



Features

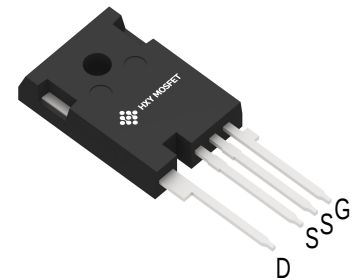
- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Q_{rr})
- Halogen free, RoHS compliant

Benefits

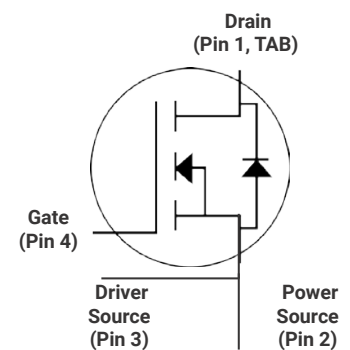
- Higher system efficiency
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency
- Easy to parallel and simple to drive
- Enable new hard switching PFC topologies (Totem-Pole)

Applications

- EV charging
- Server power supplies
- Solar PV inverters
- UPS
- DC/DC converters



TO-247H-4L



Ordering Part Number	Package	Qty(PCS)
HT39N650AKZ	TO-247H-4L	30

Maximum Ratings

Symbol	Parameter	Value	Unit	Note
V_{DSS}	Drain - Source Voltage, $T_c = 25^\circ\text{C}$	650	V	
V_{GS}	Gate - Source voltage (Under transient events $< 100\text{ ns}$)	-8/+19	V	Fig. 29
I_D	Continuous Drain Current, $V_{GS} = 15\text{ V}$, $T_c = 25^\circ\text{C}$	37	A	Fig. 19
	Continuous Drain Current, $V_{GS} = 15\text{ V}$, $T_c = 100^\circ\text{C}$	27		
$I_{D(pulse)}$	Pulsed Drain Current, Pulse width t_p limited by T_{jmax}	99	A	
P_D	Power Dissipation, $T_c=25^\circ\text{C}$, $T_j = 175^\circ\text{C}$	150	W	Fig. 20
T_j, T_{stg}	Operating Junction and Storage Temperature	-40 to +175	$^\circ\text{C}$	
T_L	Solder Temperature, 1.6mm (0.063") from case for 10s	260	$^\circ\text{C}$	
M_d	Mounting Torque, (M3 or 6-32 screw)	1 8.8	Nm lbf-in	



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	650			V	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	
V_{GSon}	Gate-Source Recommended Turn-On Voltage		15		V	Static	Fig. 29
V_{GSoff}	Gate-Source Recommended Turn-Off Voltage		-4		V		
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.3	3.6	V	$V_{DS} = V_{GS}, I_D = 5\text{ mA}$	Fig. 11
			1.9		V	$V_{DS} = V_{GS}, I_D = 5\text{ mA}, T_J = 175^\circ\text{C}$	
I_{DSS}	Zero Gate Voltage Drain Current		1	50	μA	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	
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	42	60	79	m Ω	$V_{GS} = 15\text{ V}, I_D = 13.2\text{ A}$	Fig. 4, 5, 6
			80			$V_{GS} = 15\text{ V}, I_D = 13.2\text{ A}, T_J = 175^\circ\text{C}$	
g_{fs}	Transconductance		10		S	$V_{DS} = 20\text{ V}, I_{DS} = 13.2\text{ A}$	Fig. 7
			9			$V_{DS} = 20\text{ V}, I_{DS} = 13.2\text{ A}, T_J = 175^\circ\text{C}$	
C_{iss}	Input Capacitance		1020		pF	$V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}$ $f = 1\text{ MHz}$ $V_{AS} = 25\text{ mV}$	Fig. 17, 18
C_{oss}	Output Capacitance		80				
C_{rss}	Reverse Transfer Capacitance		9				
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		95		pF	$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 400\text{ V}$	Note 1
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		132				
E_{oss}	C_{oss} Stored Energy		15		μJ	$V_{DS} = 600\text{ V}, 1\text{ MHz}$	Fig. 16
E_{ON}	Turn-On Switching Energy (Body Diode)		70		μJ	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 13.2\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 135\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = Internal Body Diode of MOSFET	Fig. 25
E_{OFF}	Turn Off Switching Energy (Body Diode)		5				
E_{ON}	Turn-On Switching Energy (External SiC Diode)		67		μJ	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 13.2\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 135\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = External SiC Diode	Fig. 25
E_{OFF}	Turn Off Switching Energy (External SiC Diode)		6				
$t_{d(on)}$	Turn-On Delay Time		8		ns	$V_{DD} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 13.2\text{ A}, R_{G(ext)} = 2.5\text{ }\Omega, L = 135\text{ }\mu\text{H}$ Timing relative to V_{DS} Inductive load	Fig. 26
t_r	Rise Time		11				
$t_{d(off)}$	Turn-Off Delay Time		17				
t_f	Fall Time		5				
$R_{G(int)}$	Internal Gate Resistance		3		Ω	$f = 1\text{ MHz}, V_{AS} = 25\text{ mV}$	
Q_{gs}	Gate to Source Charge		13		nC	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 13.2\text{ A}$ Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		17				
Q_g	Total Gate Charge		46				

Note (1): $C_{o(er)}$, a lumped capacitance that gives same stored energy as C_{oss} while V_{ds} is rising from 0 to 400V $C_{o(tr)}$, a lumped capacitance that gives same charging time as C_{oss} while V_{ds} is rising from 0 to 400V



