



Features

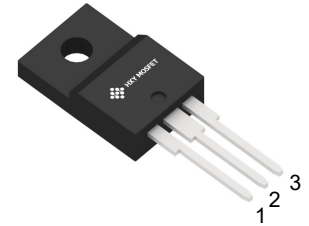
- High Speed Switching with Low Capacitances
- High Blocking Voltage with Low $R_{DS(on)}$
- Easy to parallel
- Simple to drive
- RoHS Compliant

Benefits

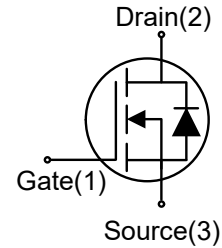
- Increased Power Density
- Faster Operating Frequency
- Reduction of Heat Sink Requirements
- Higher Efficiency
- Reduced EMI

Applications

- Power Factor Correction Modules
- Switch Mode Power Supplies
- DC-AC Inverters
- High Voltage DC/DC Converters



TO-220F



Ordering Part Number	Package	Brand
TSF65R300	TO-220F	HXY MOSFET

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

Symbol	Parameter	Value	Unit	Test Conditions	Note
V _{DSmax}	Drain - Source Voltage	650	V	V _{GS} = 0 V, I _D = 100 μA	
V _{GSmx}	Gate - Source Voltage (dynamic)	-8/+22	V	AC (f > 1 Hz)	Note 1
V _{GSop}	Gate - Source Voltage (static)	-4/+18	V	Static	Note 2
I _D	Continuous Drain Current	12	A	T _C = 25°C	Fig. 19 Note 3
		8		T _C = 100°C	
I _{D(pulse)}	Pulsed Drain Current	24	A	Pulse width t _p limited by T _{Jmax}	
		24			
P _D	Power Dissipation	48	W	T _C = 25°C	Fig. 20
		24		T _C = 100°C	
T _J , T _{stg}	Operating Junction and Storage Temperature	-40 to +175	°C		



Electrical Characteristics ($T_C = 25^\circ\text{C}$ unless other wise specified)

Static Characteristics

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$I_D=100\mu\text{A}$, $V_{GS}=0\text{V}$	650			V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS}=650\text{V}$, $V_{GS}=0\text{V}$		1		μA
I_{GSS}	Gate-Source Leakage Current	$V_{DS}=0\text{V}$, $V_{GS}=18\text{V}$			250	nA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}$, $I_D=1.33\text{mA}$ $T_J=25^\circ\text{C}$ $T_J=175^\circ\text{C}$	2	3.1 2.3	4	V
$R_{DS(on)}$	Drain-Source On-State Resistance	$V_{GS}=18\text{V}$, $I_D=4.5\text{A}$ $T_J=25^\circ\text{C}$ $T_J=175^\circ\text{C}$		270		m Ω

Thermal Characteristics

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
$R_{th(j-c)}$	Thermal Resistance from Junction to Case		3.12		$^\circ\text{C/W}$

Dynamic Characteristics

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
C_{iss}	Input Capacitance	$V_{DS}=600\text{V}$, $f=1\text{MHz}$, $V_{GS}=0\text{V}$		203		pF
C_{oss}	Output Capacitance			26		pF
C_{rss}	Reverse Transfer Capacitance			3.5		pF
$R_{G(int)}$	Internal Gate Resistance	$f=1\text{MHz}$		3.6		Ω
Q_g	Total Gate Charge	$V_{DS}=400\text{V}$, $I_D=4.5\text{A}$, $V_{GS}=-4/18\text{V}$		11.2		nC
Q_{gs}	Gate to Source Charge			2		nC
Q_{gd}	Gate to Drain Charge			5.2		nC



Switching Characteristics

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
$t_{d(on)}$	Turn-On Delay Time	$V_{DD}=400V, I_D=4.5A,$ $V_{GS}=-4V/18V,$ $R_G=2.5\Omega,$ $L=200\mu H$		5		ns
t_r	Rise Time			23		ns
$t_{d(off)}$	Turn-Off Delay Time			6		ns
t_f	Fall Time			8		ns
E_{on}	Turn-On Energy			34		μJ
E_{off}	Turn-Off Energy			4		μJ

Reverse Diode Characteristics

Symbol	Parameter	Test conditions	Value			Unit
			Min.	Typ.	Max.	
V_{SD}	Diode Forward Voltage	$V_{GS}=-4V, I_{SD}=2.5A$ $T_j=25^\circ C$ $T_j=175^\circ C$ $V_{GS}=-4V, I_{SD}=4.5A$ $T_j=25^\circ C$ $T_j=175^\circ C$		4.0 3.6 4.5 4.0		V
I_S	Continuous Diode Forward Current	$V_{GS}=-4V$ $T_c=25^\circ C$ $T_c=100^\circ C$		13 5.5		A
t_{rr}	Reverse Recovery Time	$V_{GS}=-4V, I_{SD}=4.5A,$ $V_R=400V,$ $di/dt=1000A/\mu s$		22		ns
Q_{rr}	Reverse Recovery Charge			68		nC
I_{rrm}	Peak Reverse Recovery Current			4		A



