



## SiC MOS P3M06040K4

### N-Channel Enhancement Mode

#### Features

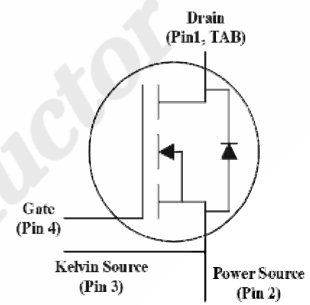
- Qualified to AEC-Q101
- High Blocking Voltage with Low On-Resistance
- High-Frequency Operation
- Ultra-Small  $Q_{gd}$
- 100% UIS tested

#### Benefits

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

#### Applications

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



TO-247-4

Drain	1
Power Source	2
Kelvin Source	3
Gate	4



#### Order Information

Part Number	Package	Marking
P3M06040K4	TO-247-4	P3M06040K4



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## 1. Maximum Ratings

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

Parameter	Symbol	Value	Unit	Test Conditions
Drain - Source Voltage	$V_{DSmax}$	650	V	$V_{GS} = 0V$ $I_D = 100\mu A$
Gate - Source Voltage (dynamic)	$V_{GSmax}$	-8 / +20	V	AC ( $f > 1 \text{ Hz}$ )
Gate - Source Voltage(static) turn-on gate voltage turn-off gate voltage	$V_{GS,on}$ $V_{GS,off}$	+15 / +18 -3	V	Static
Continuous Drain Current	$I_D$	68	A	$V_{GS} = 15V$ $T_C = 25^\circ\text{C}$
		48		$V_{GS} = 15V$ $T_C = 100^\circ\text{C}$
Pulsed Drain Current	$I_{D(pulse)}$	123	A	
Power Dissipation	$P_D$	254	W	
Operating Junction	$T_J$	-55 To +175	$^\circ\text{C}$	
Storage Temperature	$T_{stg}$	-55 To +175	$^\circ\text{C}$	
Solder Temperature	$T_L$	260	$^\circ\text{C}$	
Mounting Torque	$M_d$	1 8.8	Nm lbf-in	M3 or 6-32 screw



## 2. Electrical Characteristics

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

Parameter	Symbol	Value			Unit	Test Conditions
		Min.	Typ.	Max.		
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	650	/	/	V	$V_{GS} = 0V$ $I_D = 100\mu A$
Gate Threshold Voltage	$V_{GS(th)}$	1.8	2.4	/	V	(tested after 30ms pulse at $V_{GS} = 15V$ ) $V_{DS} = V_{GS}$ $I_D = 7.5mA$ $T_J = 25^\circ\text{C}$
		/	1.6	/	V	$V_{DS} = V_{GS}$ $I_D = 7.5mA$ $T_J = 175^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	/	1	100	$\mu A$	$V_{GS} = 0V$ $V_{DS} = 650V$
Gate-Source Leakage Current	$I_{GSS}$	/	20	250	nA	$V_{GS} = 15V$ $V_{DS} = 0V$
Drain-Source On-State Resistance	$R_{DS(on)}$	/	40	52	m $\Omega$	$V_{GS} = 15V$ $I_D = 40A$ $T_J = 25^\circ\text{C}$
		/	36	/		$V_{GS} = 18V$ $I_D = 40A$ $T_J = 25^\circ\text{C}$
Trans conductance	$g_{fs}$	/	16	/	S	$V_{DS} = 20V$ $I_{DS} = 40A$ $T_J = 25^\circ\text{C}$
		/	15	/		$V_{DS} = 20V$ $I_{DS} = 40A$ $T_J = 175^\circ\text{C}$



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Parameter	Symbol	Value			Unit	Test Conditions
		Min.	Typ.	Max.		
Input Capacitance	$C_{iss}$	/	3398	/	pF	$V_{GS} = 0V$ $V_{DS} = 400V$ $f = 1MHz$ $V_{AC} = 25mV$
Output Capacitance	$C_{oss}$	/	243	/		
Reverse Transfer Capacitance	$C_{rss}$	/	9.7	/		
Coss Stored Energy	$E_{oss}$	/	46.4	/	$\mu J$	
Turn-on Energy	$E_{on}$	/	172	/	$\mu J$	$V_{DS} = 400V$ $V_{GS} = -3/15V$ $I_D = 40A$ $R_G = 1\Omega$
Turn-off Energy	$E_{off}$	/	30	/		
Turn-on Energy	$E_{on}$	/	100	/	$\mu J$	$V_{DS} = 400V$ $V_{GS} = -3/18V$ $I_D = 40A$ $R_G = 1\Omega$
Turn-off Energy	$E_{off}$	/	29	/		
Turn-On Delay Time	$t_{d(on)}$	/	18	/	ns	$V_{DS} = 400V$ $V_{GS} = -3/15V$ $I_D = 40A$ $R_G = 1\Omega$
Rise Time	$t_r$	/	25	/		
Turn-Off Delay Time	$t_{d(off)}$	/	27	/		
Fall Time	$t_f$	/	6	/		
Internal Gate Resistance	$R_{G(int)}$	/	0.9	/	$\Omega$	$f = 1MHz$ $V_{AC} = 25mV$
Gate to Source Charge	$Q_{gs}$	/	41.2	/	nC	$V_{DS} = 400V$ $I_{DS} = 40A$ $V_{GS} = -3 \text{ to } 15V$ $I_G = 20mA$
Gate to Drain Charge	$Q_{gd}$	/	20.5	/		
Total Gate Charge	$Q_g$	/	87.3	/		