Reverse Diode Characteristics ($T_C = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode Forward Voltage	5.1		V	$V_{GS} = -4\text{ V}$, $I_{SD} = 6.6\text{ A}$, $T_J = 25^\circ\text{C}$	Fig. 8, 9, 10
		4.8		V	$V_{GS} = -4\text{ V}$, $I_{SD} = 6.6\text{ A}$, $T_J = 175^\circ\text{C}$	
I_S	Continuous Diode Forward Current		23	A	$V_{GS} = -4\text{ V}$, $T_C = 25^\circ\text{C}$	
$I_{S, \text{pulse}}$	Diode pulse Current		99	A	$V_{GS} = -4\text{ V}$, pulse width t_p limited by T_{Jmax}	
t_{rr}	Reverse Recover time	11		ns	$V_{GS} = -4\text{ V}$, $I_{SD} = 13.2\text{ A}$, $V_R = 400\text{ V}$ $\text{dif}/\text{dt} = 4500\text{ A}/\mu\text{s}$, $T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	151		nC		
I_{rrm}	Peak Reverse Recovery Current	27		A		
t_{rr}	Reverse Recover time	16		ns	$V_{GS} = -4\text{ V}$, $I_{SD} = 13.2\text{ A}$, $V_R = 400\text{ V}$ $\text{dif}/\text{dt} = 2400\text{ A}/\mu\text{s}$, $T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	110		nC		
I_{rrm}	Peak Reverse Recovery Current	12		A		

Thermal Characteristics

Symbol	Parameter	Typ.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.99	$^\circ\text{C}/\text{W}$		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			



