



Features

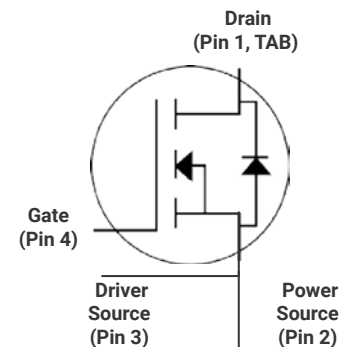
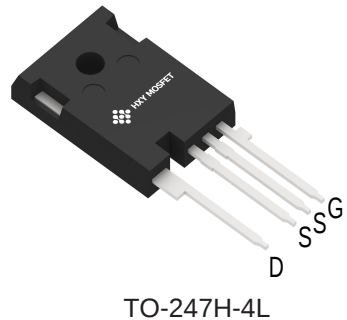
- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Q_{rr})
- Halogen free, RoHS compliant

Benefits

- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

Applications

- EV chargers
- Server & Telecom PSU
- UPS
- Solar inverters
- SMPS
- DC/DC converters



Ordering Part Number	Package	Brand	T_J, T_{stg} Range
NVH4L060N065SC1	TO-247H-4L	HXY MOSFET	-55 - 150 °C

Maximum Ratings ($T_C = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain - Source Voltage	650	V	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	
V_{GS}	Gate - Source voltage (Under transient events)	-8/+19	V	AC ($f > 1\text{ Hz}$)	Fig.28
I_D	Continuous Drain Current	49	A	$V_{GS} = 15\text{ V}, T_C = 25^\circ\text{C}$	Fig. 19
		35		$V_{GS} = 15\text{ V}, T_C = 100^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	132	A	Pulse width t_p limited by T_{Jmax}	
P_D	Power Dissipation	176	W	$T_C = 25^\circ\text{C}, T_J = 175^\circ\text{C}$	Fig. 20
T_J, T_{stg}	Operating Junction and Storage Temperature	-40 to +175	$^\circ\text{C}$		
T_L	Solder Temperature	260	$^\circ\text{C}$	1.6mm (0.063") from case for 10s	
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. 28
V_{GSoff}	Gate-Source Recommended Turn-Off Voltage		-4		V		
$V_{GS(th)}$	Gate Threshold Voltage	1.8	2.6	3.6	V	$V_{DS} = V_{GS}, I_D = 4.84\text{ mA}$	Fig. 11
			2.2		V	$V_{DS} = V_{GS}, I_D = 23\text{ mA}, T_J = 175^\circ\text{C}$	
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		45	60	m Ω	$V_{GS} = 15\text{ V}, I_D = 17.6\text{ A}$	Fig. 4, 5, 6
			61			$V_{GS} = 15\text{ V}, I_D = 17.6\text{ A}, T_J = 175^\circ\text{C}$	
g_{fs}	Transconductance		12		S	$V_{DS} = 20\text{ V}, I_{DS} = 17.6\text{ A}$	Fig. 7
			11			$V_{DS} = 20\text{ V}, I_{DS} = 17.6\text{ A}, T_J = 175^\circ\text{C}$	
C_{iss}	Input Capacitance		1621		pF	$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 600\text{ V}$ $f = 1\text{ MHz}$ $V_{AC} = 25\text{ mV}$	Fig. 17, 18
C_{oss}	Output Capacitance		101				
C_{rss}	Reverse Transfer Capacitance		8				
$C_{o(er)}$	Effective Output Capacitance (Energy Related)		126			$V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 400\text{ V}$	Note:1
$C_{o(tr)}$	Effective Output Capacitance (Time Related)		178				
E_{oss}	C_{oss} Stored Energy		20		μJ	$V_{GS} = 600\text{ V}, f = 1\text{ MHz}$	Fig. 16
E_{ON}	Turn-On Switching Energy (Body Diode)		57		μJ	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 17.6\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 99\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = Internal Body Diode of MOSFET	Fig. 24
E_{OFF}	Turn-Off Switching Energy (Body Diode)		14				
E_{ON}	Turn-On Switching Energy (External Diode)		44		μJ	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}, I_D = 17.6\text{ A},$ $R_{G(ext)} = 2.5\text{ }\Omega, L = 99\text{ }\mu\text{H}, T_J = 175^\circ\text{C}$ FWD = Internal Body Diode of MOSFET	Fig. 24
E_{OFF}	Turn Off Switching Energy (External Diode)		14				
$t_{d(on)}$	Turn-On Delay Time		9		ns	$V_{DD} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 17.6\text{ A}, R_{G(ext)} = 2.5\text{ }\Omega, L = 99\text{ }\mu\text{H},$ Timing relative to V_{DS} Inductive load	Fig. 25
t_r	Rise Time		12				
$t_{d(off)}$	Turn-Off Delay Time		18				
t_f	Fall Time		6				
$R_{G(int)}$	Internal Gate Resistance		3		Ω	$f = 1\text{ MHz}, V_{AC} = 25\text{ mV}$	
Q_{gs}	Gate to Source Charge		21		nC	$V_{DS} = 400\text{ V}, V_{GS} = -4\text{ V}/15\text{ V}$ $I_D = 17.6\text{ A}$ Per IEC60747-8-4 pg 21	Fig. 12
Q_{gd}	Gate to Drain Charge		18				
Q_g	Total Gate Charge		63				

