



Features

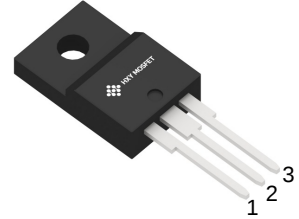
- Wide bandgap SiC MOSFET technology
- Low On-Resistance with High Blocking Voltage
- Low Capacitances with High-Speed switching
- Low reverse recovery(Qrr)
- Halogen free, RoHs compliant

Benefits

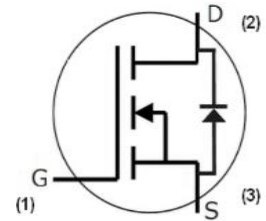
- Reduce switching losses
- Increased system Switching Frequency
- Increased power density
- Reduction of heat sink requirements

Applications

- Switch mode power supplies
- Renewable energy
- On Board Charger
- High Voltage DC/DC Converters



TO-220F



Ordering Part Number	Package	Brand
TK9A65W,S5X	TO-220F	HXY MOSFET

Maximum Ratings (T_C = 25 °C unless otherwise specified)

Symbol	Parameter	Test conditions	Value	Unit	Note
V _{DSmax}	Drain-Source Voltage	V _{GS} = 0V, I _D = 100μA	650	V	
V _{GS}	Gate-Source voltage (transient)	t _p ≤ 500ns, duty cycle ≤ 1%	-8/+20	V	
V _{GSop}	Recommend Gate-Source Voltage	Static	-4/+18	V	
EAS	Single pulse avalanche energy	V _{DS} =650V, V _{DD} =50V, V _{GS} =10V, L=10mH, T _C =25°C	68	mJ	
I _D	Continuous Drain current	V _{GS} = 18V, T _C = 25°C	7.1	A	Fig. 14
		V _{GS} = 18V, T _C = 100°C	4.1		
I _{D,pulse}	Pulsed Drain Current	Pulse with t _p limited by T _{jmax}	15	A	
P _D	Power Dissipation	T _C = 25°C, T _j = 175°C	30	W	Fig. 16
T _j	Operating junction temperature		-55~175	°C	
T _{stg}	Storage temperature		-55~175	°C	



Thermal Characteristics

Symbol	Parameter	Value			Unit	Note
		Min.	Typ.	Max.		
$R_{th(jc)}$	Thermal resistance from Junction to Case		5.0		K/W	Fig. 15
$R_{th(ja)}$	Thermal resistance from Junction to Ambient		40		K/W	

Electrical Characteristics (T_c = 25°C unless other wise specified)

Static Characteristics

Symbol	Parameter	Test conditions	Value			Unit	Note
			Min.	Typ.	Max.		
$V_{(BR)DSS}$	Drain-Source Breakdown voltage	$V_{GS} = 0V, I_D = 100\mu A$	650			V	
$V_{GS(th)}$	Gate Threshold voltage	$V_{GS} = V_{DS}, I_D = 0.7mA$		2.8		V	Fig. 9
		$V_{GS} = V_{DS}, I_D = 0.7mA, T_j = 175^\circ C$		2.0			
I_{GSS}	Gate-Source Leakage current	$V_{GS} = 18V, V_{DS} = 0V$			250	nA	
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$		1	50	μA	
$R_{DS(on)}$	Drain-Source On-state Resistance	$V_{GS} = 15V, I_D = 3A$		530	690	m Ω	Fig. 3, 4, 5
		$V_{GS} = 18V, I_D = 3A$		410			
		$V_{GS} = 15V, I_D = 3A, T_j = 175^\circ C$ $V_{GS} = 18V, I_D = 3A, T_j = 175^\circ C$		550 500			
g_{fs}	Transconductance	$V_{DS} = 15V, I_D = 3A$		2.4		S	Fig. 6
		$V_{DS} = 15V, I_D = 3A, T_j = 175^\circ C$		1.9			



Gate Charge Characteristics

Symbol	Parameter	Test conditions	Value			Unit	Note
			Min.	Typ.	Max.		
Q_{GS}	Gate to Source Charge	$V_{DS} = 400V$ $I_D = 3A$ $V_{GS} = -4V/18V$		2.4		nC	Fig. 10
Q_{GD}	Gate to Drain Charge			4.0			
Q_G	Total Gate Charge			9.7			

AC Characteristics

Symbol	Parameter	Test conditions	Value			Unit	Note
			Min.	Typ.	Max.		
C_{iss}	Input Capacitance	$V_{GS} = 0V, V_{DS} = 600V$ $f = 1\text{ MHz}$ $V_{AC} = 25mV$		147		pF	Fig. 13
C_{oss}	Output Capacitance			19		pF	
C_{rss}	Reverse Transfer Capacitance			2.5		pF	
$R_{G(int)}$	Internal Gate Resistance	$f = 1\text{ MHz}, V_{AC} = 25mV$		5		Ω	