Typical Performance

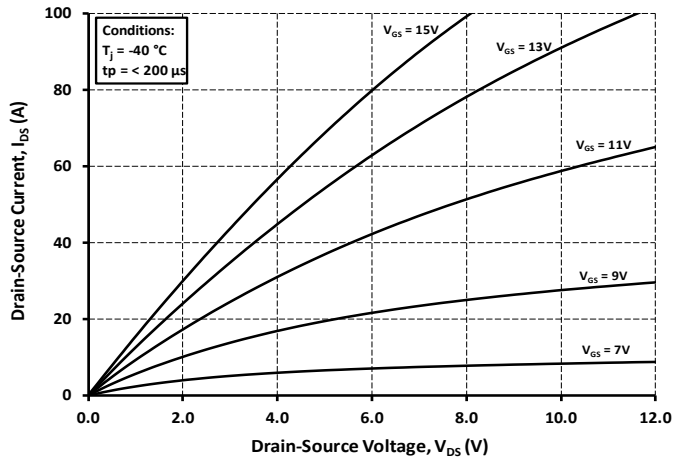


Figure 1. Output Characteristics $T_j = -40^\circ\text{C}$

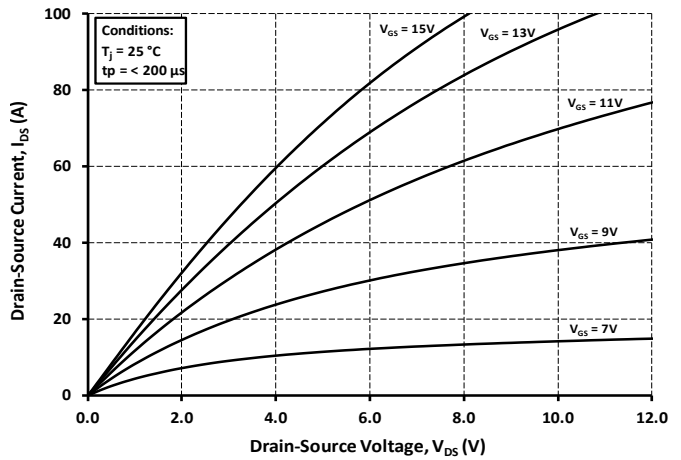


Figure 2. Output Characteristics $T_j = 25^\circ\text{C}$

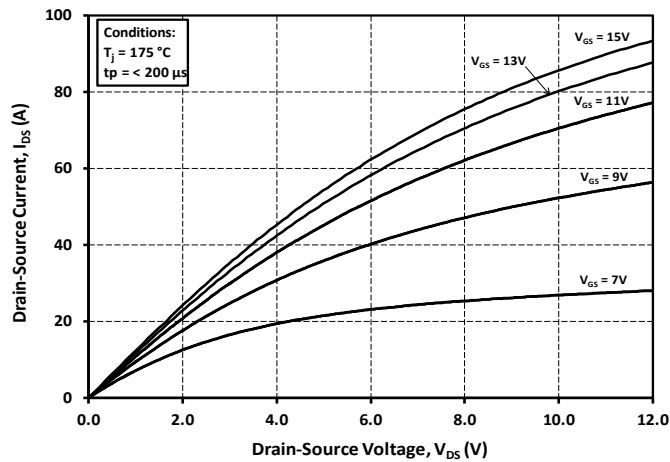


Figure 3. Output Characteristics $T_j = 175^\circ\text{C}$

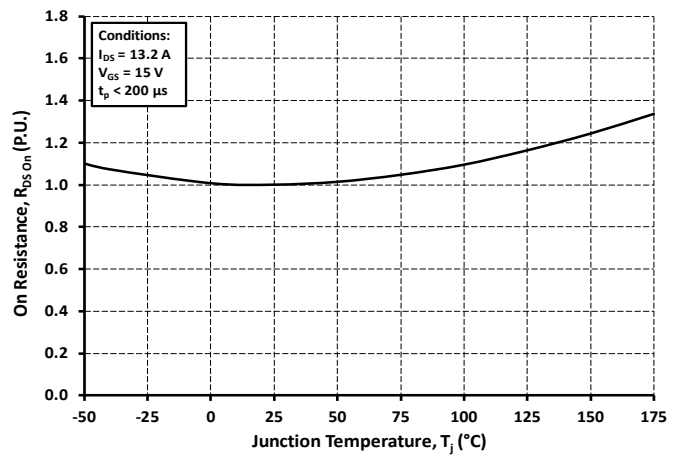


Figure 4. Normalized On-Resistance vs. Temperature

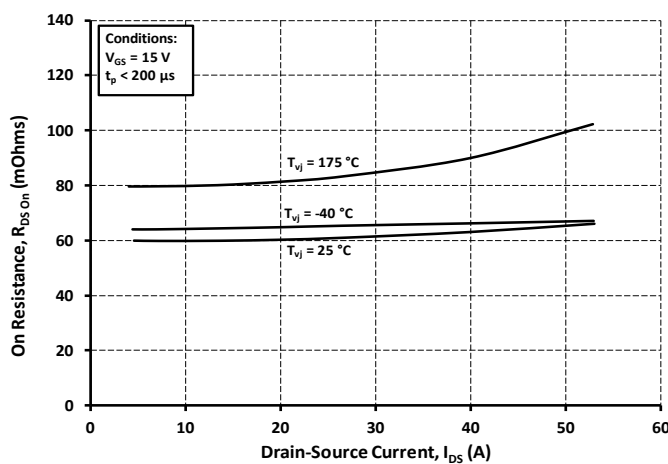


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

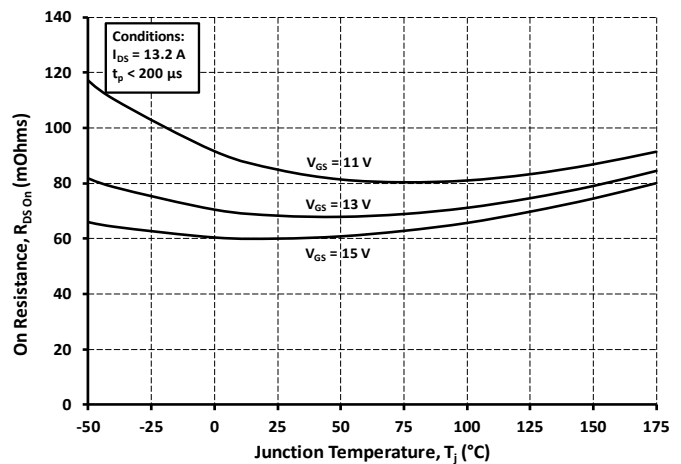


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