Typical Performance

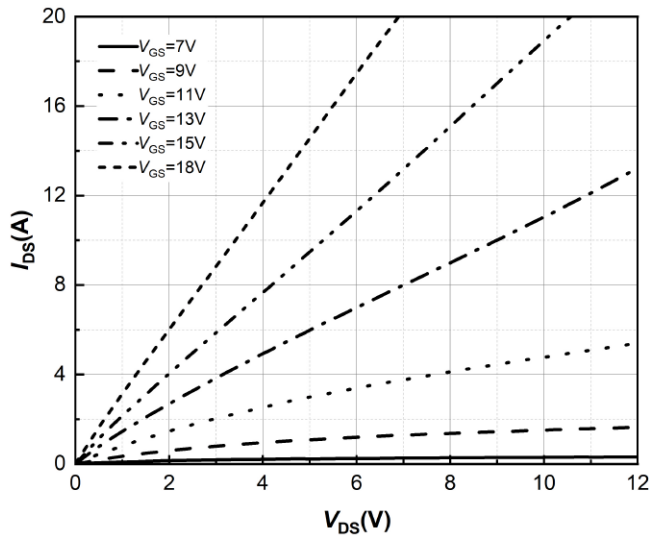


Figure 1. Output Characteristics
 $T_j = -40^\circ\text{C}$

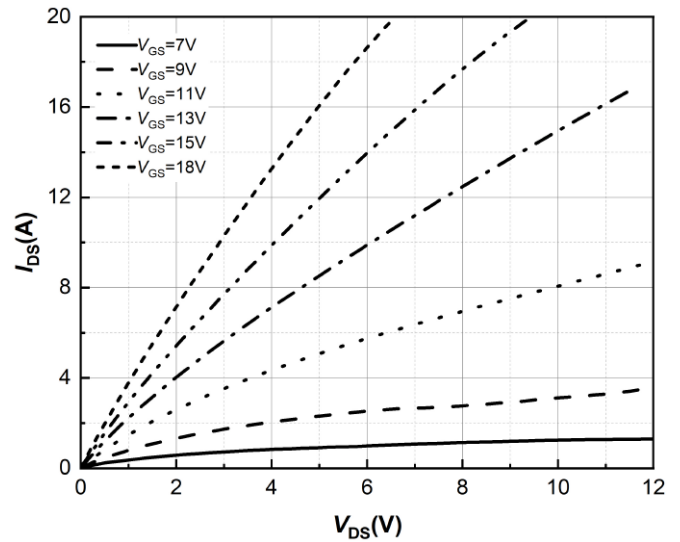


Figure 2 Output Characteristics

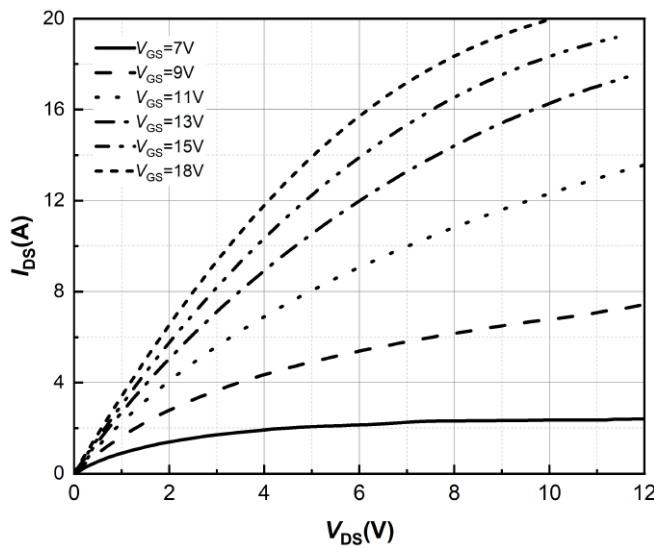


Figure 3. Output Characteristics
 $T_j = 175^\circ\text{C}$

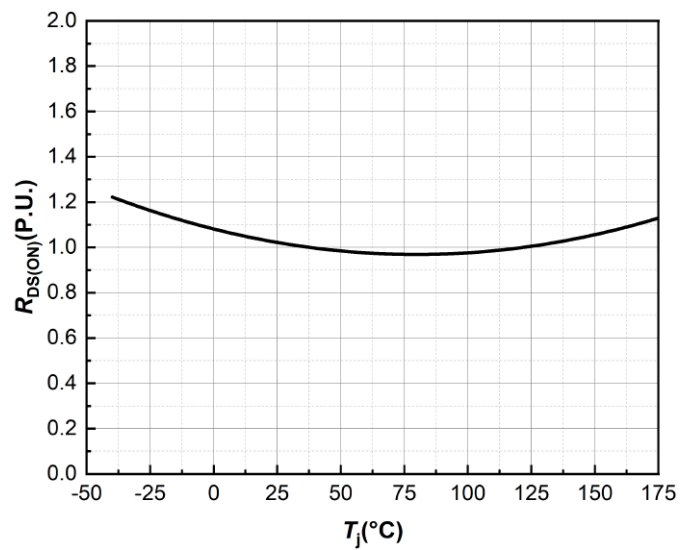


Figure 4. Normalized On-Resistance vs.
Temperature

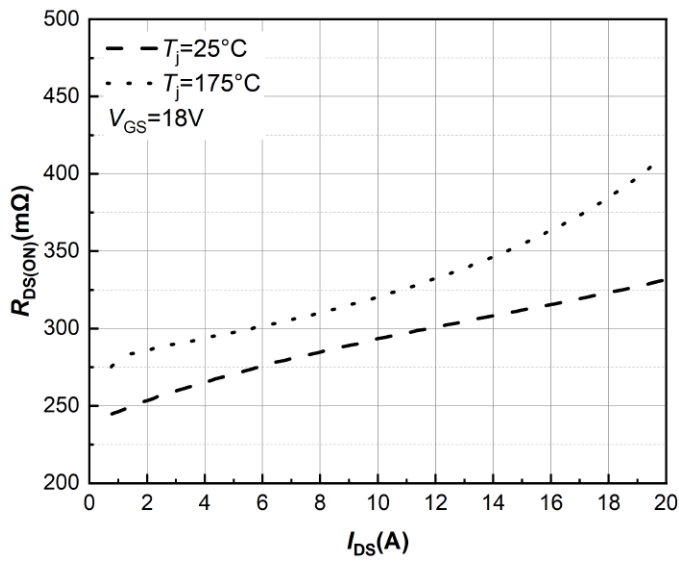


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

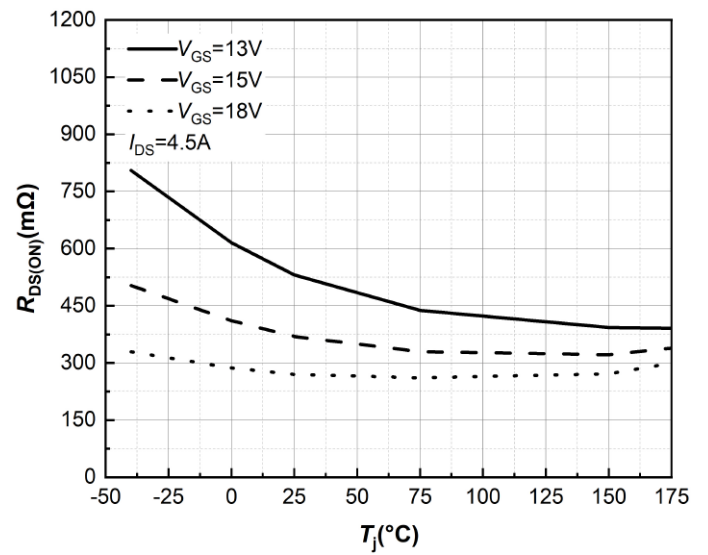