Reverse Diode Characteristics

Symbol	Parameter	Test conditions	Value			Unit	Note
			Min.	Typ.	Max.		
V_{SD}	Diode Forward Voltage	$V_{GS} = -4V, I_{SD} = 1.5A$		4.4		V	Fig. 7,8
		$V_{GS} = -4V, I_{SD} = 1.5A, T_j = 175^{\circ}C$		3.9			
I_S	Continuous Diode Forward Current	$V_{GS} = -4V, T_C = 25^{\circ}C$		5.4		A	
$I_{S, pulse}$	Diode pulse Current	$V_{GS} = -4V$, pulse width t_p limited by T_{jmax}		15		A	
t_{rr}	Reverse Recovery Time	$V_{GS} = -4V, I_{SD} = 3A, V_R = 400V$ $diff/dt = 1000A/us$		26		nS	
Q_{rr}	Reverse Recovery Charge			31		nC	
I_{rm}	Peak Reverse Recovery Current			2		A	

Switching Characteristics

Symbol	Parameter	Test conditions	Value			Unit	Note
			Min.	Typ.	Max.		
$t_{d(on)}$	Turn-On Delay Time	$V_{DS} = 400V, V_{GS} = -4/+18V$ $I_D = 3A, R_{G(ext)} = 20\Omega$ $L = 294\mu H$		1		nS	Fig.21
t_r	Rise Time			7		nS	
$t_{d(off)}$	Turn-Off Delay Time			5		nS	
t_f	Fall Time			10		nS	
E_{on}	Turn-On Energy			8		μJ	Fig.19
E_{off}	Turn-Off Energy			7		μJ	
E_{tot}	Total switching energy			16		μJ	