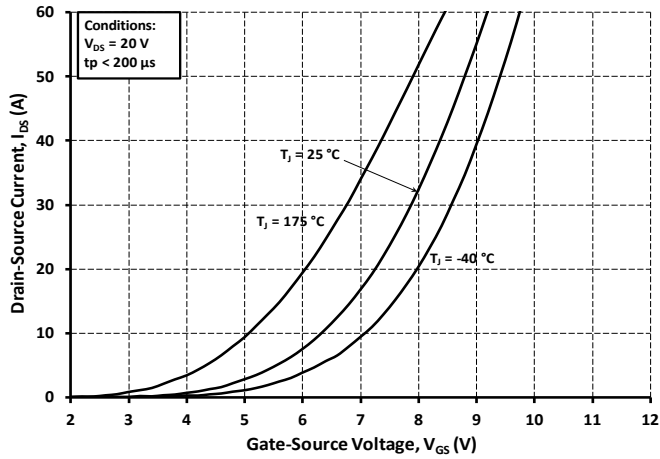


Figure 7. Transfer Characteristic for Various Junction Temperatures

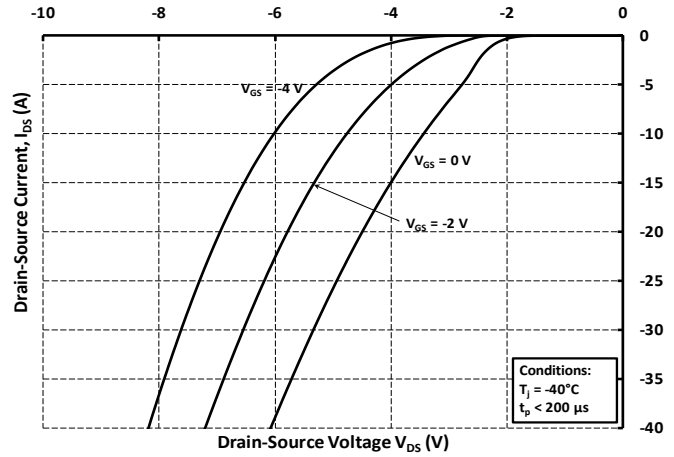


Figure 8. Body Diode Characteristic at $-40\text{ }^{\circ}\text{C}$

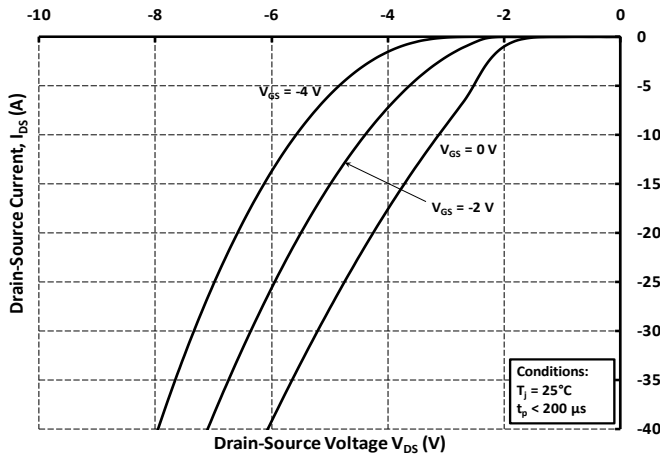


Figure 9. Body Diode Characteristic at $25\text{ }^{\circ}\text{C}$

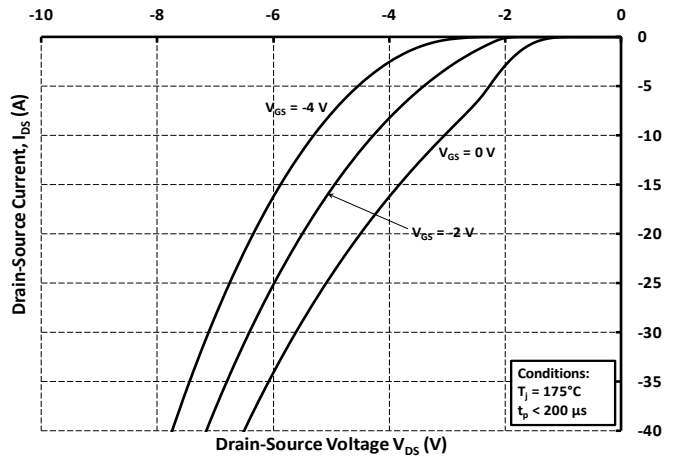


Figure 10. Body Diode Characteristic at $175\text{ }^{\circ}\text{C}$

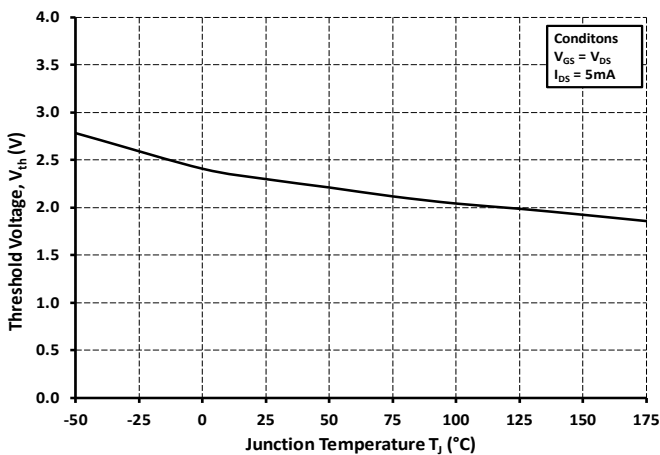


Figure 11. Threshold Voltage vs. Temperature

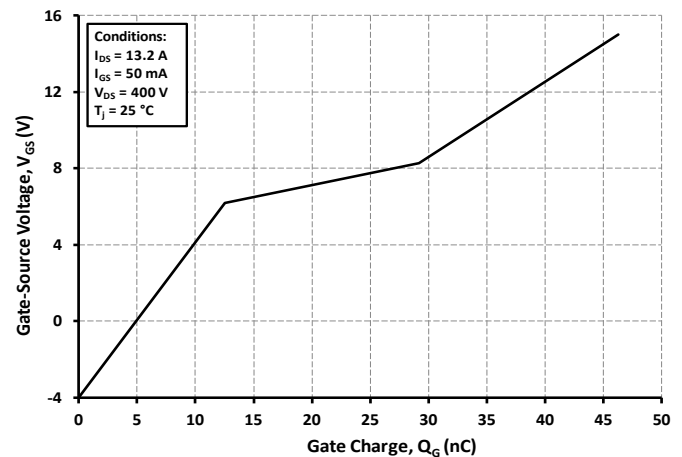


