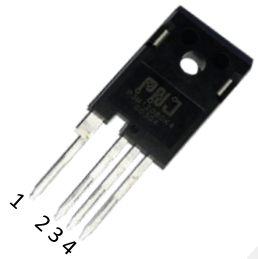
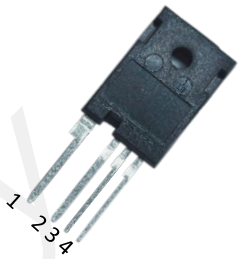
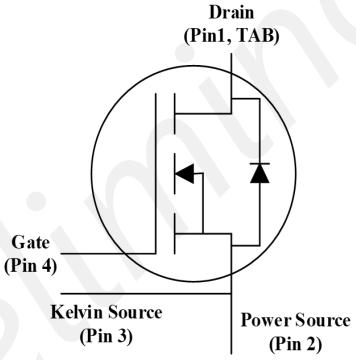
SiC MOSFET P3M15013K4/P3M15013K4S

N-Channel Enhancement Mode

TO-247-4	TO-247-4S
	

Features

- High Blocking Voltage with Low On-Resistance
- High-Frequency Operation
- Ultra-Small Q_{gd}
- 100% UIS tested



Standards Benefits

- Improve System Efficiency
- Increase Power Density
- Reduce Heat Sink Requirements
- Reduction of System Cost

TO-247-4

Drain	1
Power Source	2
Driver Source	3
Gate	4

Application

- Solar Inverters
- EV Battery Chargers
- High Voltage DC/DC Converters
- Switch Mode Power Supplies

Order Information

Part number	Package	Marking
P3M15013K4	TO-247-4	P3M15013K4
P3M15013K4S	TO-247-4S	P3M15013K4S

PNJ Preliminary

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PNJ Preliminary

1. Maximum Ratings

At T_J= 25℃, unless specified otherwise

Parameter	Symbol	Value	Unit	Test Conditions
Drain - Source Voltage	V_{DSmax}	1500	V	V_{GS}= 0V I_D= 100μA
Gate - Source Voltage (Dynamic)	V_{GSmax}	-8 / +22	V	Duty cycle ≤ 1%
Gate - Source Voltage (Static)	V_{GSop}	+15 / +18 -3	V	Static
Continuous Drain Current	I_D	130	A	V_{GS}= 18V T_C= 25℃
		92		V_{GS}= 18V T_C= 100℃
		121		V_{GS}= 15V T_C= 25℃
		85		V_{GS}= 15V T_C= 100℃
Pulsed Drain Current	$I_{D(pulse)}$	300	A	PW≤ 10us， Duty cycle ≤ 1%
Power Dissipation	P_D	652	W	
Operating Junction Temperature	T_J	-55 To +175	℃	
Storage Temperature	T_{stg}	-55 To +175	℃	
Solder Temperature	T_L	260	℃	
Mounting Torque	M_d	1 8.8	Nm lbf-in	M3 or 6-32 screw

PNJ Preliminary

2. Electrical Characteristics

At T_J= 25℃, unless specified otherwise

Parameter	Symbol	Value			Unit	Test Conditions
		Min.	Typ	Max.		
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	1500	/	/	V	V_{GS}= 0V I_D= 2.4mA
Gate Threshold Voltage	$V_{GS(th)}$	2.0	2.8	/	V	V_{DS}= V_{GS} I_D= 30mA T_J= 25℃
		/	2.0	/	V	V_{DS}= V_{GS} I_D= 30mA T_J= 175℃
Reverse Bias Drain Current	I_{DSS}	/	1	100	μA	V_{GS}= 0V V_{DS}= 1500V
Gate-Source Leakage Current	I_{GSS}	/	20	250	nA	V_{GS}= -5~18V V_{DS}= 0V
Drain-Source On-State Resistance	$R_{DS(on)}$	/	13	19	mΩ	V_{GS}= 18V I_D= 60A T_J= 25℃
		/	24	/		V_{GS}= 18V I_D= 60A T_J= 175℃
		/	15	/		V_{GS}= 15V I_D= 60A T_J= 25℃
		/	29	/		V_{GS}= 15V I_D= 60A T_J= 175℃
Trans conductance	g_{fs}	/	47	/	S	V_{DS}= 20V I_{DS}= 60A T_J= 25℃
		/	45	/	S	V_{DS}= 20V I_{DS}= 60A T_J= 175℃

PNJ Preliminary

Parameter	Symbol	Value			Unit	Test Conditions
		Min.	Typ	Max.		
Input Capacitance	C_{iss}	/	5380	/	pF	V_{GS}= 0V V_{DS}= 800V f= 400kHz V_{AC}= 25mV
Output Capacitance	C_{oss}	/	193	/	pF	
Reverse Transfer Capacitance	C_{rss}	/	14	/	pF	
Coss Stored Energy	E_{oss}	/	168	/	μJ	
Turn-on Energy	E_{on}	/	1020	/	μJ	V_{DS}= 800V V_{GS}= -4/15V I_{DS}=60A R_G= 1Ω
Turn-off Energy	E_{off}	/	647	/		
Turn-On Delay Time	$T_{d(on)}$	/	53	/	ns	
Rise Time	T_r	/	39	/		
Turn-Off Delay Time	$T_{d(off)}$	/	69	/		
Fall Time	T_f	/	23	/		
Turn-on Energy	E_{on}	/	767	/	μJ	V_{DS}= 800V V_{GS}= -4/18V I_{DS}=60A R_G= 1Ω
Turn-off Energy	E_{off}	/	555	/		
Turn-On Delay Time	$T_{d(on)}$	/	43	/	ns	
Rise Time	T_r	/	31	/		
Turn-Off Delay Time	$T_{d(off)}$	/	77	/		
Fall Time	T_f	/	25	/		
Internal Gate Resistance	$R_{G(int)}$	/	3.5	/	Ω	f= 1MHz V_{AC}= 25mV