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

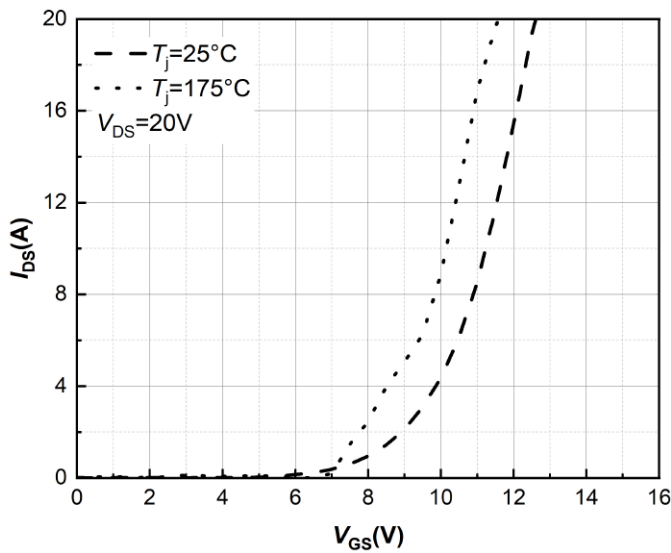


Figure 7. Transfer Characteristic for
Various Junction Temperatures

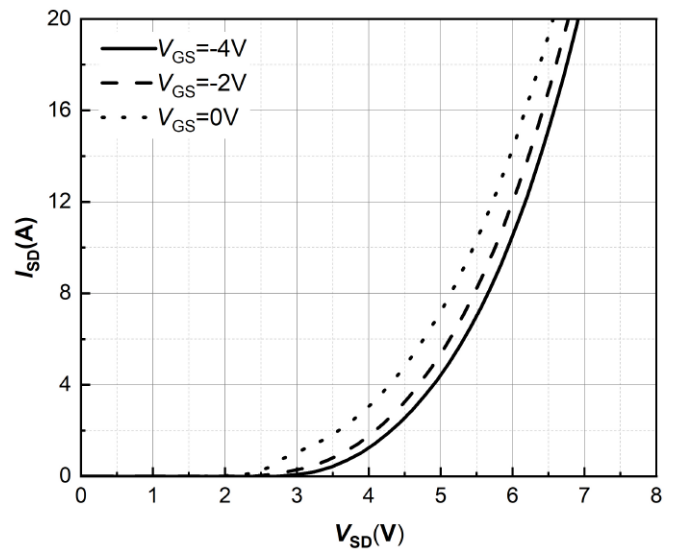


Figure 8. Body Diode Characteristic
 $T_j = -40^\circ C$

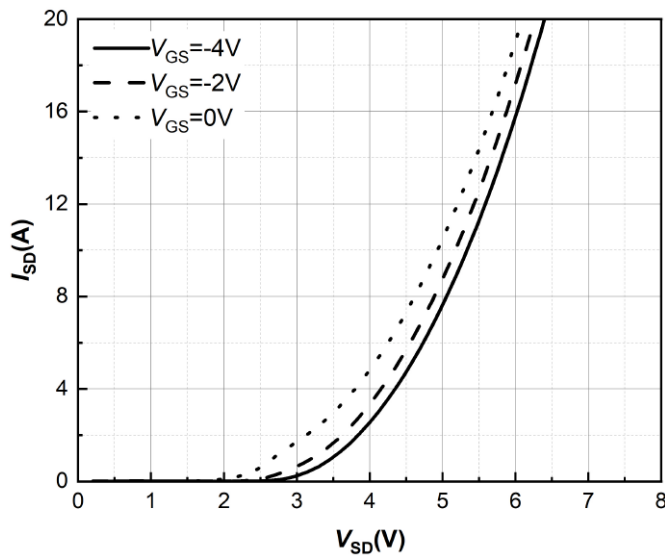


Figure 9. Body Diode Characteristic
 $T_j = 25^\circ\text{C}$

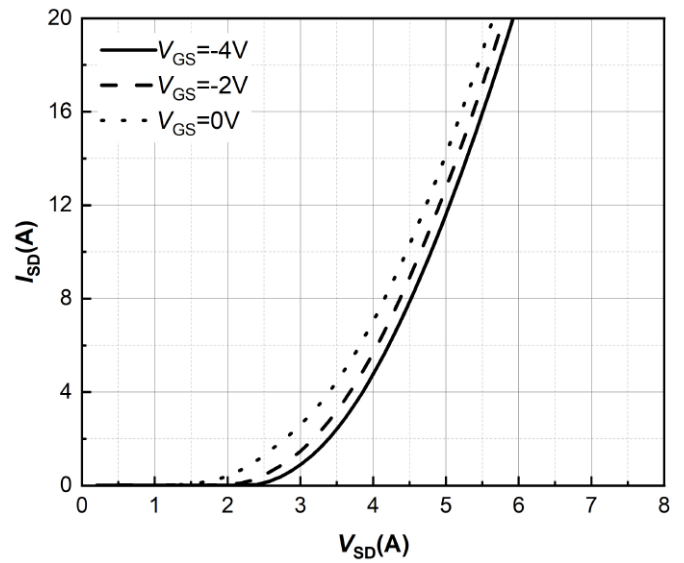


Figure 10. Body Diode Characteristic
 $T_j = 175^\circ\text{C}$

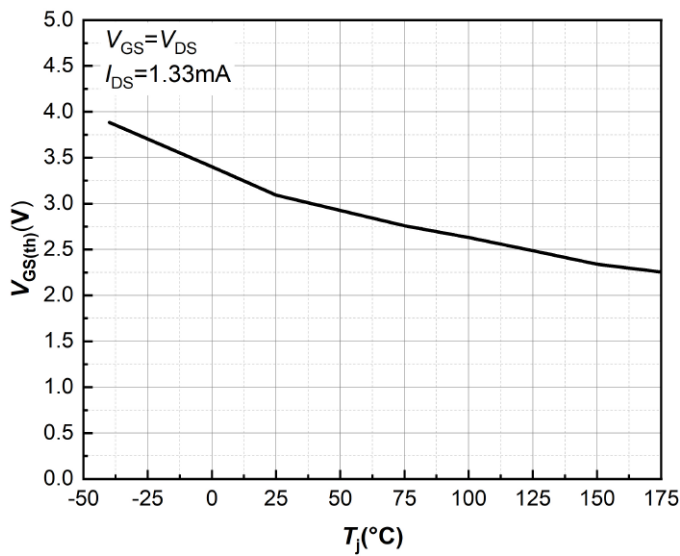


Figure 11. Threshold Voltage vs.
Temperature