Figure 12. Gate Charge Characteristics

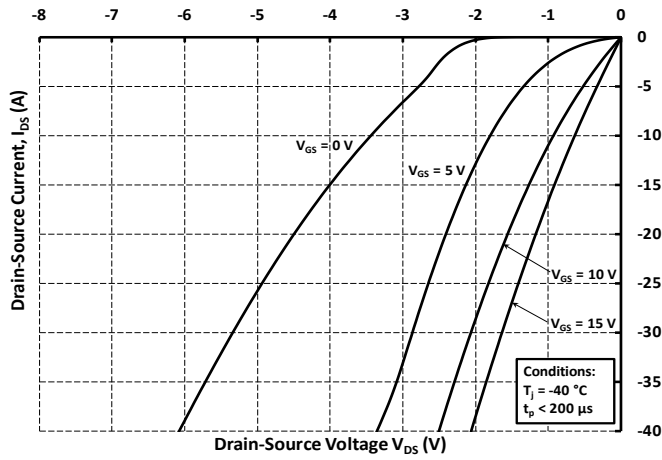


Figure 13. 3rd Quadrant Characteristic at -40°C

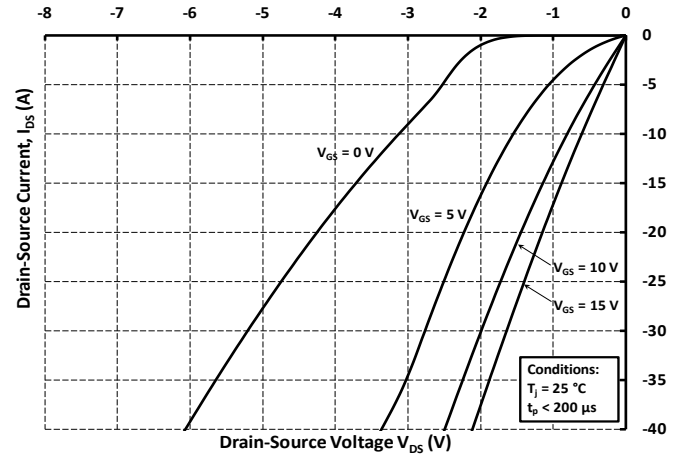


Figure 14. 3rd Quadrant Characteristic at 25°C

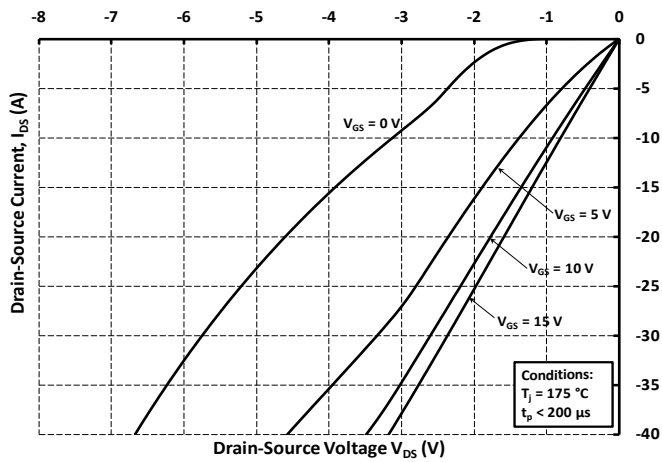


Figure 15. 3rd Quadrant Characteristic at 175°C

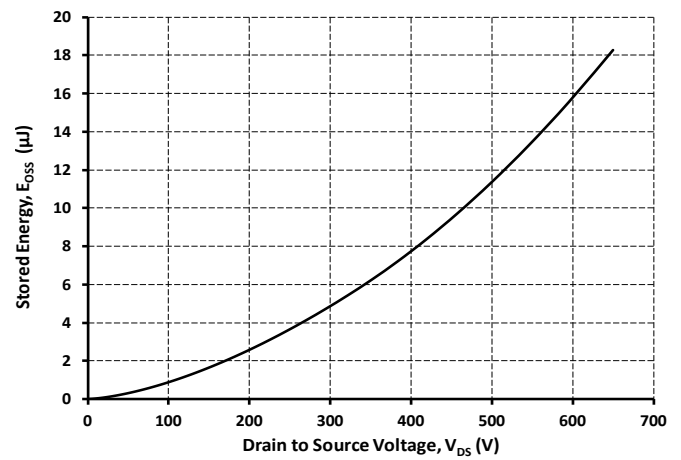


Figure 16. Output Capacitor Stored Energy

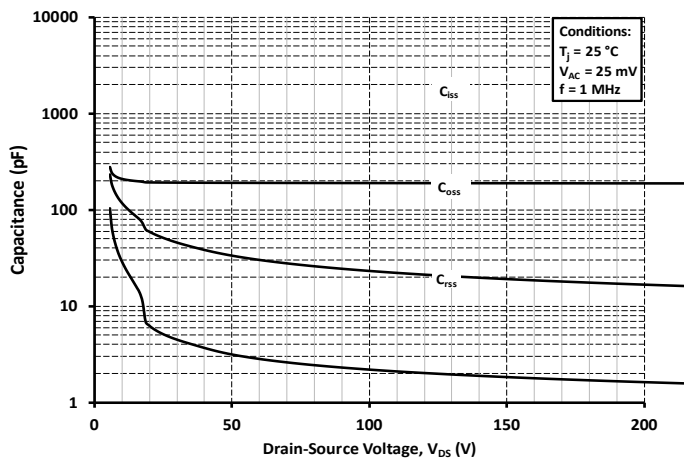


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

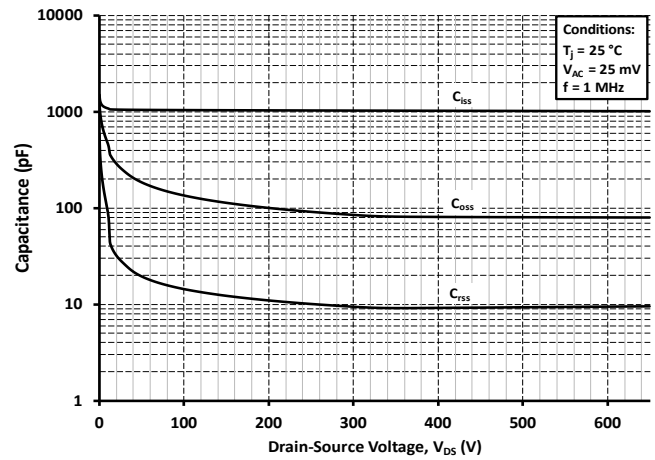


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)