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	4.8		V	$V_{GS} = -4\text{ V}, I_{SD} = 8.8\text{ A}, T_J = 25^\circ\text{C}$	Fig. 8, 9, 10
		4.2		V	$V_{GS} = -4\text{ V}, I_{SD} = 8.8\text{ A}, T_J = 175^\circ\text{C}$	
I_S	Continuous Diode Forward Current		29	A	$V_{GS} = -4\text{ V}, T_J = 25^\circ\text{C}$	
$I_{S, \text{pulse}}$	Diode pulse Current		132	A	$V_{GS} = -4\text{ V}$, pulse width t_p limited by T_{Jmax}	
t_{rr}	Reverse Recover time	13		ns	$V_{GS} = -4\text{ V}, I_{SD} = 17.6\text{ A}, V_R = 400\text{ V}$ $\text{dif}/\text{dt} = 4000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	247		nC		
I_{rrm}	Peak Reverse Recovery Current	36		A		
t_{rr}	Reverse Recover time	18		ns	$V_{GS} = -4\text{ V}, I_{SD} = 17.6\text{ A}, V_R = 400\text{ V}$ $\text{dif}/\text{dt} = 5500\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$	
Q_{rr}	Reverse Recovery Charge	171		nC		
I_{rrm}	Peak Reverse Recovery Current	16		A		

Thermal Characteristics

Symbol	Parameter	Max.	Unit	Test Conditions	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	0.85	$^\circ\text{C}/\text{W}$		Fig. 21
$R_{\theta JA}$	Thermal Resistance From Junction to Ambient	40			