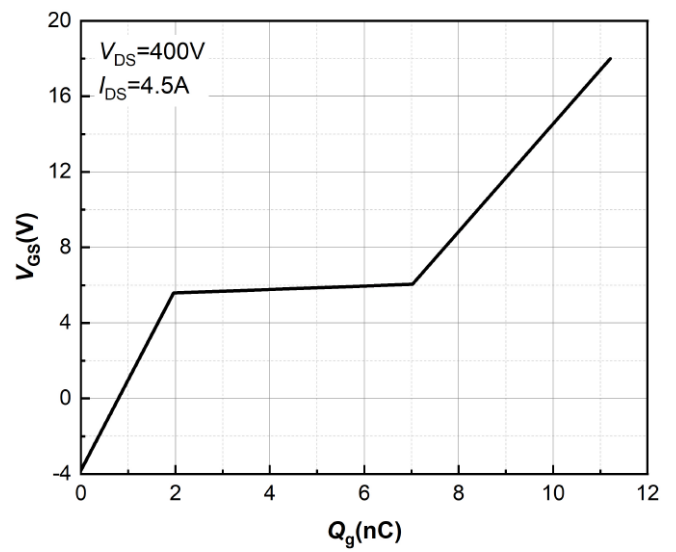


Figure 12. Gate Charge Characteristics

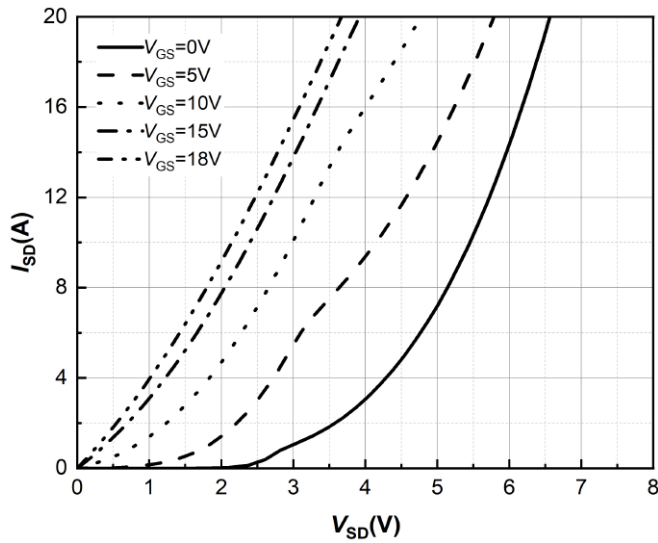


Figure 13. 3rd Quadrant Characteristic
 $T_j = -40^\circ\text{C}$

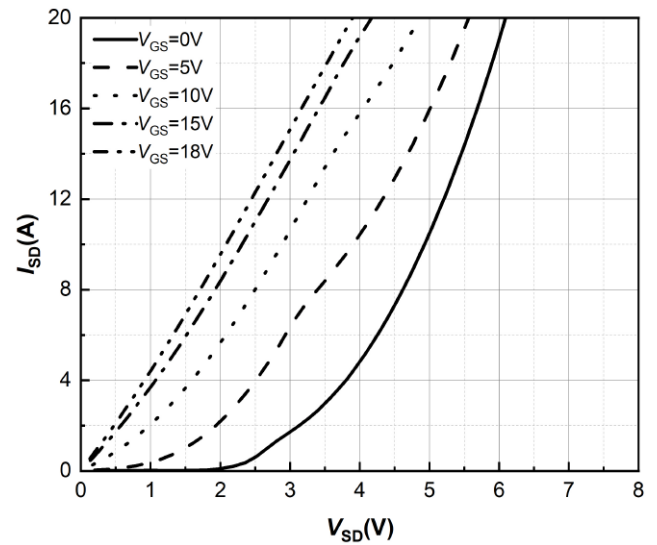


Figure 14. 3rd Quadrant Characteristic
 $T_j = 25^\circ\text{C}$

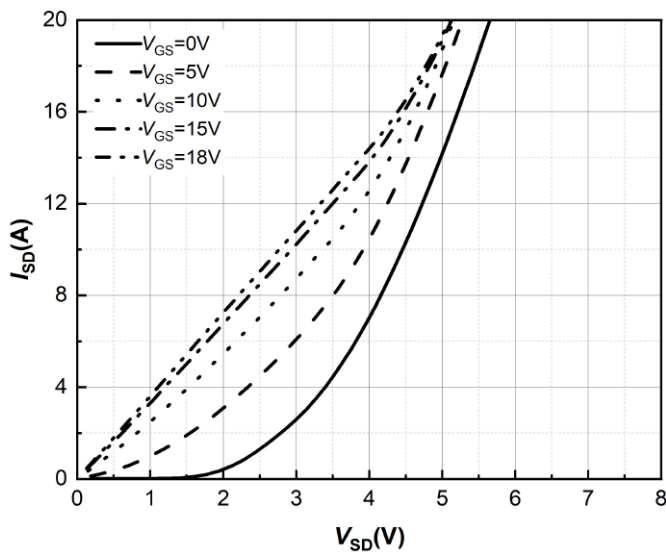


Figure 15. 3rd Quadrant Characteristic
 $T_j = 175^\circ\text{C}$

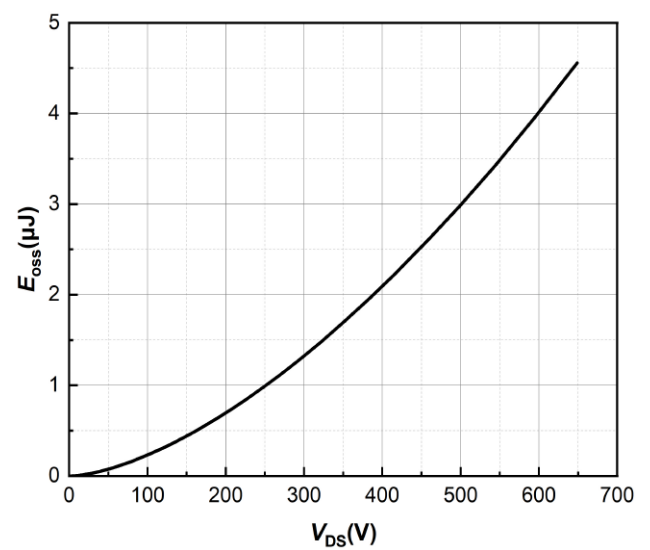


Figure 16. Output Capacitor Stored Energy

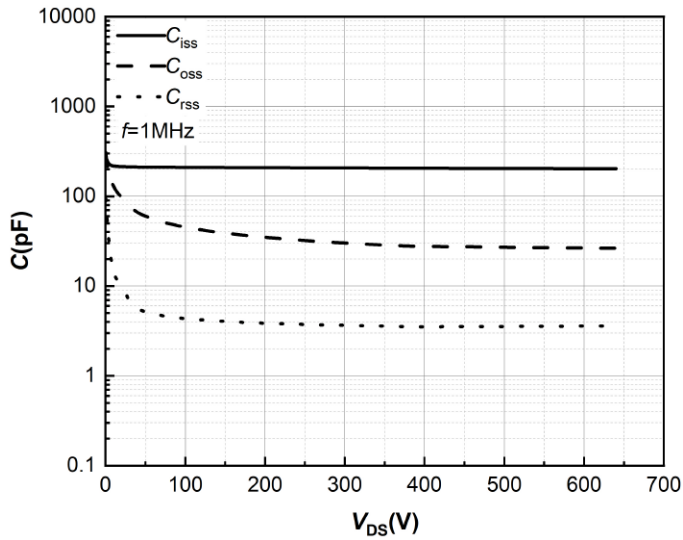


Figure 17. Capacitances vs. Drain-Source