Typical Performance

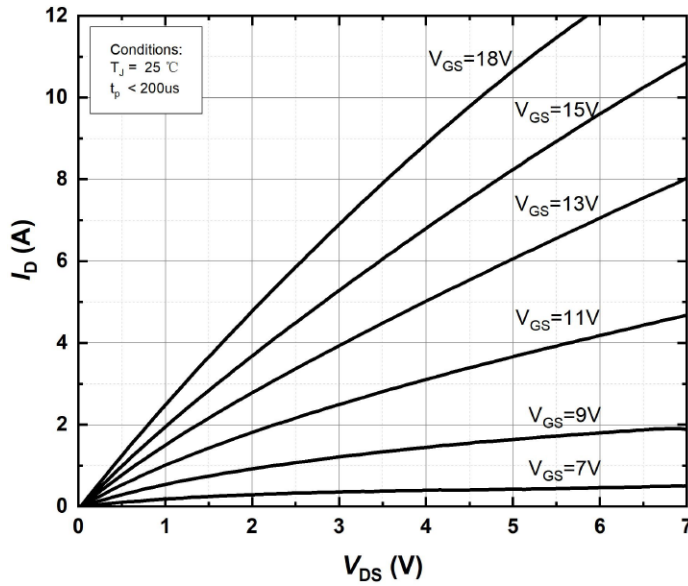


Figure 1. Output characteristics at $T_j=25^\circ\text{C}$

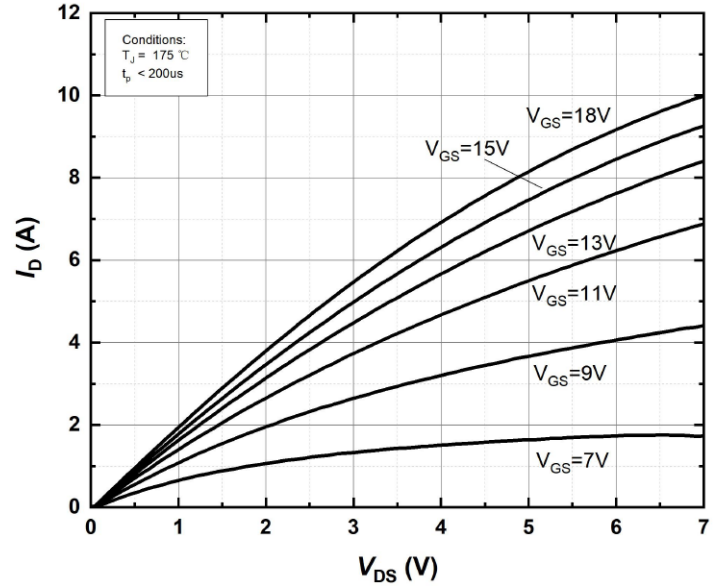


Figure 2. Output characteristics at $T_j=175^\circ\text{C}$

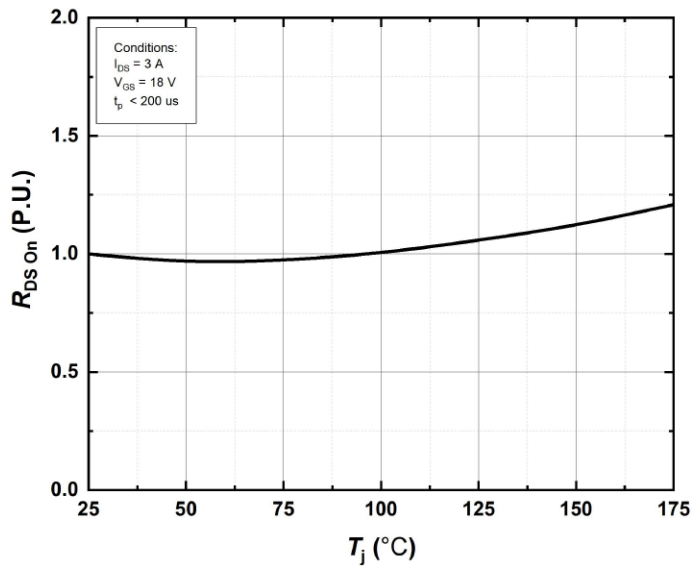


Figure 3. Normalized On-Resistance vs. Temperature

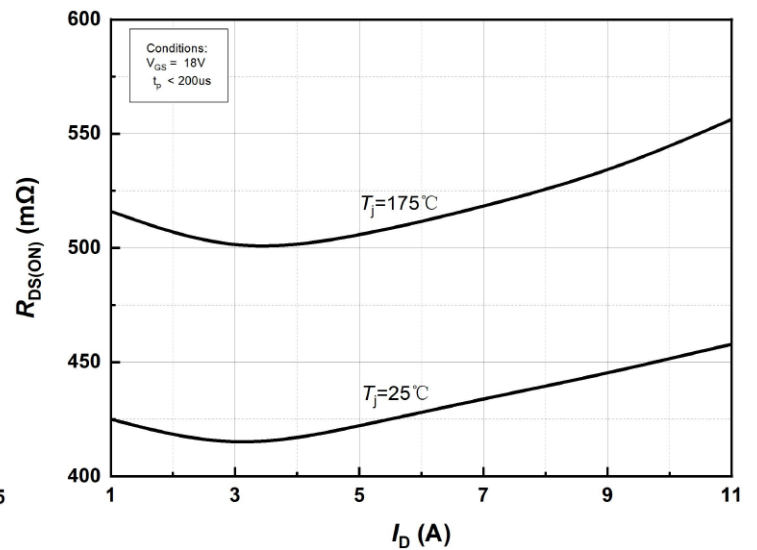