### 3. Reverse Diode Characteristics

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

Parameter	Symbol	Value		Unit	Test Conditions
		Typ.	Max.		
Diode Forward Voltage	$V_{SD}$	5.7	/	V	$V_{GS} = -3\text{V}$ $I_{SD} = 20\text{A}$ $T_J = 25^\circ\text{C}$
		5.0	/	V	$V_{GS} = -3\text{V}$ $I_{SD} = 20\text{A}$ $T_J = 175^\circ\text{C}$
Continuous Diode Forward Current	$I_S$	40.6	/	A	$V_{GS} = -3\text{V}$
Reverse Recover Time	$t_{rr}$	17	/	ns	$V_{GS} = -3\text{V}$ $I_{SD} = 40\text{A}$ $V_R = 400\text{V}$ $d_{if}/d_t = 3600\text{A}/\mu\text{s}$ $T_J = 25^\circ\text{C}$
Reverse Recovery Charge	$Q_{rr}$	376	/	nC	
Peak Reverse Recovery Current	$I_{rrm}$	38	/	A	$T_J = 25^\circ\text{C}$
Reverse Recover Time	$t_{rr}$	16	/	ns	$V_{GS} = -3\text{V}$ $I_{SD} = 40\text{A}$ $V_R = 400\text{V}$ $d_{if}/d_t = 4200\text{A}/\mu\text{s}$ $T_J = 25^\circ\text{C}$
Reverse Recovery Charge	$Q_{rr}$	433	/	nC	
Peak Reverse Recovery Current	$I_{rrm}$	45	/	A	

### 4. Thermal Characteristics

Parameter	Symbol	Value	Unit
Thermal Resistance from Junction to Case	$R_{\theta JC}$	0.59	$^\circ\text{C}/\text{W}$