PNJ Preliminary

Parameter	Symbol	Value			Unit	Test Conditions
		Min.	Typ	Max.		
Gate to Source Charge	Q_{gs}	/	55	/	nC	V_{DS}= 800V I_{DS}= 60A V_{GS}=-3/15V I_G= 20mA
Gate to Drain Charge	Q_{gd}	/	36	/		
Total Gate Charge	Q_g	/	167	/		
Gate to Source Charge	Q_{gs}	/	61	/		V_{DS}= 800V I_{DS}= 60A V_{GS}=-5/18V I_G= 20mA
Gate to Drain Charge	Q_{gd}	/	39	/		
Total Gate Charge	Q_g	/	203	/		

PNJ Preliminary

3. Reverse Diode Characteristics

At T_J= 25℃, unless specified otherwise

Parameter	Symbol	Value		Unit	Test Conditions
		Typ.	Max.		
Diode Forward Voltage	V_{SD}	4.1	/	V	V_{GS}= -3V I_{SD}= 30A T_J= 25℃
		3.7	/	V	V_{GS}= -3V I_{SD}= 30A T_J= 175℃
Continuous Diode Forward Current	I_S	/	130	A	V_{GS}= -3V
Reverse Recover Time	t_{rr}	67	/	ns	V_{GS}= -4/15V I_{SD}= 60A V_R= 800V d_{if}/d_t= 3300A/μs T_J= 25℃
Reverse Recovery Charge	Q_{rr}	949	/	nC	
Peak Reverse Recovery Current	I_{rrm}	30	/	A	
Reverse Recover Time	t_{rr}	63	/	ns	V_{GS}= -4/18V I_{SD}= 60A V_R= 800V d_{if}/d_t= 4400A/μs T_J= 25℃
Reverse Recovery Charge	Q_{rr}	986	/	nC	
Peak Reverse Recovery Current	I_{rrm}	36	/	A	

4. Thermal Characteristics

Parameter	Symbol	Value	Unit
Thermal Resistance from Junction to Case	$R_{\theta JC}$	0.23	℃/W