Figure 4. On-Resistance vs. Drain current for Various Temperature

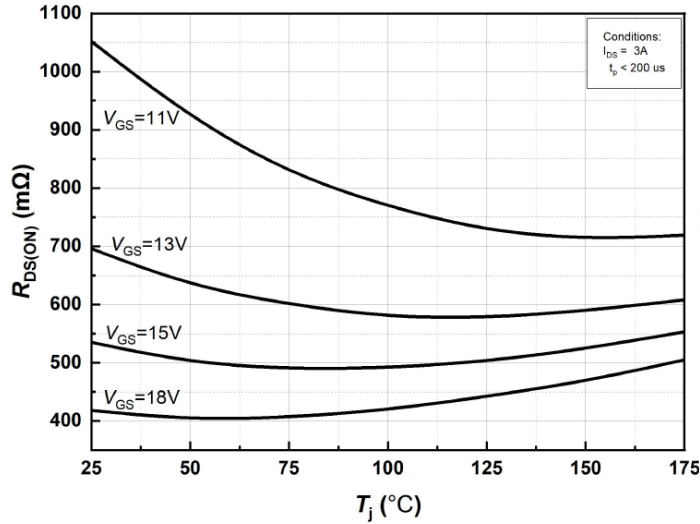


Figure 5. On-Resistance vs. Temperature for Various Gate Voltage

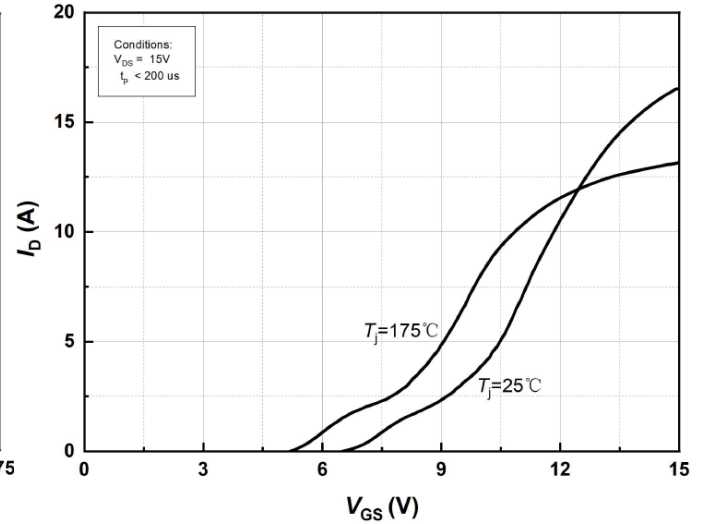


Figure 6. Transfer Characteristics for Various Junction Temperatures

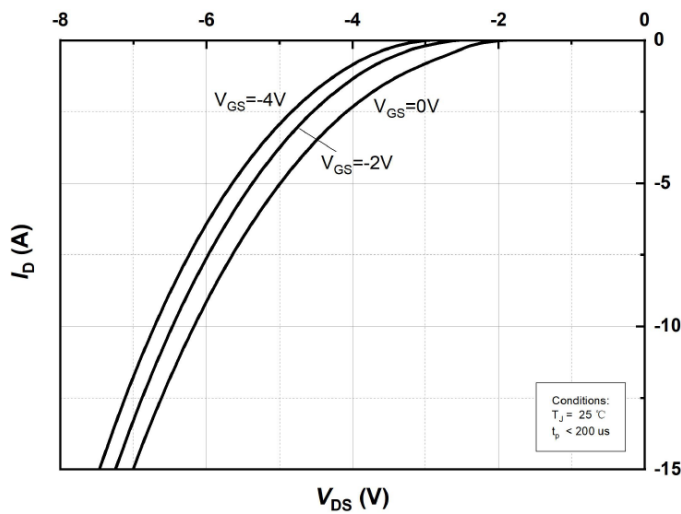


Figure 7. Body Diode Characteristics at $T_J=25^{\circ}C$

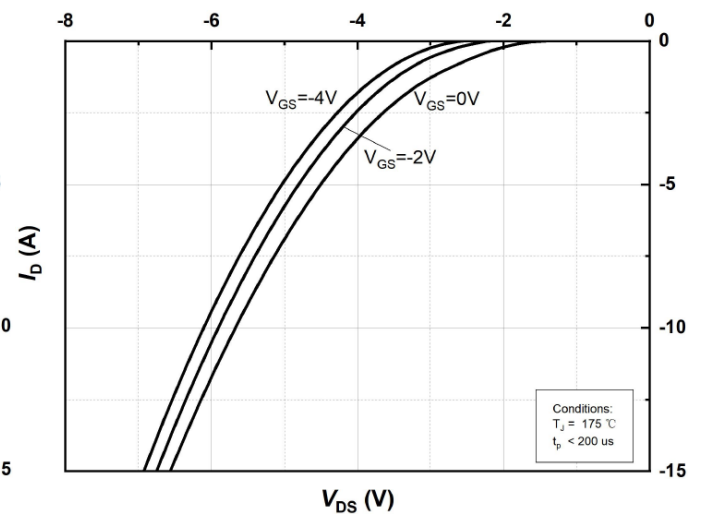