## 5. Typical Performance

At  $T_J = 25^\circ\text{C}$ , unless specified otherwise

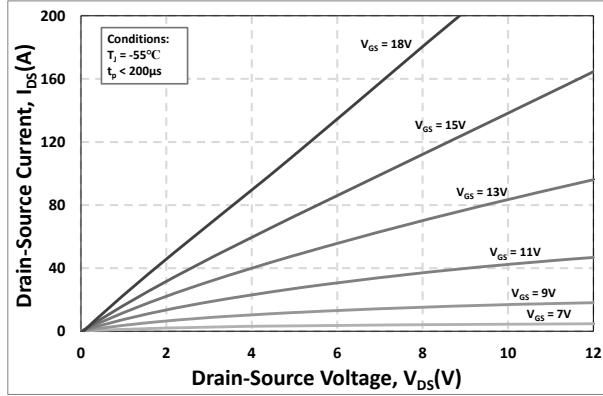


Figure 1. Output Characteristics  $T_J = -55^\circ\text{C}$

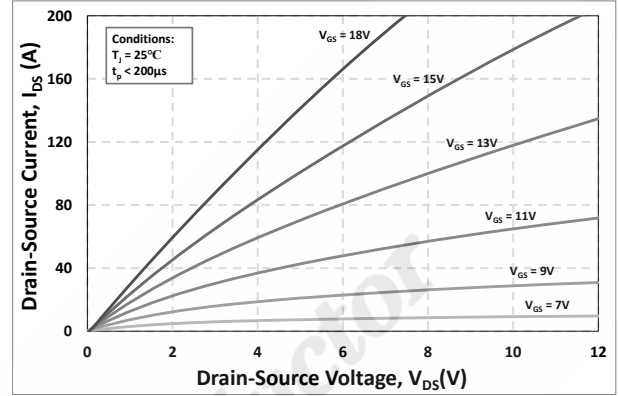


Figure 2. Output Characteristics  $T_J = 25^\circ\text{C}$

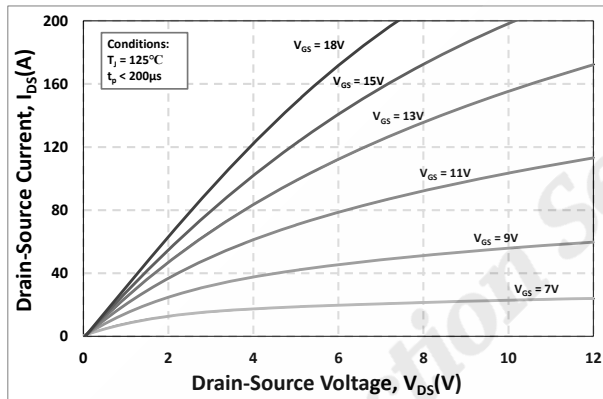


Figure 3. Output Characteristics  $T_J = 125^\circ\text{C}$

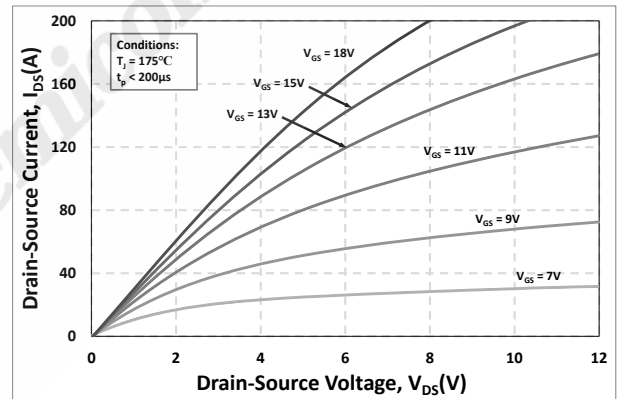


Figure 4. Output Characteristics  $T_J = 175^\circ\text{C}$

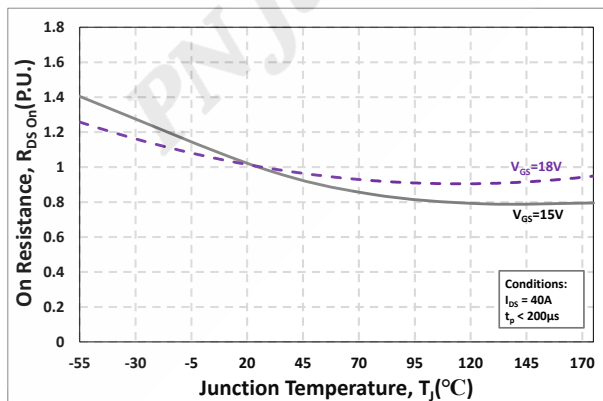


Figure 5. Normalized On-Resistance vs. Temperature

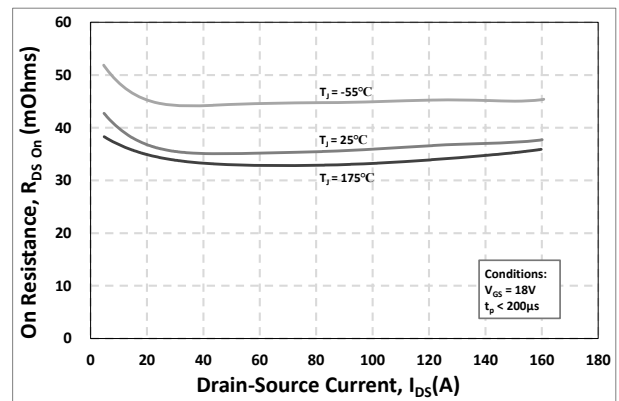


Figure 6. On-Resistance vs. Drain Current Various Temperatures



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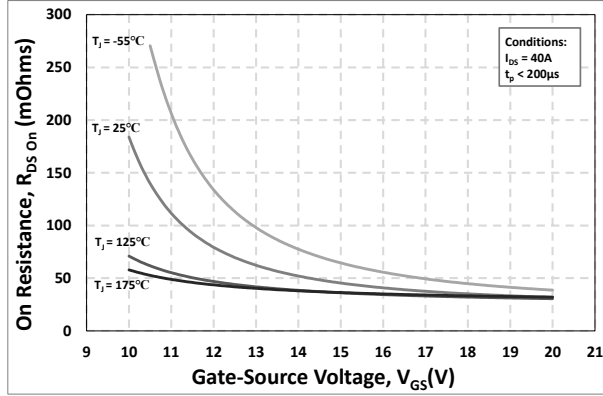