PNJ Preliminary

5. Typical Performance

At T_J= 25℃, unless specified otherwise

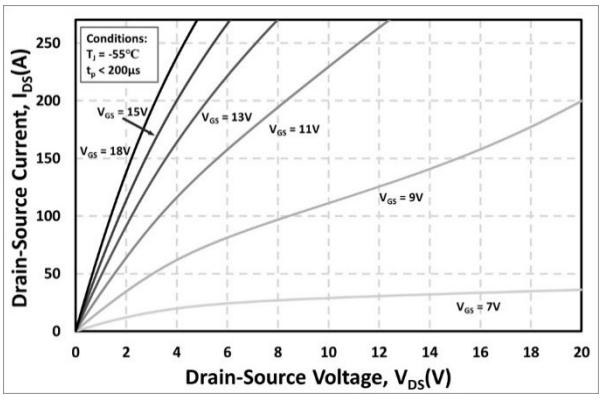

Figure 1. Output Characteristics T_J = -55℃

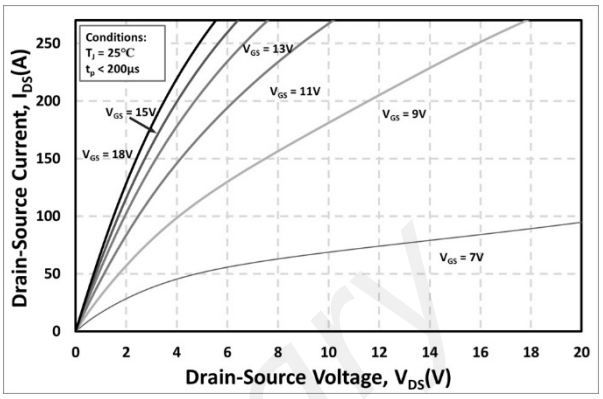

Figure 2. Output Characteristics T_J = 25℃

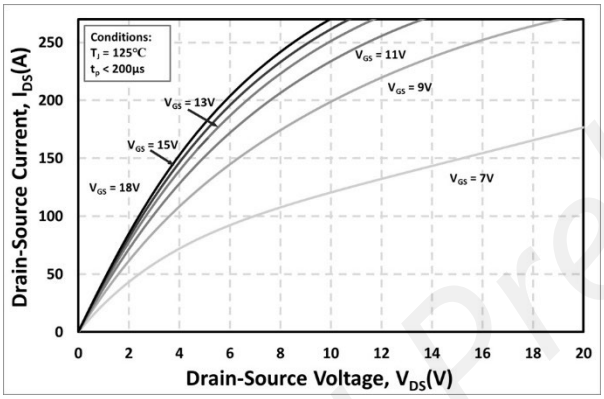

Figure 3. Output Characteristics T_J = 125℃

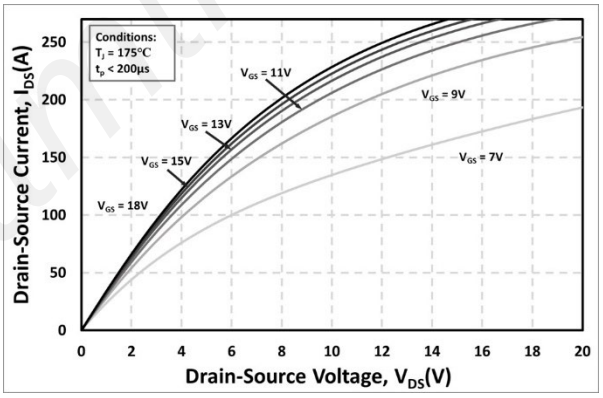

Figure 4. Output Characteristics T_J = 175℃

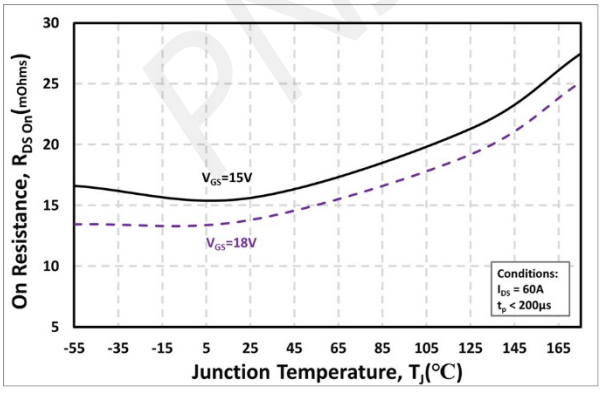

Figure 5. On-Resistance vs. Temperature

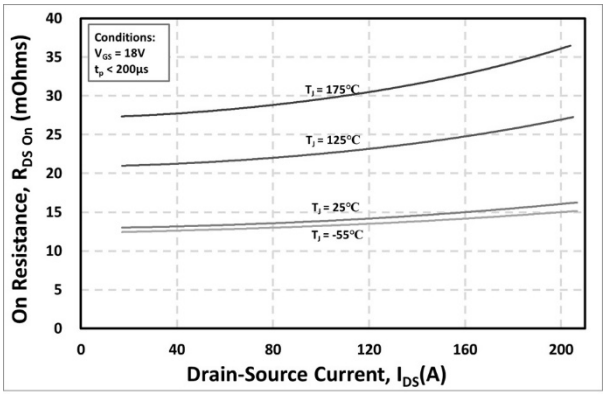

Figure 6. On-Resistance vs. Drain Current Various Temperatures

PNJ Preliminary