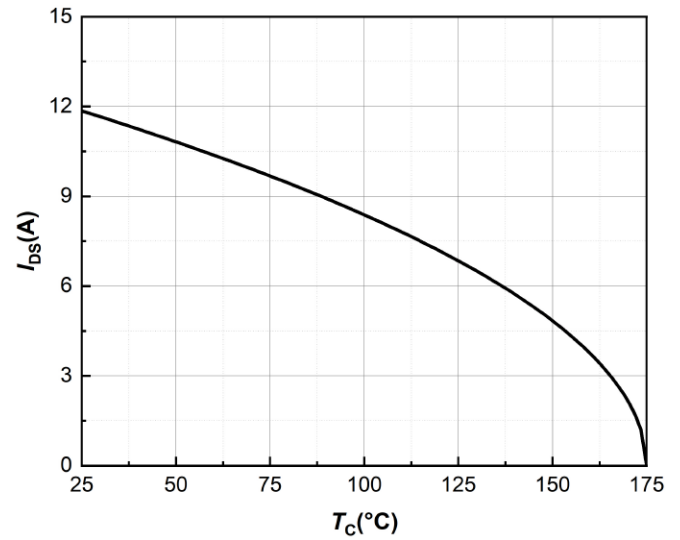


Figure 18. Continuous Drain Current Derating vs. Case Temperature

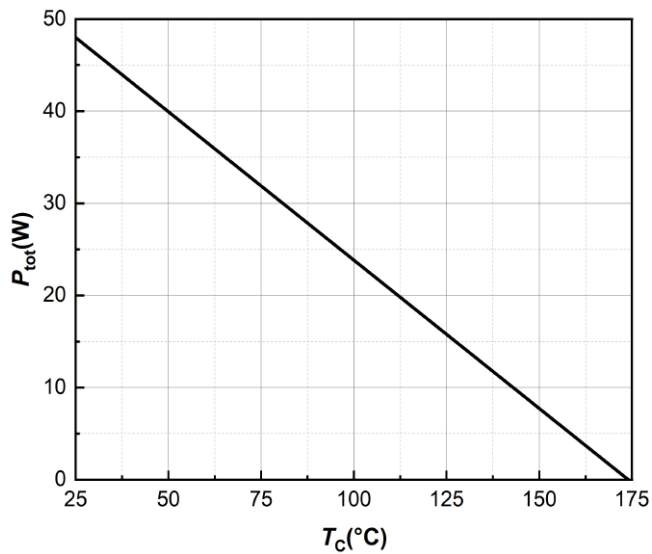


Figure 19. Maximum Power Dissipation Derating vs. Case Temperature

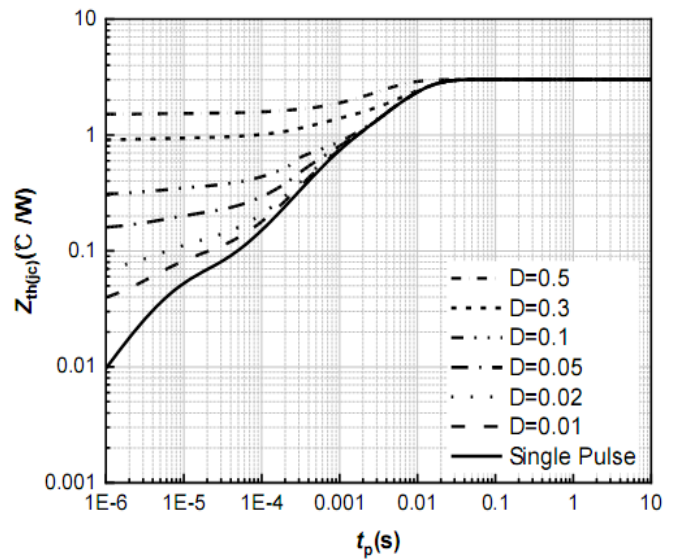


Figure 20. Transient Thermal Impedance

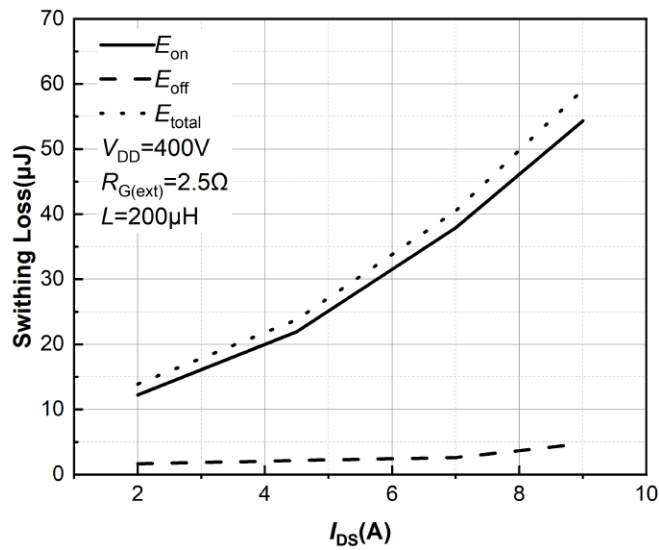


Figure 21. Clamped Inductive Switching Energy vs. Drain Current

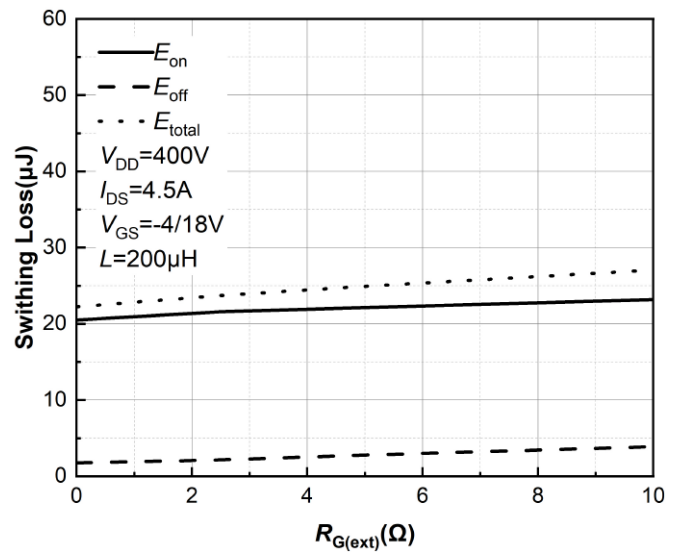


Figure 22. Clamped Inductive Switching Energy vs. R_G

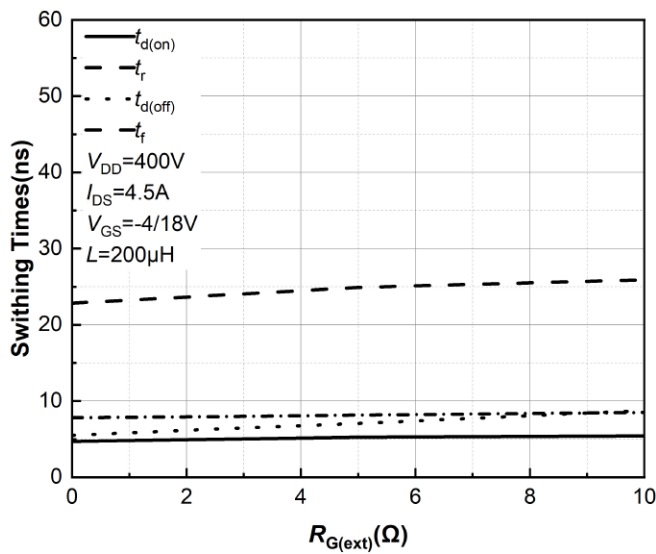