Typical Performance

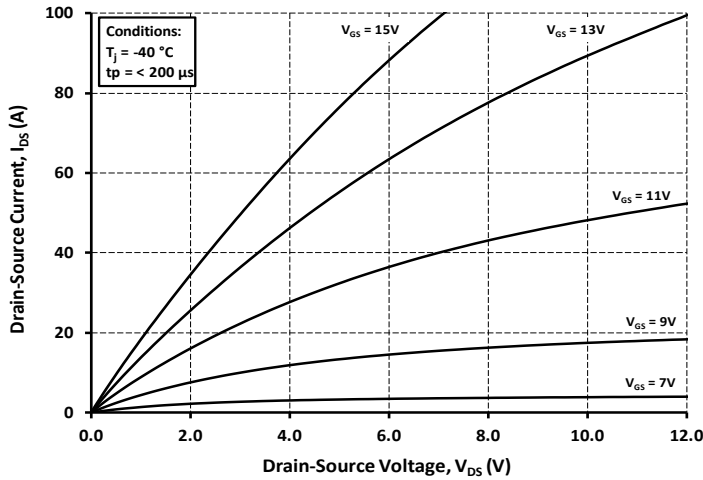


Figure 1. Output Characteristics $T_j = -40^\circ\text{C}$

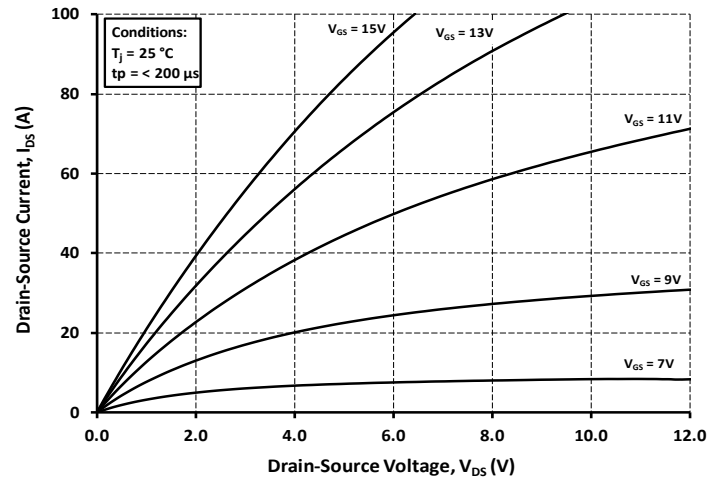


Figure 2. Output Characteristics $T_j = 25^\circ\text{C}$

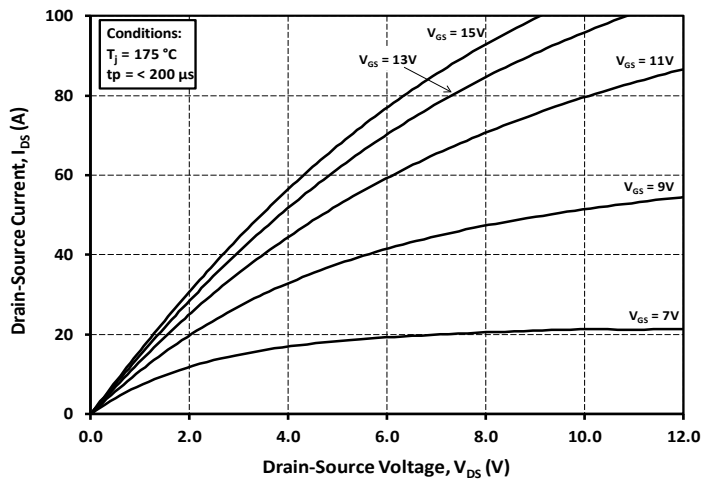


Figure 3. Output Characteristics $T_j = 175^\circ\text{C}$

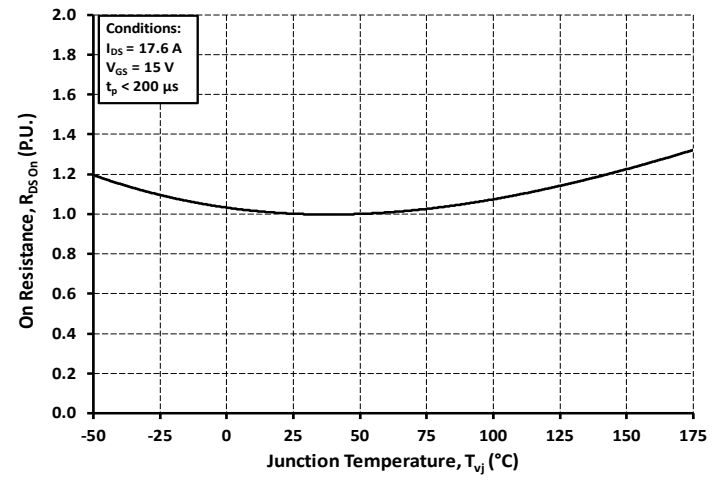


Figure 4. Normalized On-Resistance vs. Temperature