Figure 7. On-Resistance vs. Gate-Source Voltage

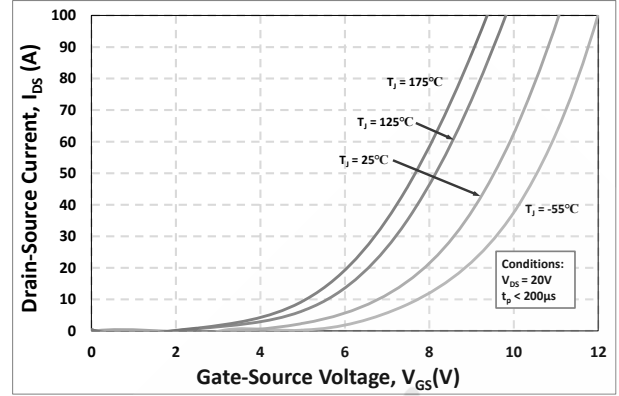


Figure 8. Transfer Characteristic for Various Junction Temperatures

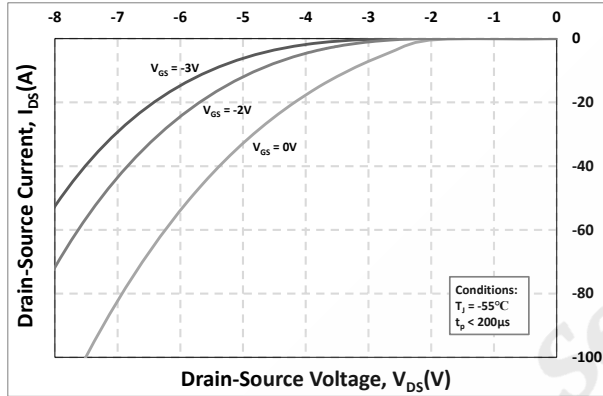


Figure 9. Body Diode Characteristic at -55°C

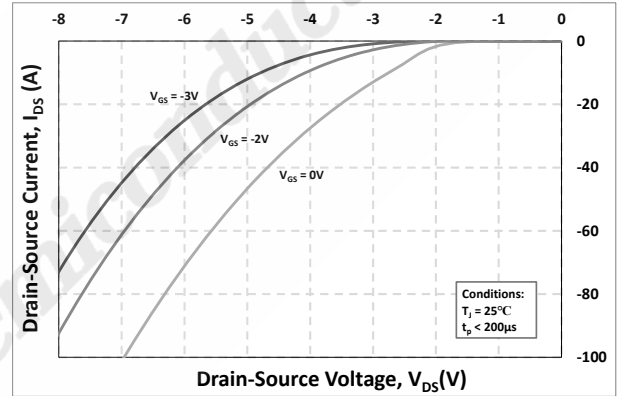


Figure 10. Body Diode Characteristic at 25°C

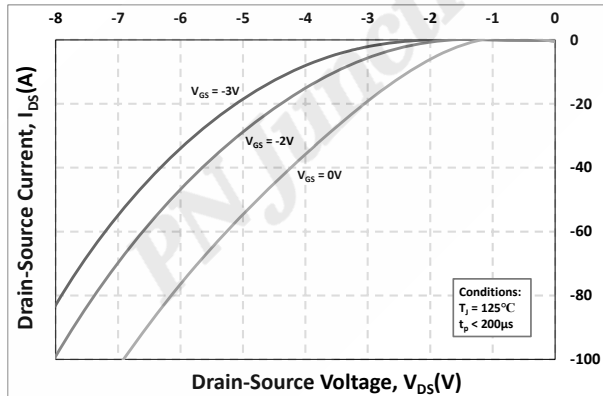


Figure 11. Body Diode Characteristic at 125°C

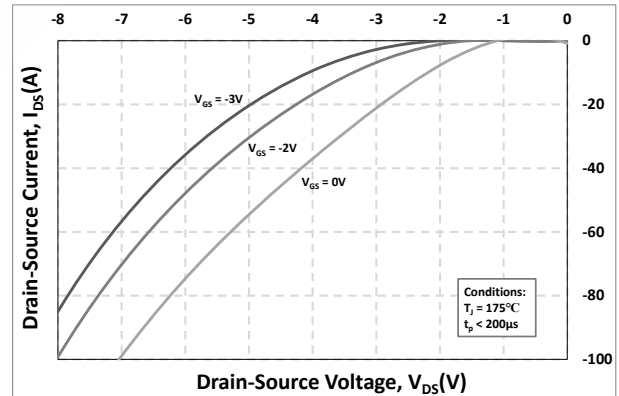


Figure 12. Body Diode Characteristic at 175°C



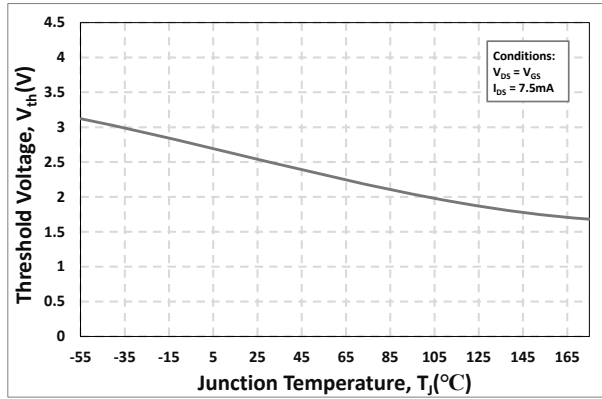


Figure 13. Threshold Voltage vs. Temperature