Figure 8. Body Diode Characteristics at $T_J=175^{\circ}C$

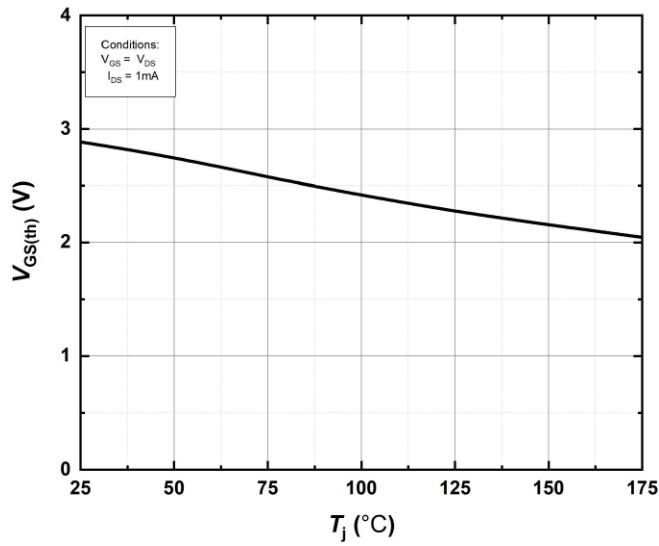


Figure 9. Threshold Voltage vs. Temperature

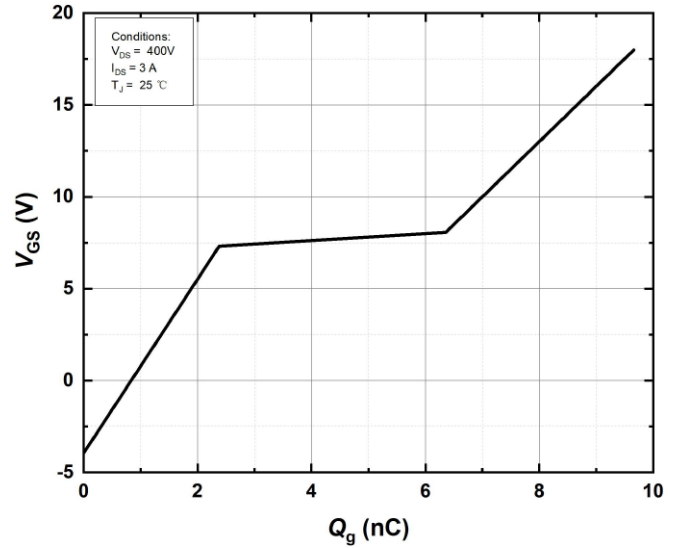


Figure 10 Gate Charge Characteristics

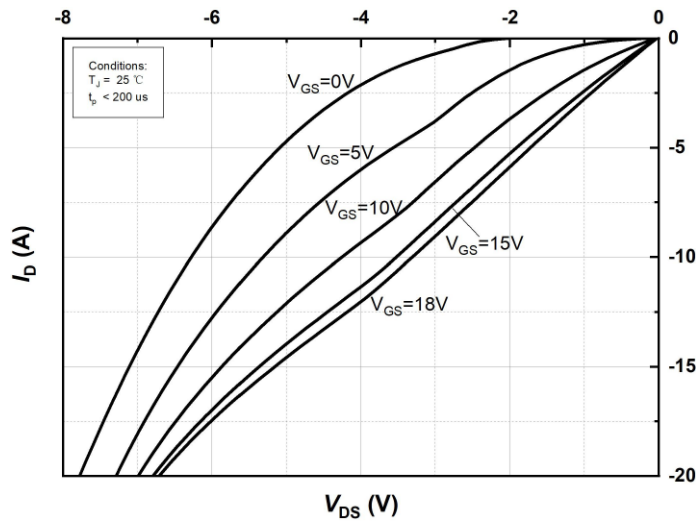


Figure 11. 3rd Quadrant Characteristic at $T_j=25^\circ\text{C}$

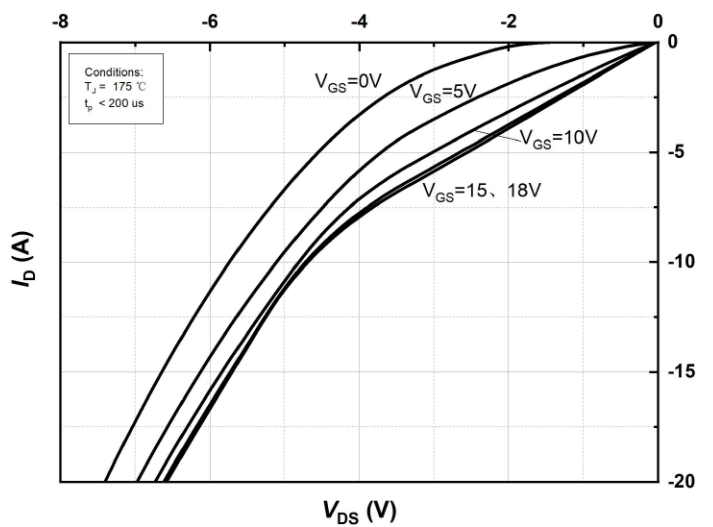