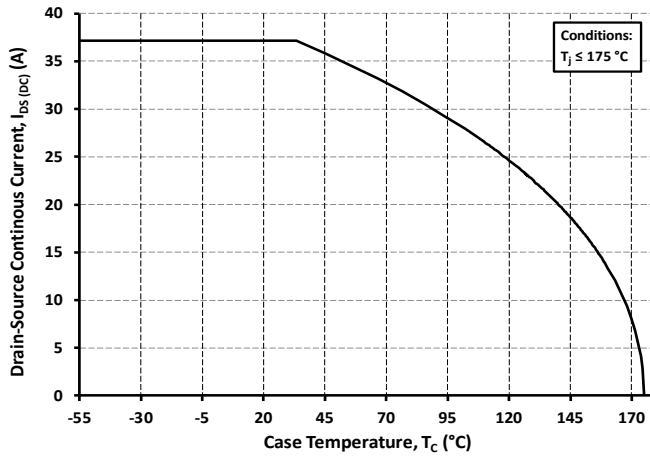


Figure 19. Continuous Drain Current Derating vs. Case Temperature

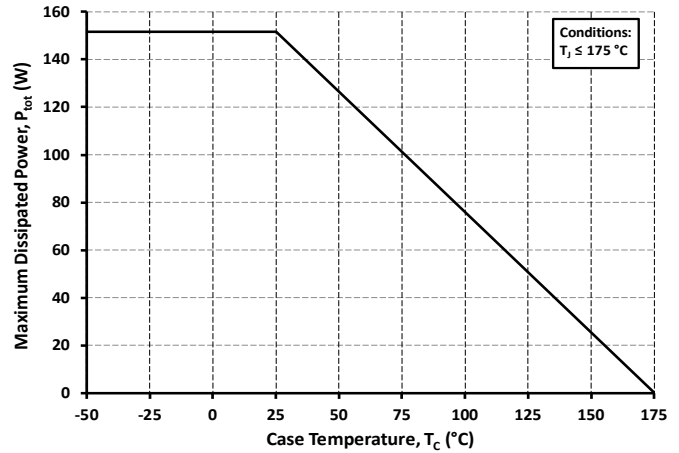


Figure 20. Maximum Power Dissipation Derating Vs Case Temperature

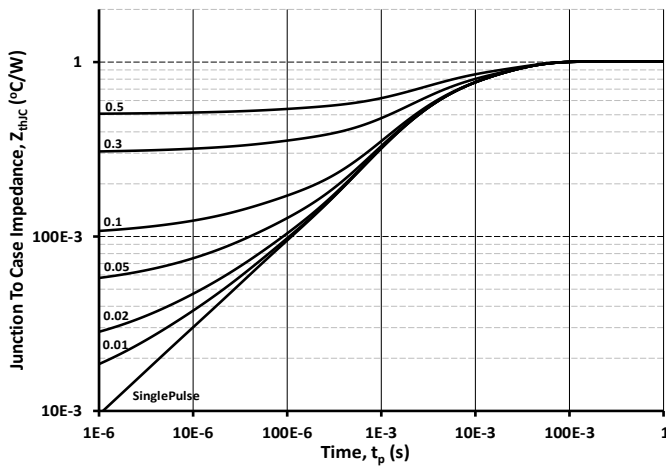


Figure 21. Transient Thermal Impedance (Junction - Case)

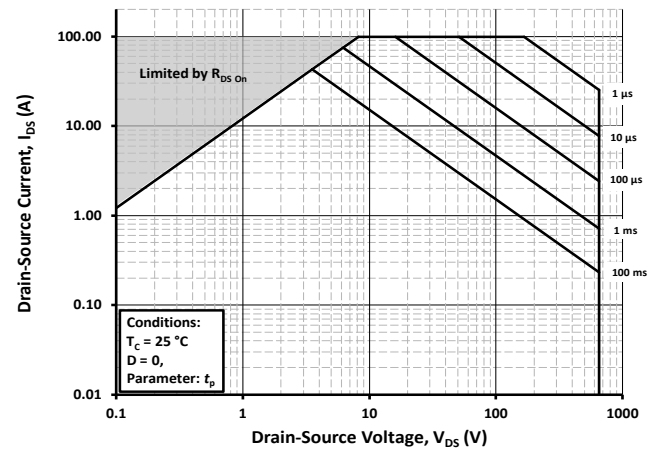


Figure 22. Safe Operating Area

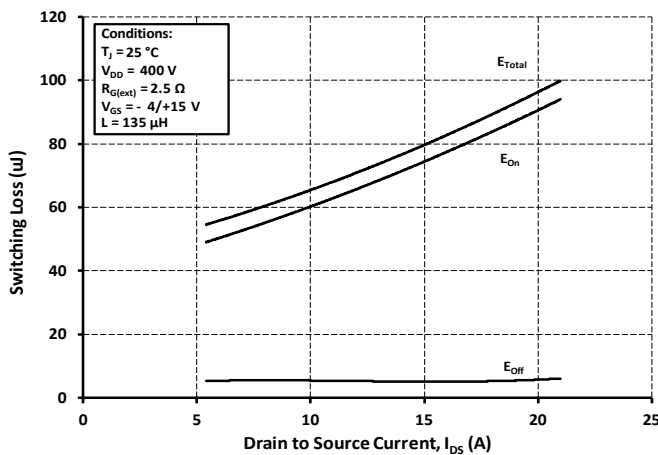


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 400V$)