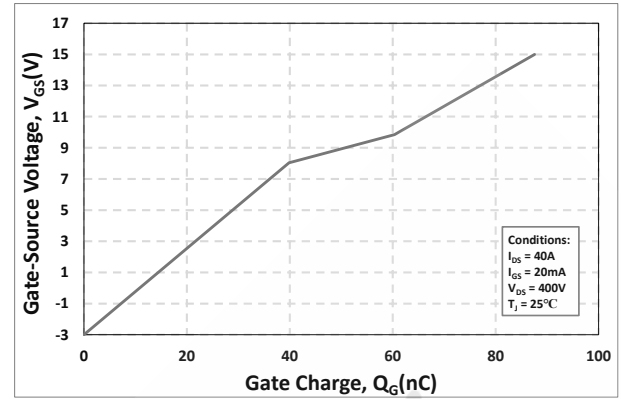


Figure 14. Gate Charge Characteristics

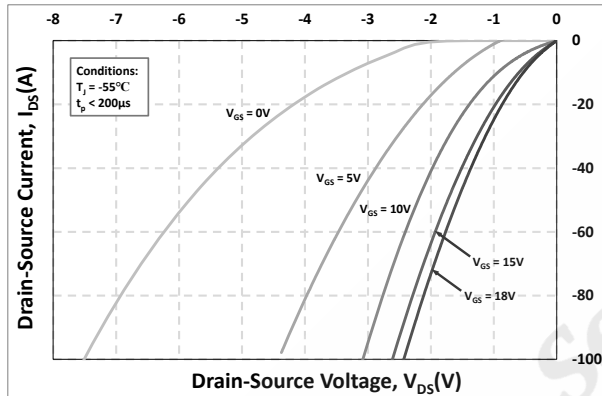


Figure 15. 3rd Quadrant Characteristic at -55°C

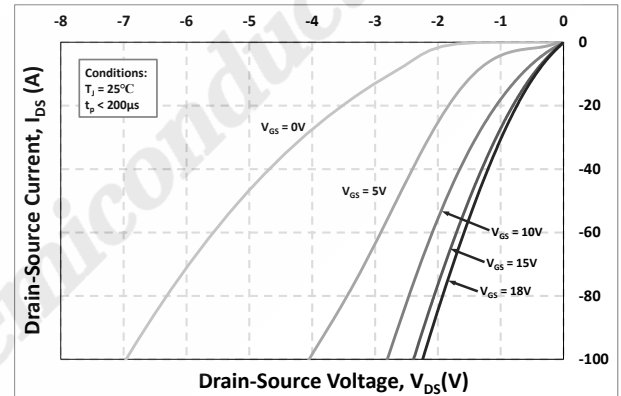


Figure 16. 3rd Quadrant Characteristic at 25°C

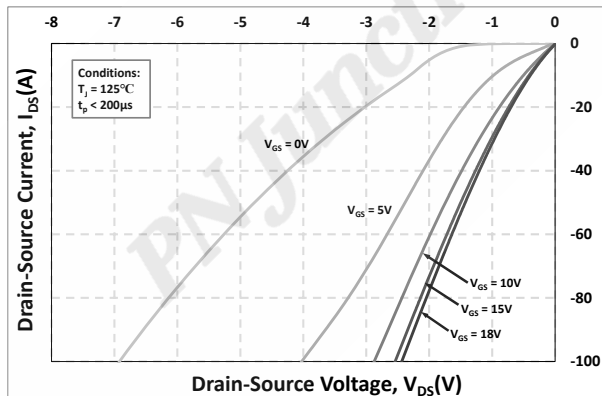


Figure 17. 3rd Quadrant Characteristic at 125°C

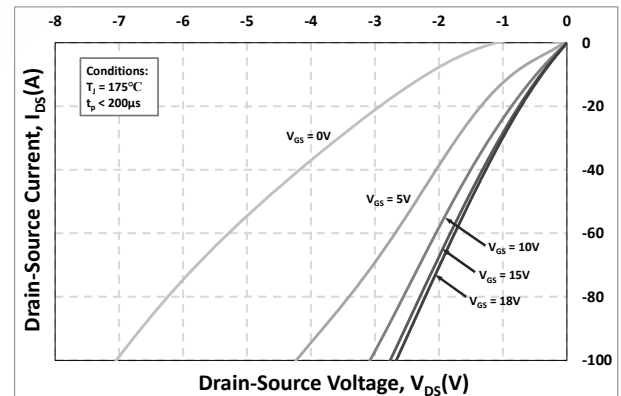


Figure 18. 3rd Quadrant Characteristic at 175°C

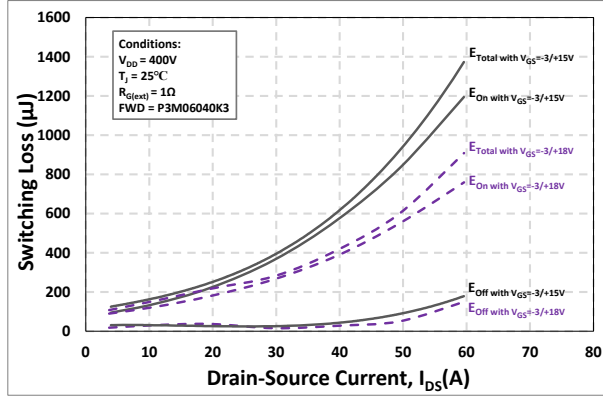


Figure 19. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 400V$ )