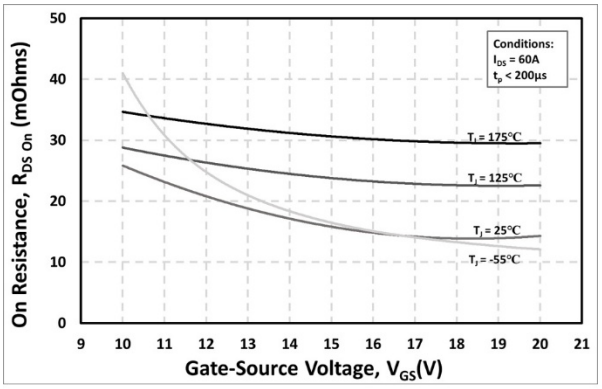

Figure 7. On-Resistance vs. Gate-Source Voltage

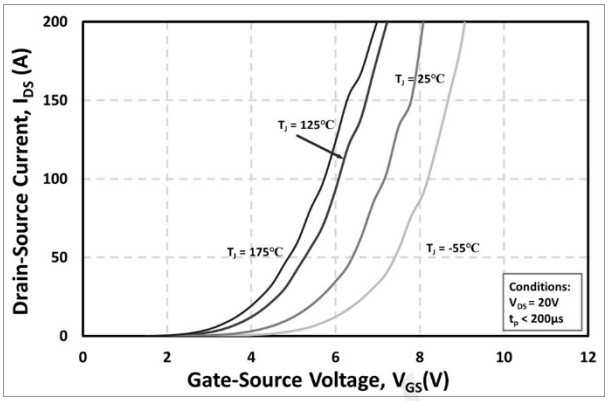

Figure 8. Transfer Characteristic for Various Junction Temperatures

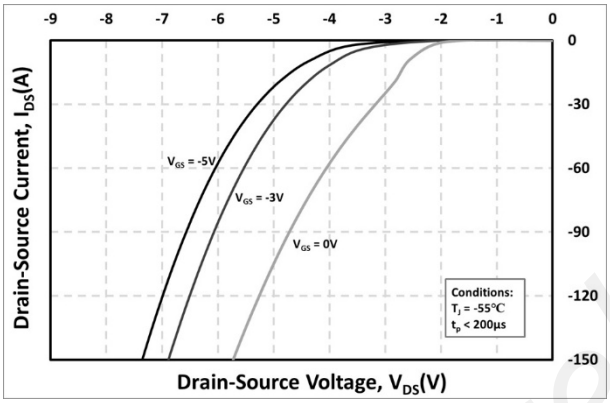

Figure 9. Body Diode Characteristic at -55°C

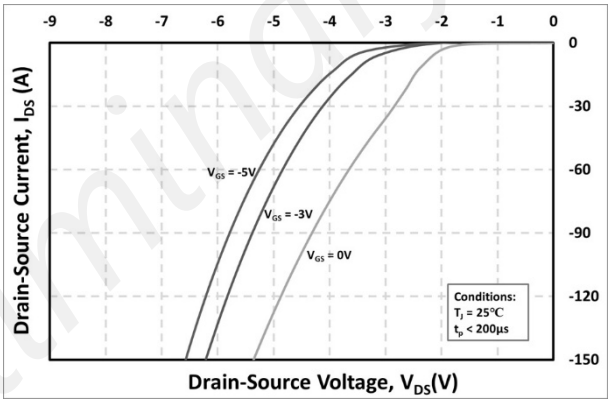

Figure 10. Body Diode Characteristic at 25°C

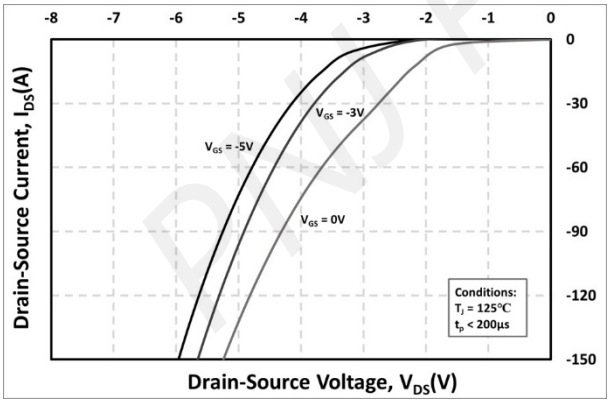

Figure 11. Body Diode Characteristic at 125°C

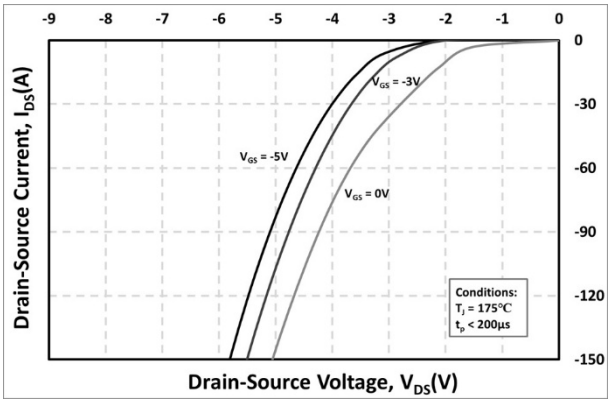

Figure 12. Body Diode Characteristic at 175°C

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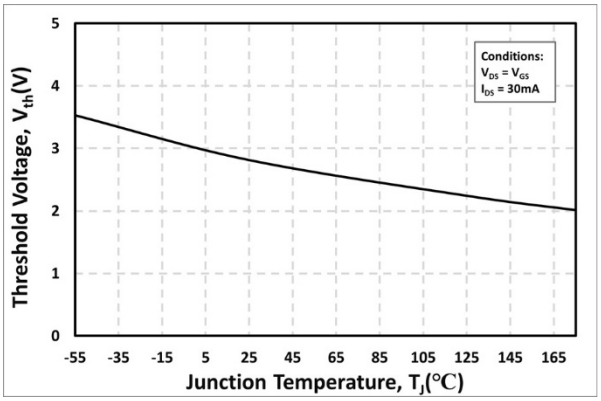