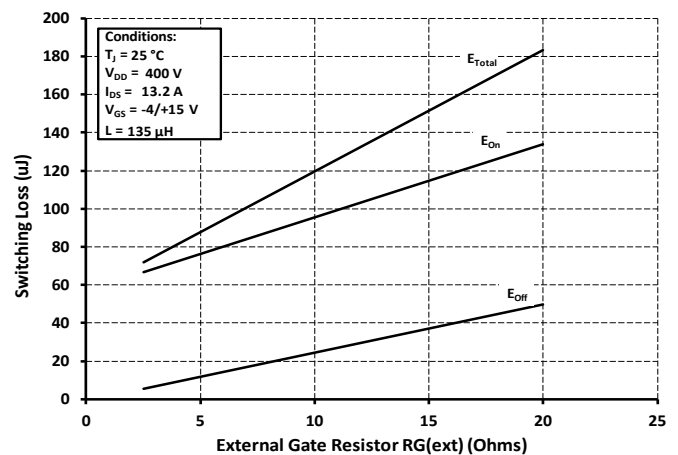


Figure 24. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

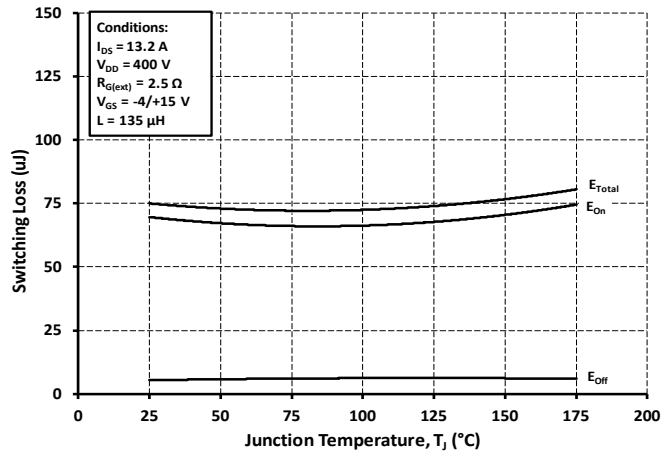


Figure 25. Clamped Inductive Switching Energy vs. Temperature

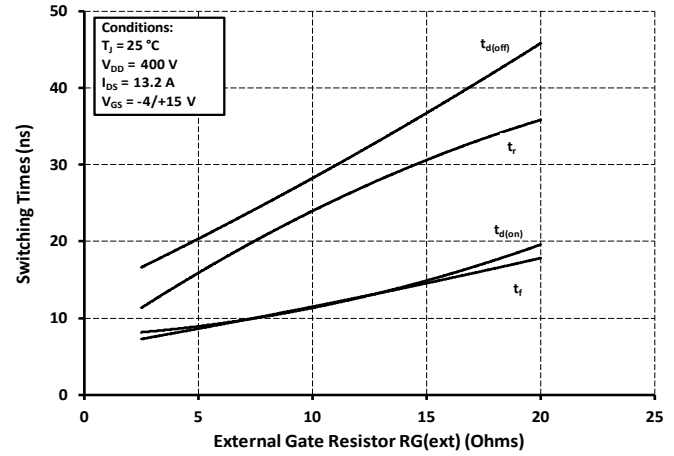


Figure 26. Switching Times vs. $R_{G(ext)}$



Test Circuit Schematic

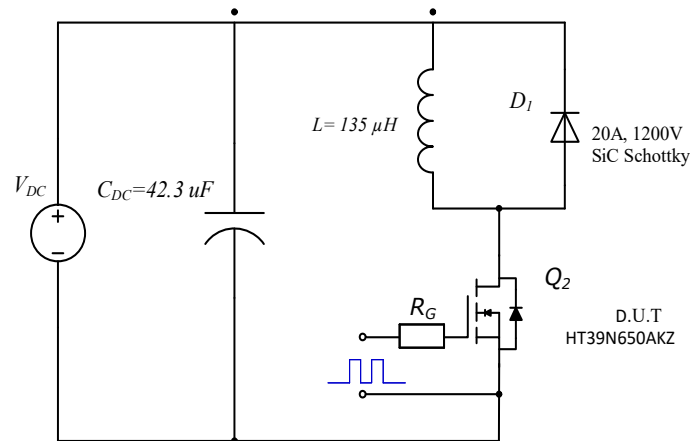


Figure 27. Clamped Inductive Switching
Waveform Test Circuit

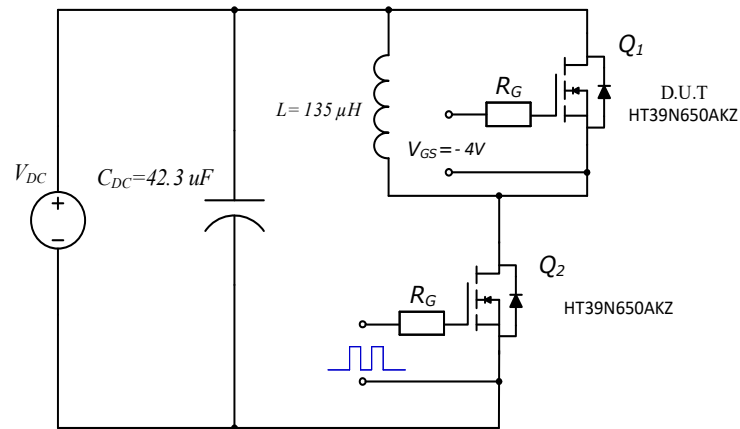


Figure 28. Body Diode Recovery Test Circuit

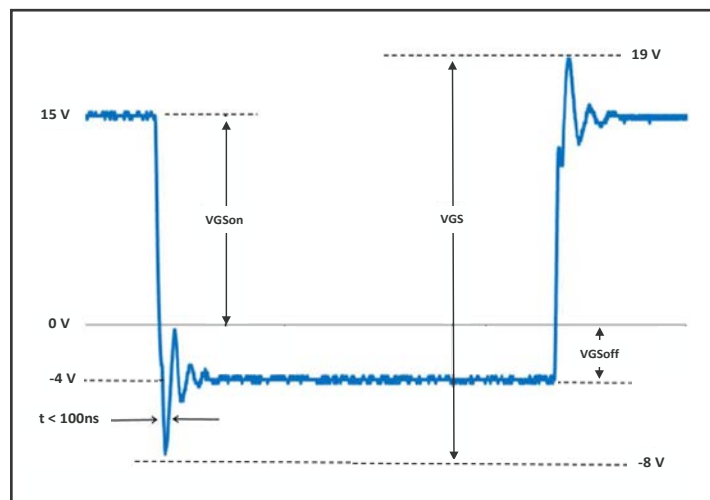
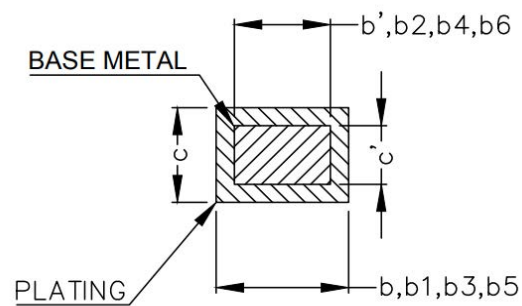
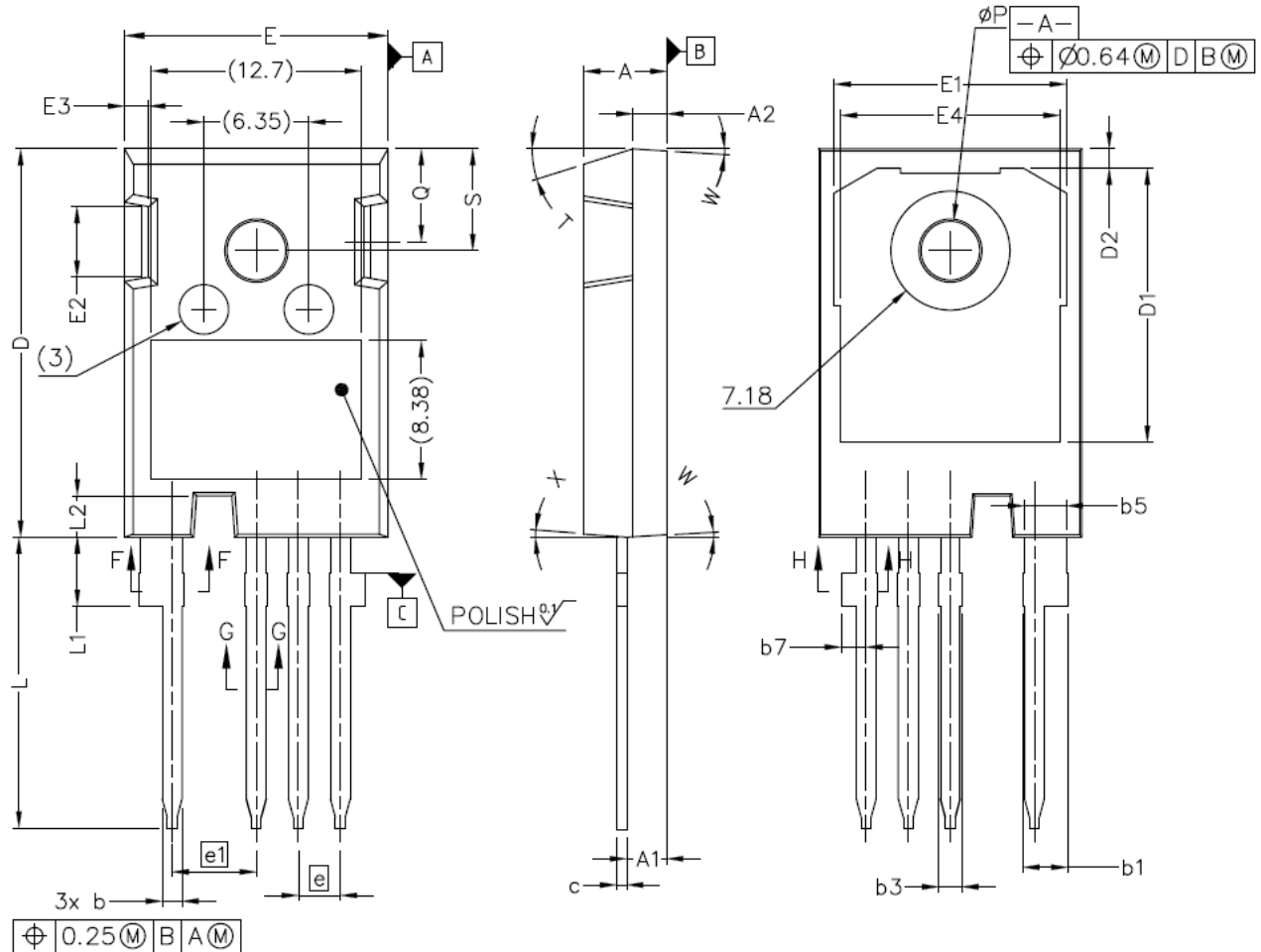


Figure 29. V_{GS} Waveform Example

Package Dimensions

Package TO-247H-4L



SECTION "F-F", "G-G" AND "H-H"
SCALE: NONE



Package Dimensions