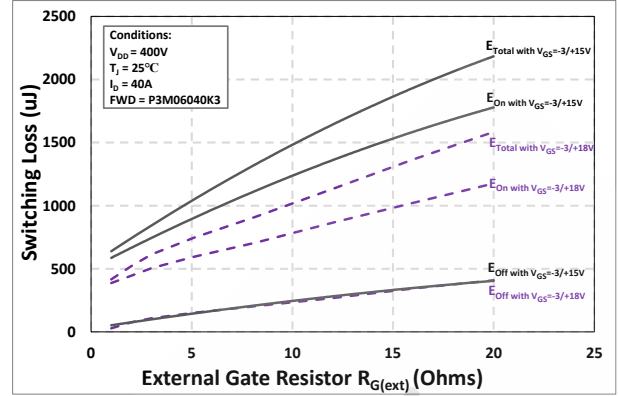


Figure 20. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

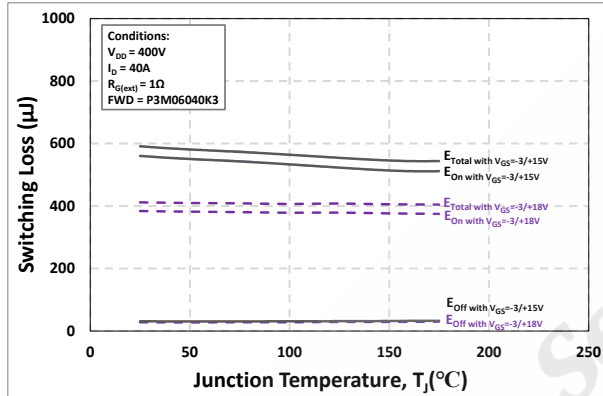


Figure 21. Clamped Inductive Switching Energy vs. Temperature

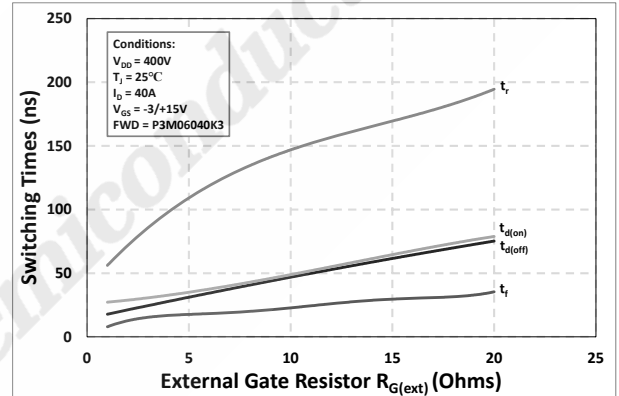


Figure 22. Switching Times vs.  $R_{G(ext)}$

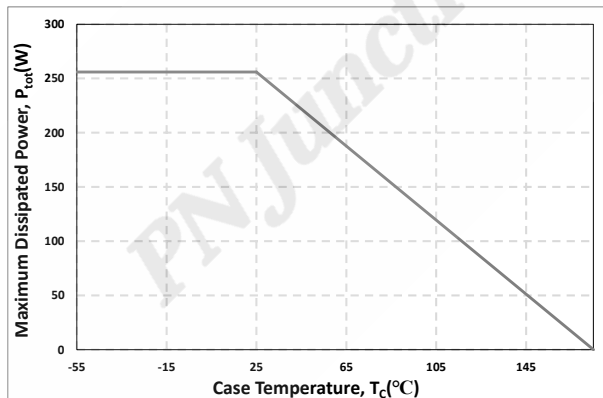


Figure 23. Maximum Power Dissipation Derating vs. Case Temperature