Figure 13. Threshold Voltage vs. Temperature

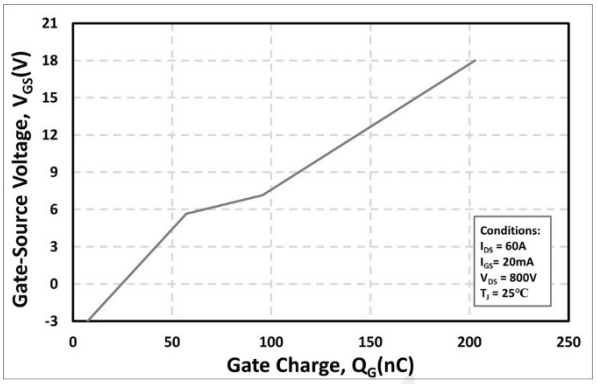

Figure 14. Gate Charge Characteristics

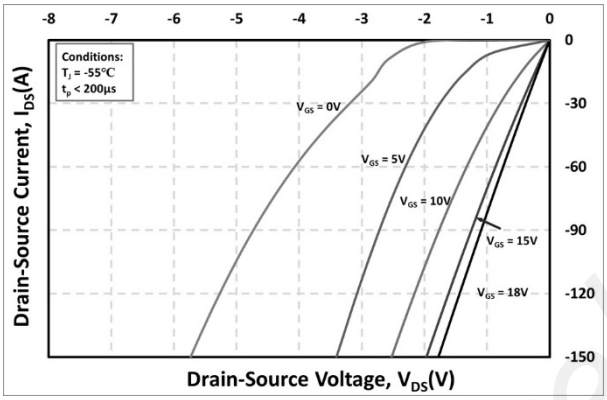

Figure 15. 3rd Quadrant Characteristic at -55°C

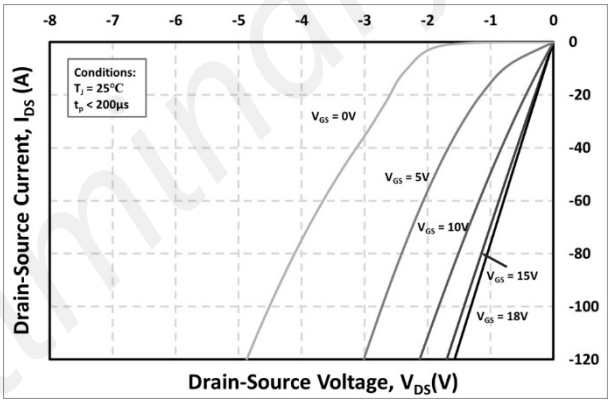

Figure 16. 3rd Quadrant Characteristic at 25°C

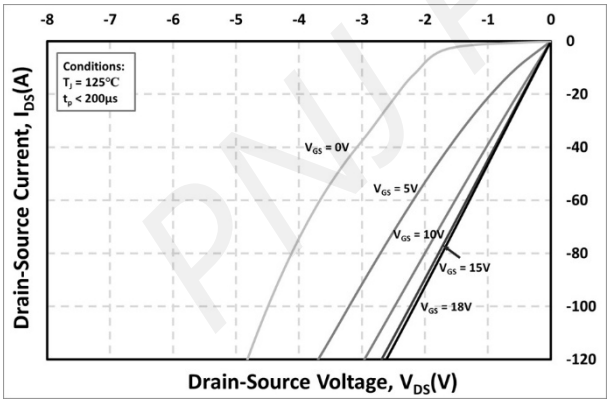

Figure 17. 3rd Quadrant Characteristic at 125°C

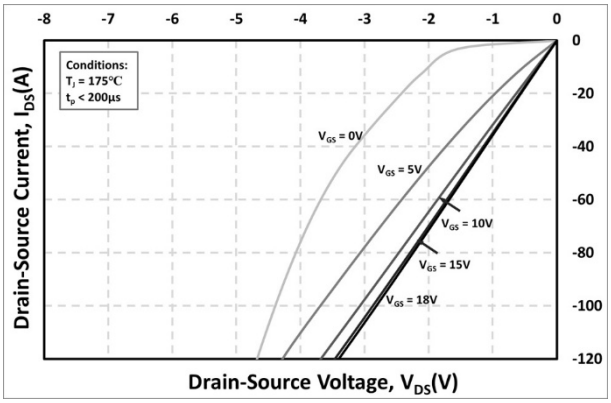

Figure 18. 3rd Quadrant Characteristic at 175°C

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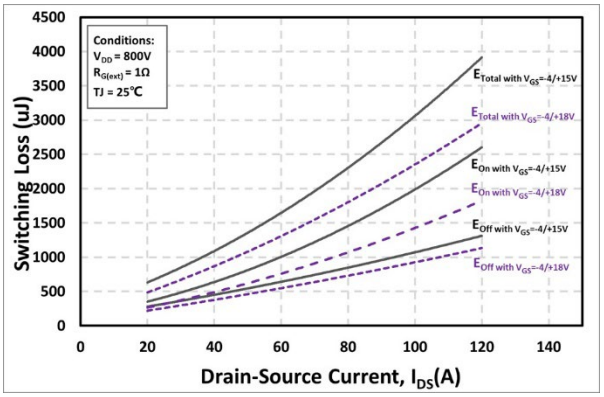

Figure 19. Clamped Inductive Switching Energy vs. Drain Current (V_{DD}= 800V)