Figure 12. 3rd Quadrant Characteristic at $T_j=175^\circ\text{C}$

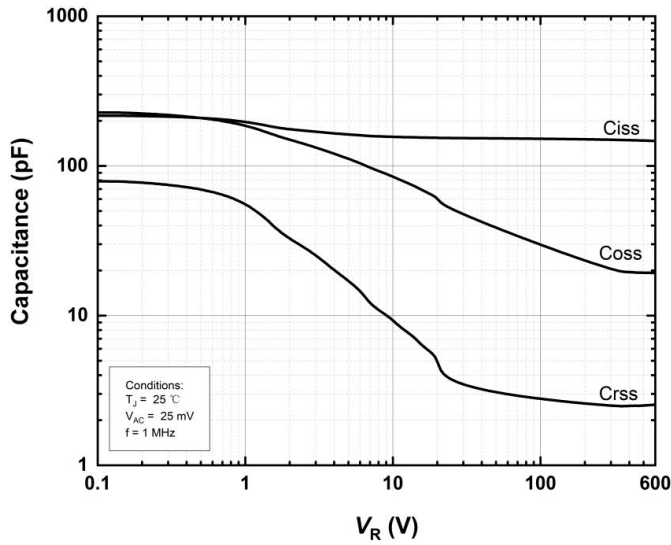


Figure 13. Capacitances vs. Drain-Source Voltage (0 – 600V)

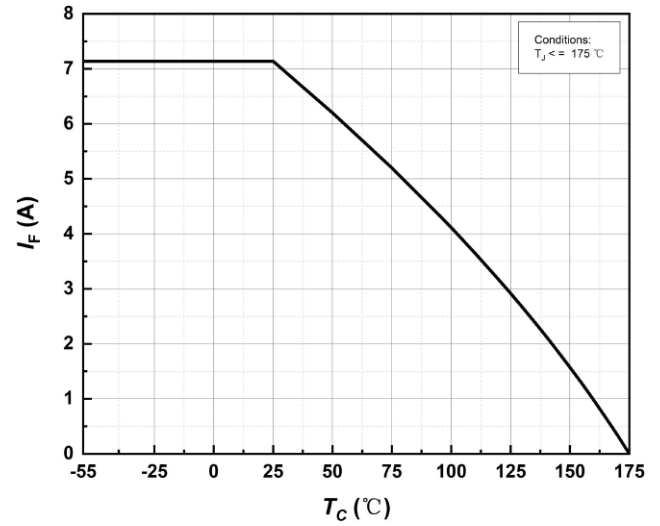


Figure 14. Continuous Drain Current Derating vs Case Temperature

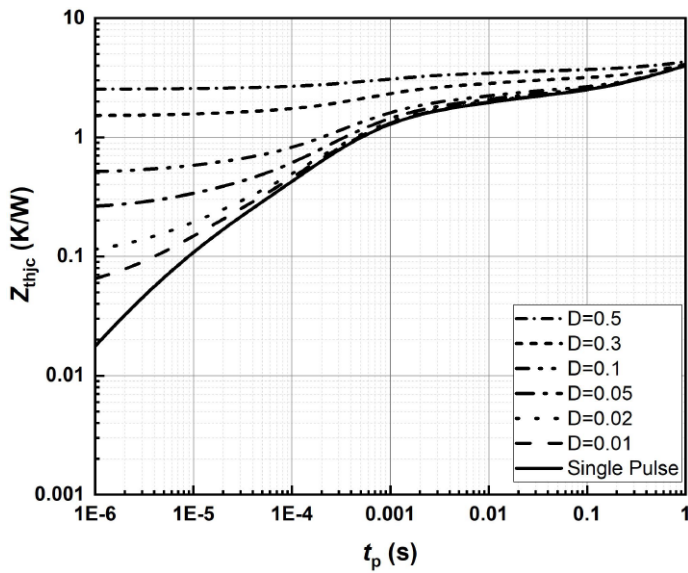


Figure 15. Transient Thermal Impedance (Junction – Case)