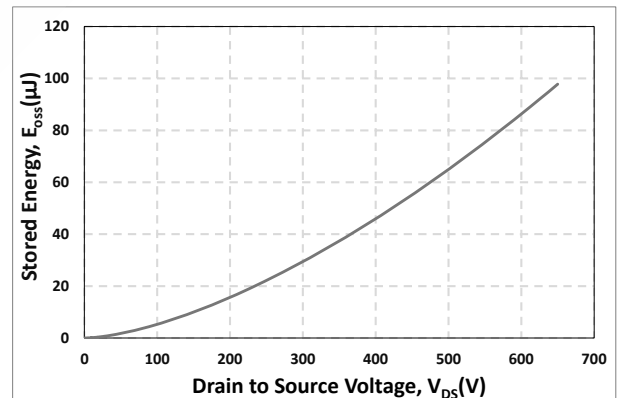


Figure 24. Output Capacitor Stored Energy

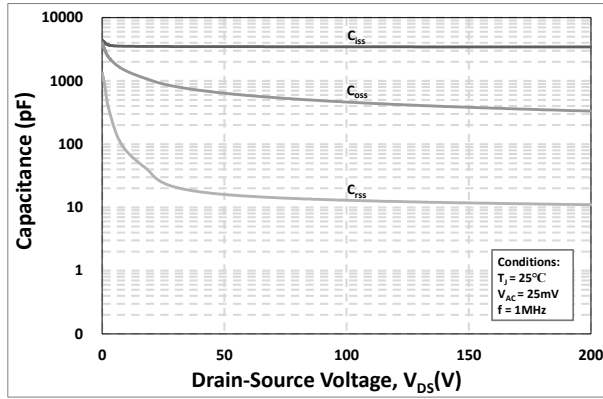


Figure 25. Capacitances vs. Drain-Source Voltage (0 - 200V)

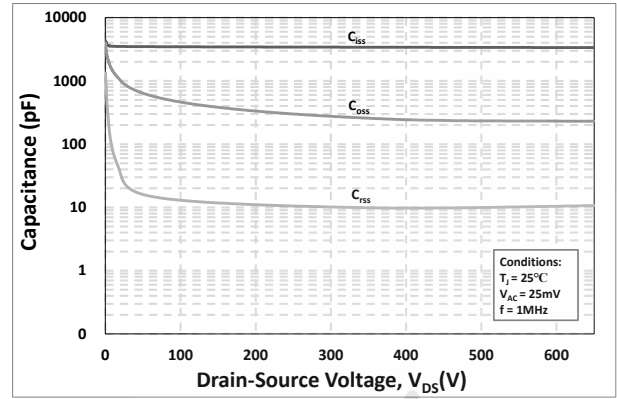


Figure 26. Capacitances vs. Drain-Source Voltage (0 - 650V)

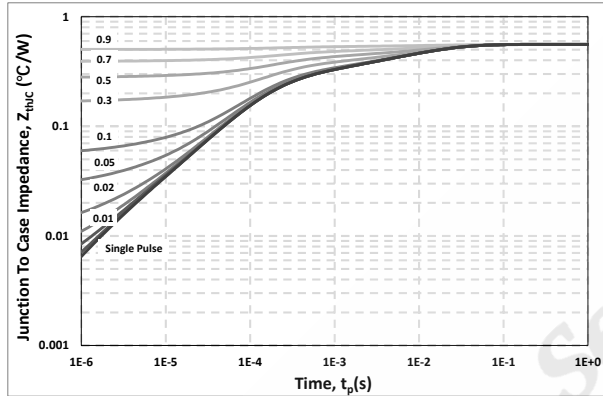


Figure 27. Transient Thermal Impedance (Junction - Case)