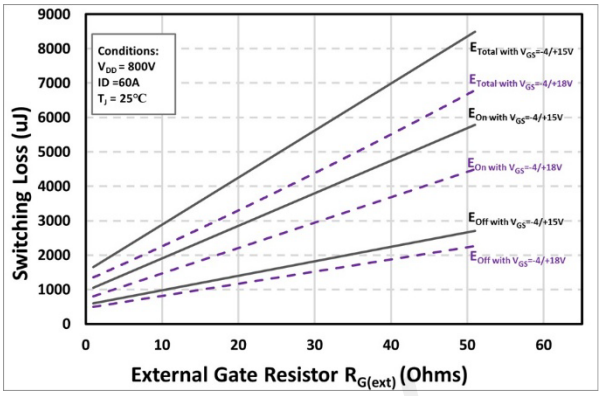

Figure 20. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

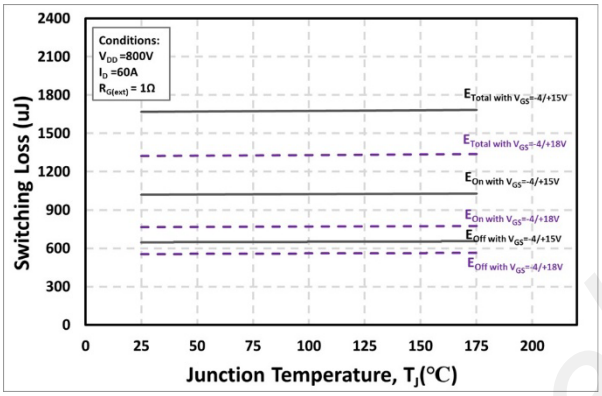

Figure 21. Clamped Inductive Switching Energy vs. Temperature

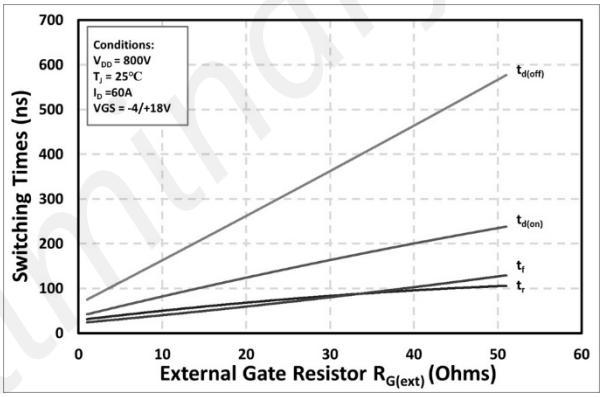

Figure 22. Switching Times vs. $R_{G(ext)}$

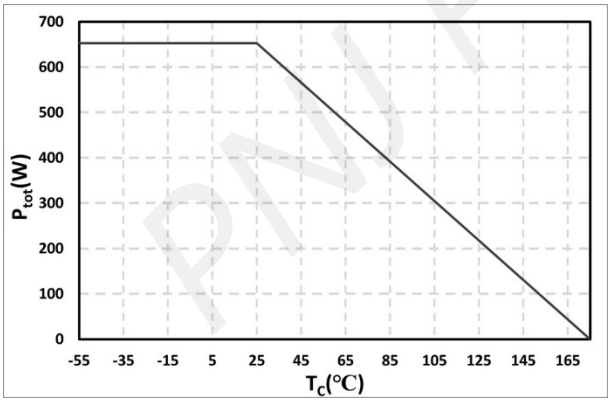

Figure 23. Maximum Power Dissipation Derating vs. Case Temperature

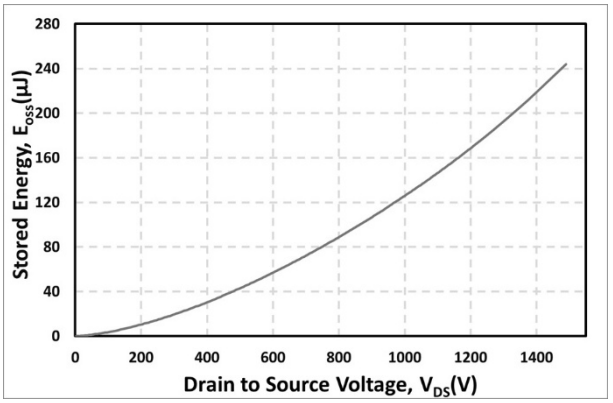

Figure 24. Output Capacitor Stored Energy

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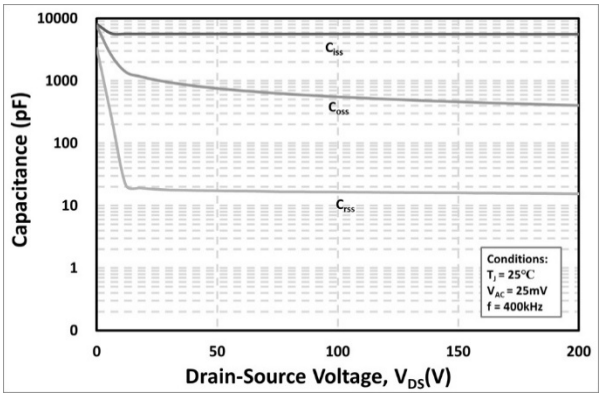

Figure 25. Capacitances vs. Drain-Source Voltage (0 - 200V)

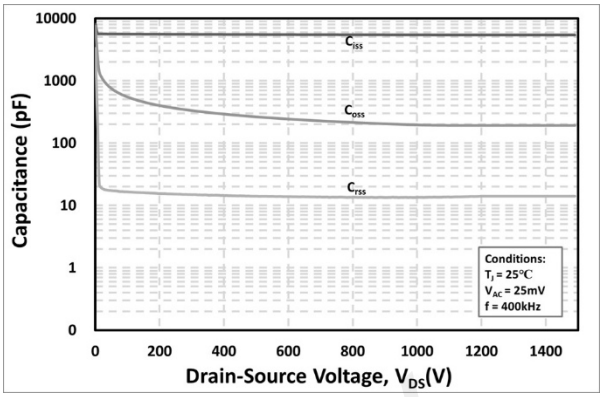

Figure 26. Capacitances vs. Drain-Source Voltage (0 - 1500V)

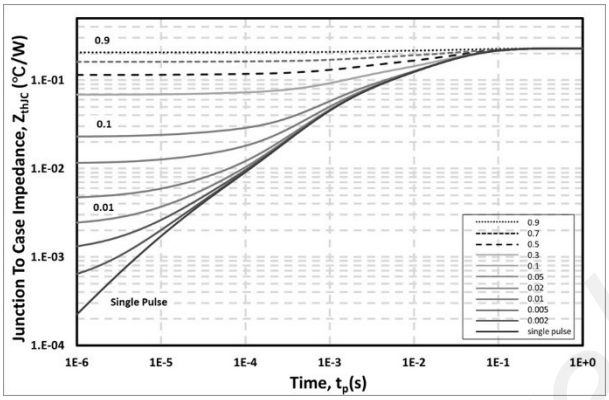

Figure 27. Transient Thermal Impedance (Junction - Case)