Package TO-247H-4L

NOTE ;

1. ALL METAL SURFACES: TIN PLATED, EXCEPT AREA OF CUT
2. DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE IN MILLIMETERS.
ANGLES ARE IN DEGREES.
4. 'N' IS THE NUMBER OF TERMINAL POSITIONS

SYM	MILLIMETERS	
	MIN	MAX
A	4.83	5.21
A1	2.29	2.54
A2	1.91	2.16
b`	1.07	1.28
b	1.07	1.33
b1	2.39	2.94
b2	2.39	2.84
b3	1.07	1.60
b4	1.07	1.50
b5	2.39	2.69
b6	2.39	2.64
b7	1.30	1.70
c`	0.55	0.65
c	0.55	0.68
D	23.30	23.60
D1	16.25	17.65
D2	0.95	1.25
E	15.75	16.13

SYM	MILLIMETERS	
	MIN	MAX
E1	13.10	14.15
E2	3.68	5.10
E3	1.00	1.90
E4	12.38	13.43
e	2.54 BSC	
e1	5.08 BSC	
N*	4	
L	17.31	17.82
L1	3.97	4.37
L2	2.35	2.65
Ø P	3.51	3.65
Q	5.49	6.00
S	6.04	6.30
T	17.5° REF.	
W	3.5° REF.	
X	4° REF.	





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