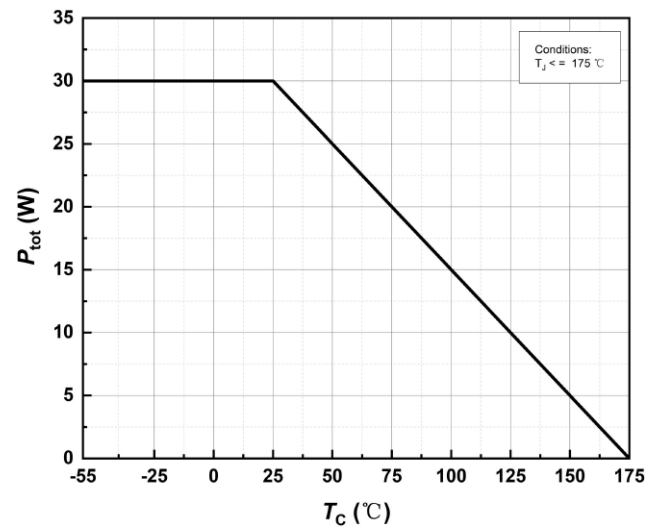


Figure 16. Maximum Power Dissipation Derating vs. Case Temperature

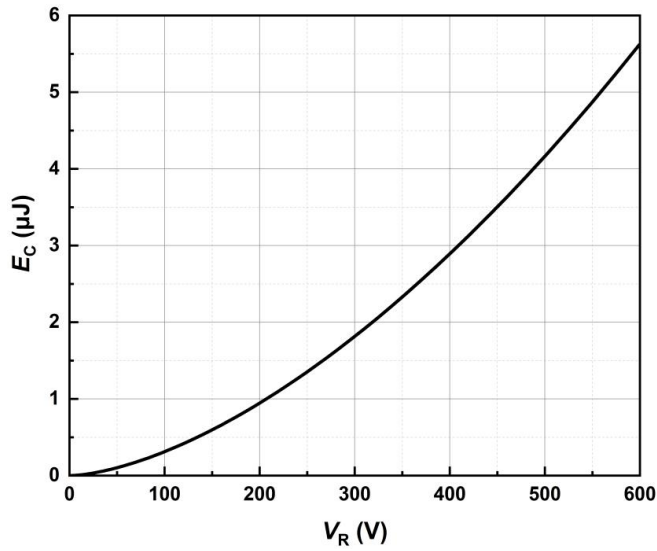


Figure 17. Output Capacitor Stored Energy

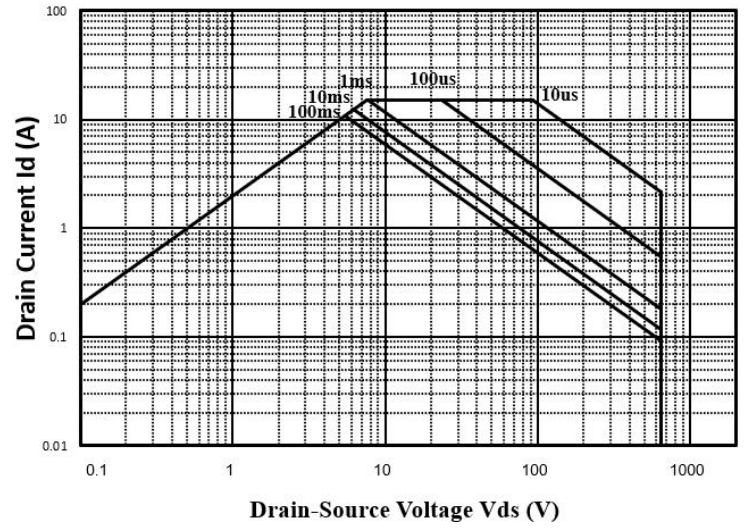


Figure 18. Safe Operating Area

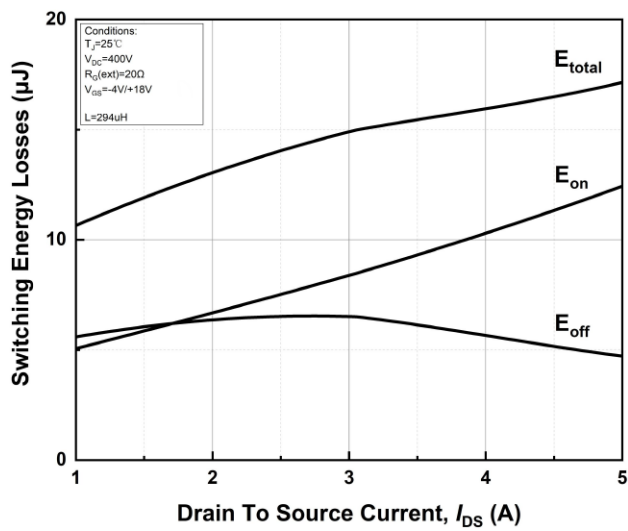


Figure 19. Clamped Inductive Switching Energy vs. Drain Current($V_{DD} = 400V$)