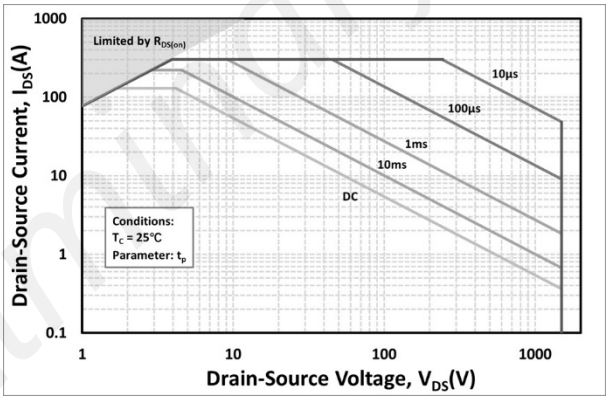

Figure 28. Safe Operating Area

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6. Definitions

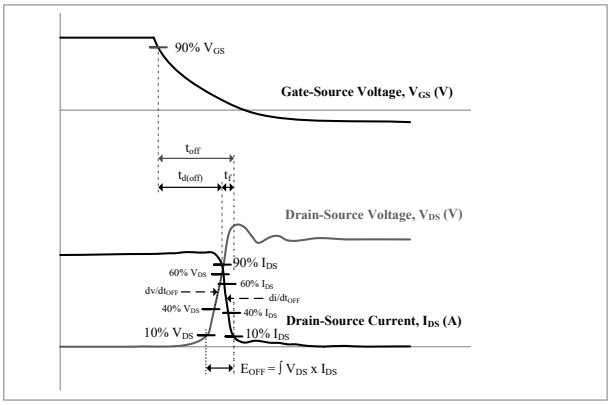

Figure 29. Turn-off Transient Definitions

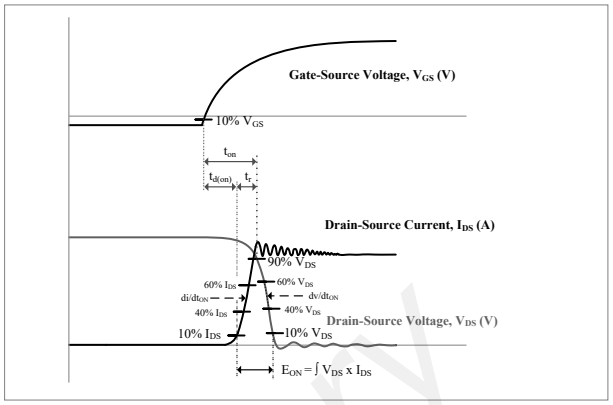

Figure 30. Turn-on Transient Definitions

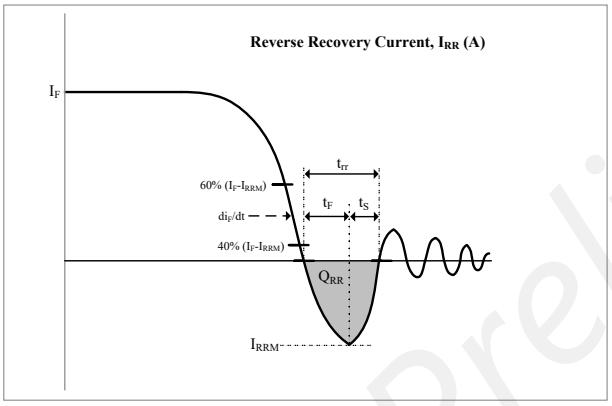

Figure 31. Reverse Recovery Definitions

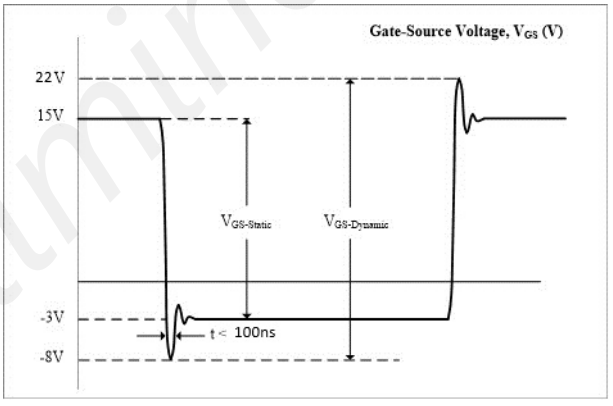

Figure 32. Vgs Transient Definitions

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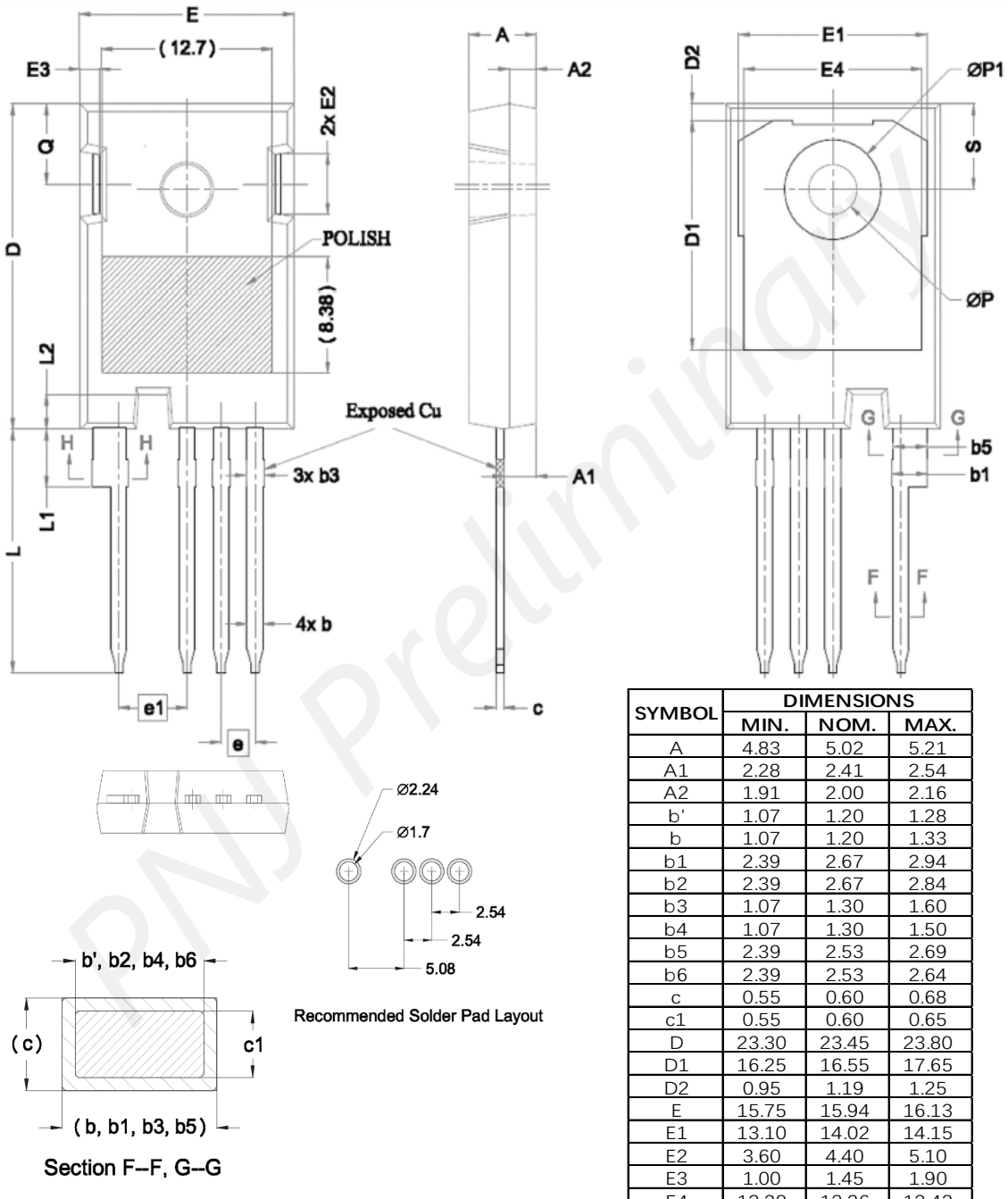
7. Package Outlines