Figure 23. Switching Times vs. R_G

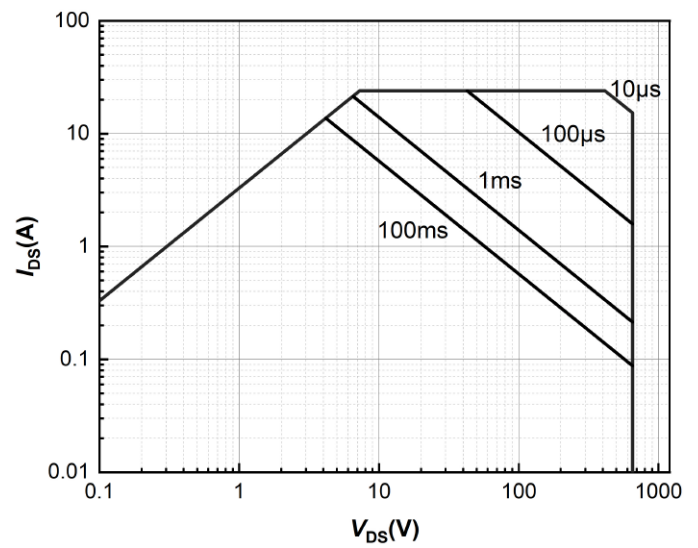
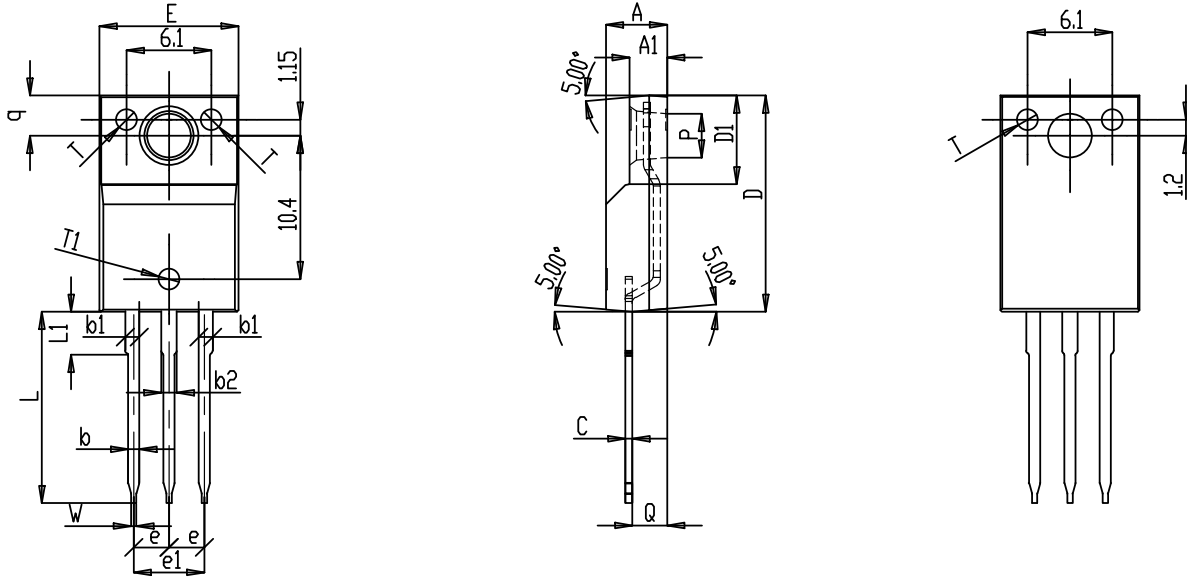


Figure 24. Safe Operating Area



Package Dimensions

Package TO-220F



SYMBOL	MILLIMETERS			NOTES	SYMBOL	MILLIMETERS			NOTES
	Normal	MIN.	MAX.			Normal	MIN.	MAX.	
A	4.4	4.2	4.6		e1	5.08	5	5.12	
A1	2.7	2.5	2.9		L	13.90	13.5	14.4	
b	0.8	0.7	0.9		L1	3.12	2.8	3.3	
b1	1.07	0.9	1.3		P	3.14	3.00	3.20	
b2	1.17	1	1.4		Q	2.44	2.3	2.6	
C	0.5	0.4	0.6		q	2.87	2.6	3	
D	15.63	15.4	15.8		W	0.37	0.3	0.5	
D1	6.22	6	6.4		T	1.52	1.3	1.7	
E	10.06	9.7	10.3		T1	1.20	1.1	1.3	
e	2.54	2.5	2.58						



Attention

- Any and all HUA XUAN YANG ELECTRONICS products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your HUA XUAN YANG ELECTRONICS representative nearest you before using any HUA XUAN YANG ELECTRONICS products described or contained herein in such applications.
- HUA XUAN YANG ELECTRONICS assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all HUA XUAN YANG ELECTRONICS products described or contained herein.
- Specifications of any and all HUA XUAN YANG ELECTRONICS products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- HUA XUAN YANG ELECTRONICS CO.,LTD. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all HUA XUAN YANG ELECTRONICS products(including technical data, services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of HUA XUAN YANG ELECTRONICS CO.,LTD.
- Information (including circuit diagrams and circuit parameters) herein is for example only ; it is not guaranteed for volume production. HUA XUAN YANG ELECTRONICS believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the HUA XUAN YANG ELECTRONICS product that you intend to use.