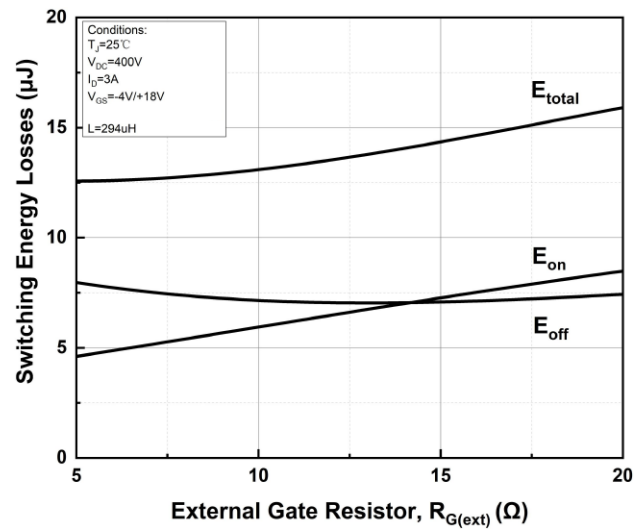


Figure 20. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

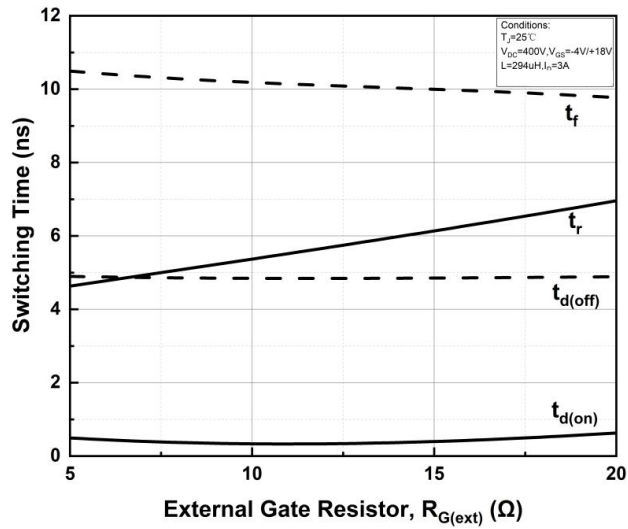
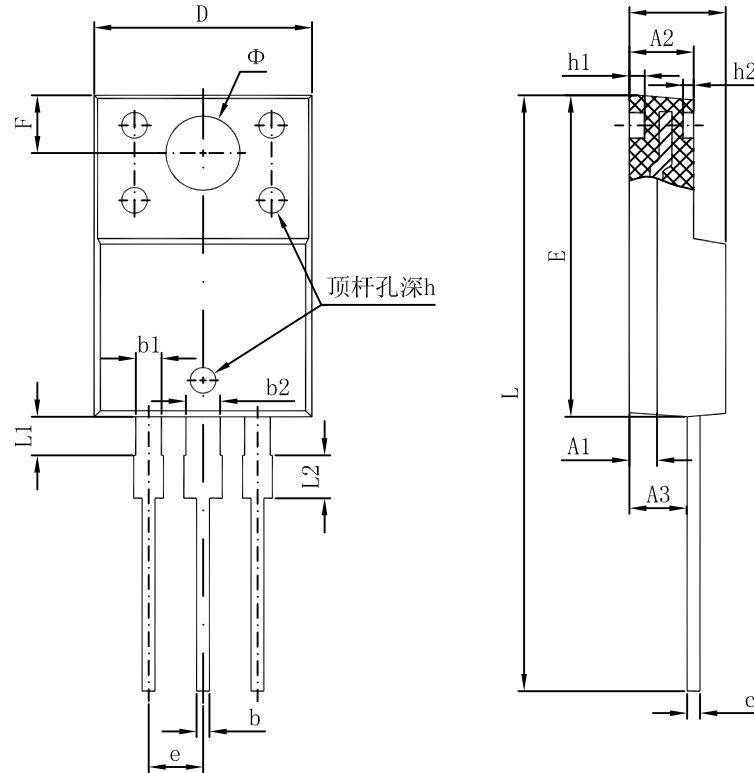


Figure 21. Switching Times vs. $R_{G(ext)}$



Package Dimensions

Package TO-220F



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.300	4.700	0.169	0.185
A1	1.300 REF.		0.051 REF.	
A2	2.800	3.200	0.110	0.126
A3	2.500	2.900	0.098	0.114
b	0.500	0.750	0.020	0.030
b1	1.100	1.350	0.043	0.053
b2	1.500	1.750	0.059	0.069
c	0.500	0.750	0.020	0.030
D	9.960	10.360	0.392	0.408
E	14.800	15.200	0.583	0.598
e	2.540 TYP.		0.100 TYP.	
F	2.700 REF.		0.106 REF.	
Φ	3.500 REF.		0.138 REF.	
h	0.000	0.300	0.000	0.012
h1	0.800 REF.		0.031 REF.	
h2	0.500 REF.		0.020 REF.	
L	28.000	28.400	1.102	1.118
L1	1.700	1.900	0.067	0.075
L2	1.900	2.100	0.075	0.083



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