TO-247-4 Drawing and Dimension



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	4.83	5.02	5.21
A1	2.28	2.41	2.54
A2	1.91	2.00	2.16
b'	1.07	1.20	1.28
b	1.07	1.20	1.33
b1	2.39	2.67	2.94
b2	2.39	2.67	2.84
b3	1.07	1.30	1.60
b4	1.07	1.30	1.50
b5	2.39	2.53	2.69
b6	2.39	2.53	2.64
c	0.55	0.60	0.68
c1	0.55	0.60	0.65
D	23.30	23.45	23.80
D1	16.25	16.55	17.65
D2	0.95	1.19	1.25
E	15.75	15.94	16.13
E1	13.10	14.02	14.15
E2	3.60	4.40	5.10
E3	1.00	1.45	1.90
E4	12.38	13.26	13.43
●	2.54 BSC		
e1	5.08 BSC		
L	17.31	17.57	17.82
L1	3.97	4.19	4.37
L2	2.35	2.50	2.65
ΦP	3.51	3.61	3.65
ΦP1	7.19 REF		
Q	5.49	5.79	6.00
S	6.04	6.17	6.30

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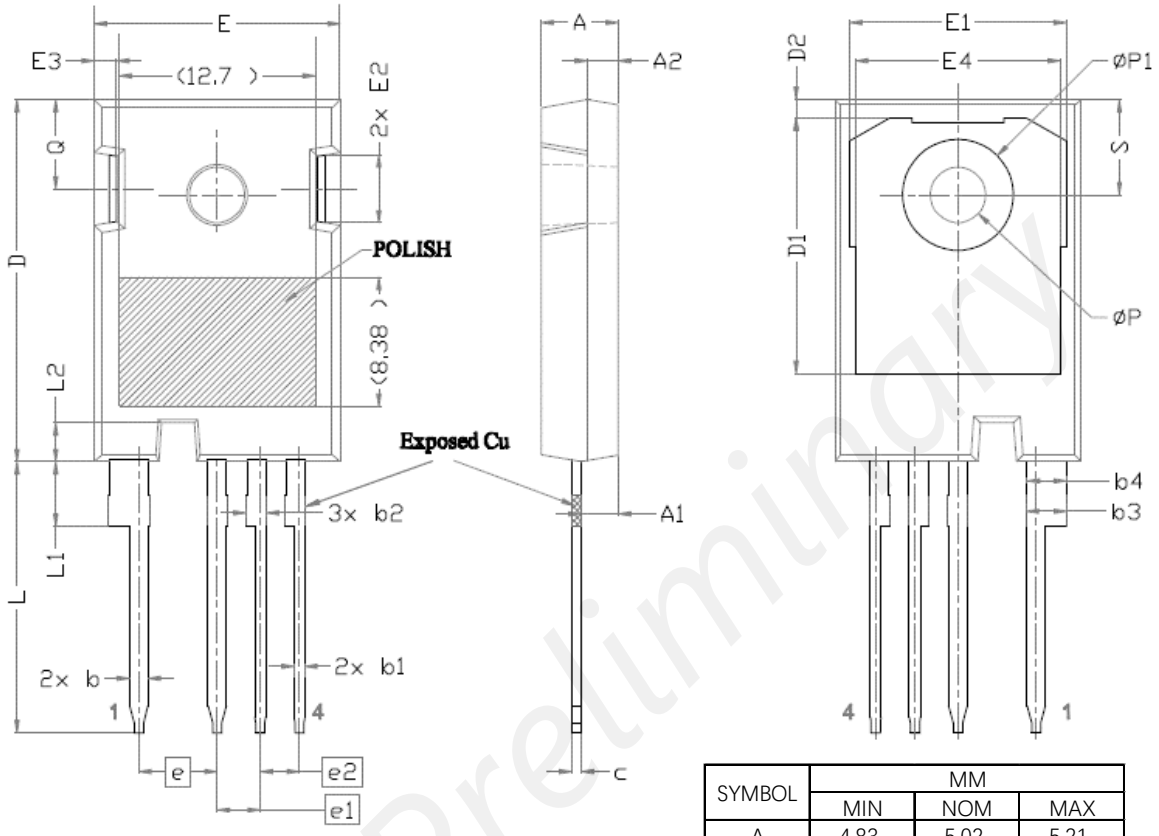
TO-247-4S Drawing and Dimension



SYMBOL	MM		
	MIN	NOM	MAX
A	4.83	5.02	5.21
A1	2.29	2..41	2.54
A2	1.91	2.00	2.16
b	1.10	1.20	1.30
b1	0.65	0.70	0.80
b2	1.07	1.30	1.60
b3	2.39	2.67	2.94
b4	2.39	2.53	2.69
c	0.55	0.60	0.68
c1	0.55	0.60	0.65
D	23.30	23.45	23.60
D1	16.25	16.55	17.65
D2	0.95	1.19	1.25
E	15.75	15.94	16.13
E1	13.10	14.02	14.15
E2	3.68	4.40	5.10
E3	1.00	1.45	1.90
E4	12.38	13.26	13.43
e	5.08 BSC		
e1	2.79 BSC		
e2	2.54 BSC		
L	17.31	17.57	17.82
L1	3.97	4.19	4.37
L2	2.35	2.50	2.65
ΦP	3.51	3.61	3.65
ΦP1	7.19 REF.		
Q	5.49	5.79	6.00
S	6.04	6.17	6.30

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