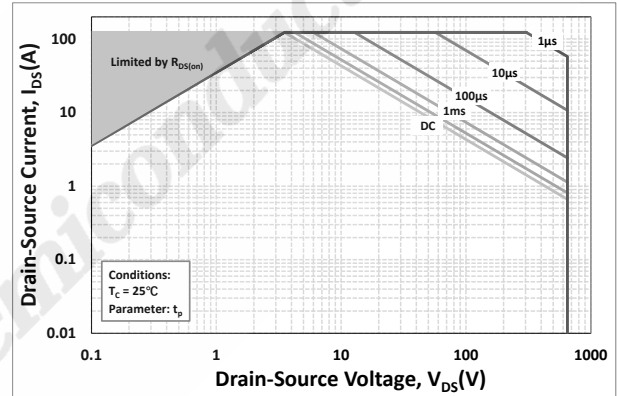


Figure 28. Safe Operating Area

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## 6. Definitions

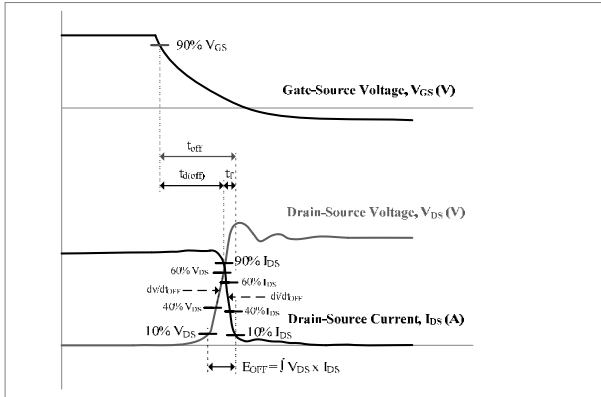


Figure 29. Turn-off Transient Definitions

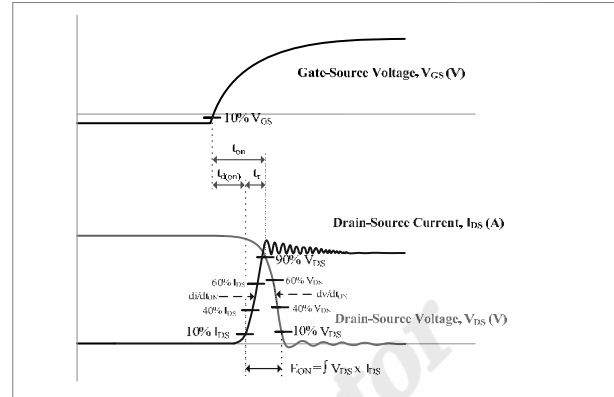


Figure 30. Turn-on Transient Definitions

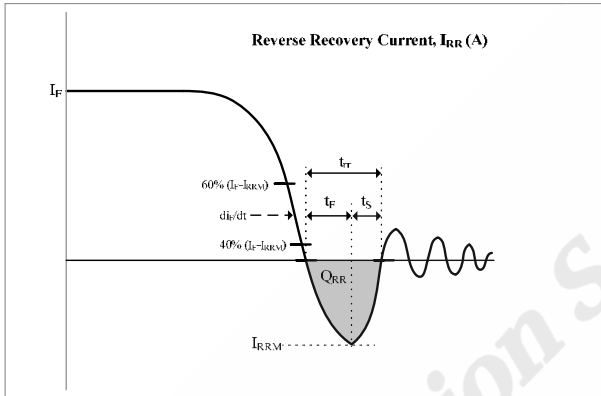


Figure 31. Reverse Recovery Definitions

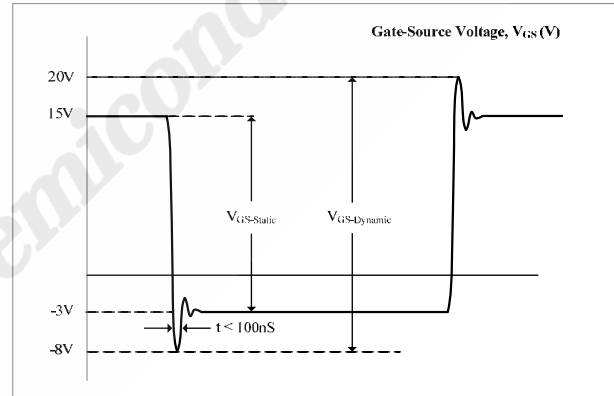
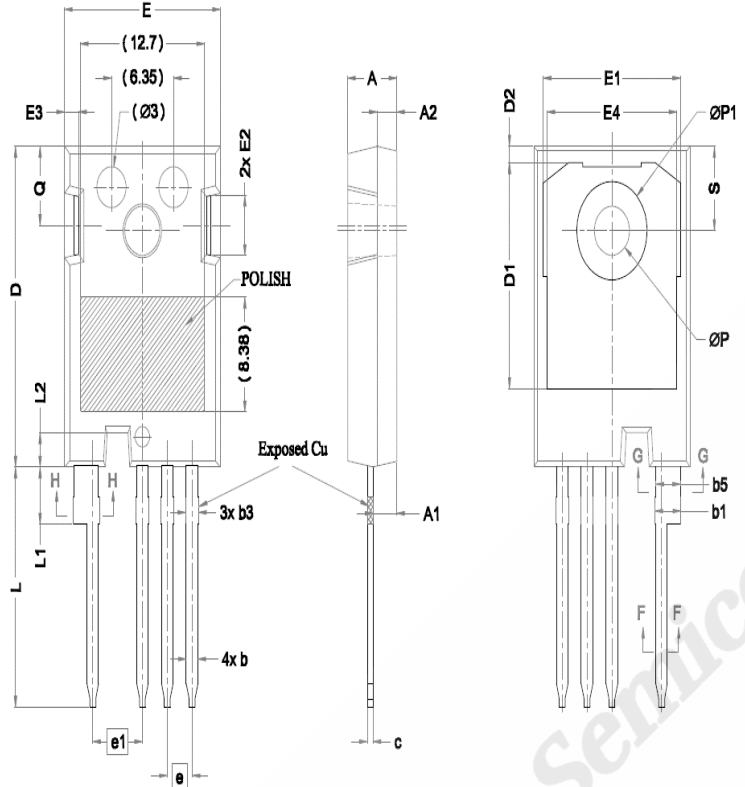


Figure 32. vgs Transient Definitions

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## 7. Package Outlines



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 <sup>1</sup>	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	22.30	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	1.10	5.10
E3	1.00	1.45	1.90
E4	12.38	13.26	13.43
e	2.54BSC		
e1	5.08BSC		
L	17.31	17.57	17.82
L1	3.97	4.19	4.37
L2	2.35	2.50	2.65
$\phi P$	3.51	3.61	3.65
$\phi P$	7.19 REF.		
Q	5.49	5.79	6.00
S	6.04	6.17	6.30

Drawing and Dimensions

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## Important Notice

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