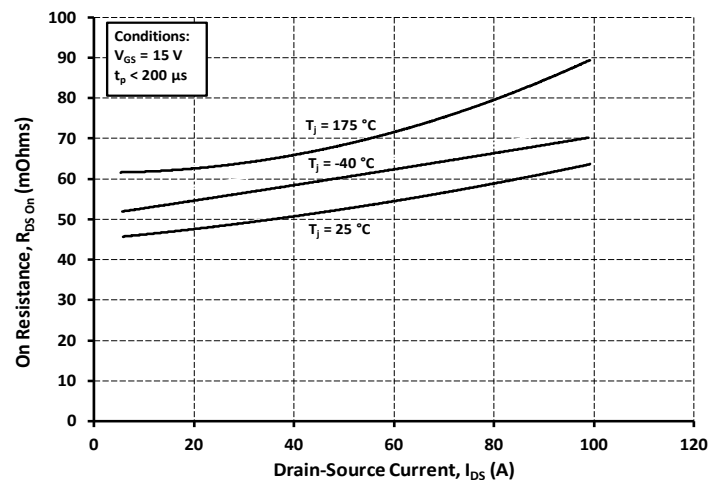


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

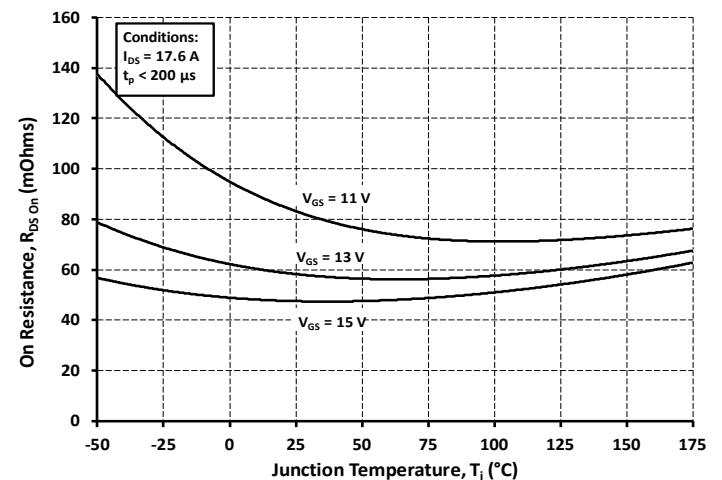


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

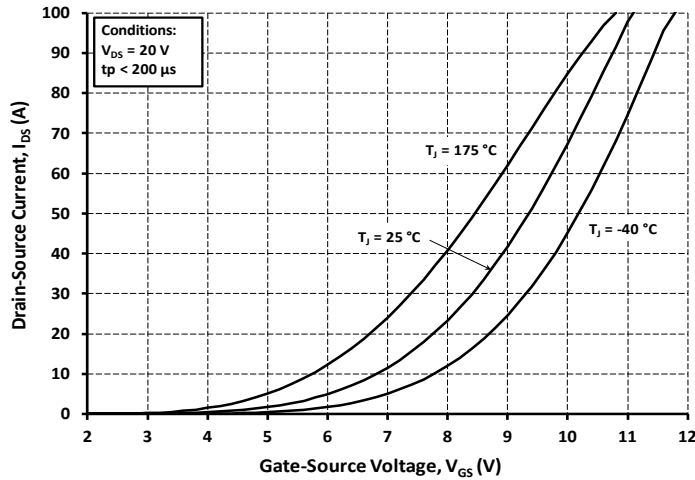


Figure 7. Transfer Characteristic for Various Junction Temperatures

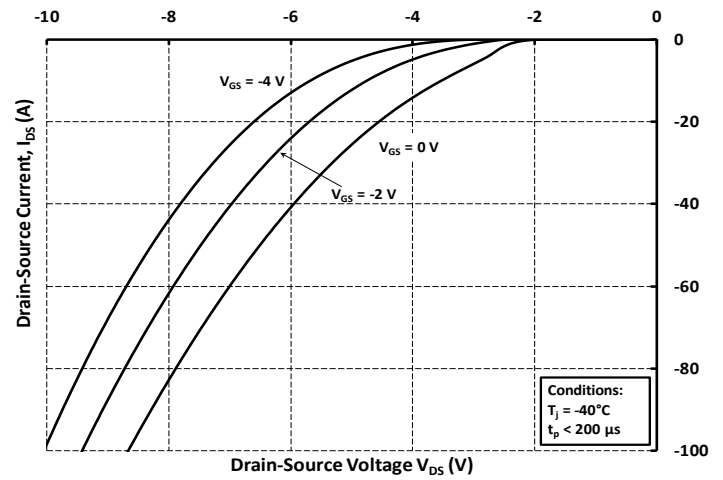


Figure 8. Body Diode Characteristic at -40 °C

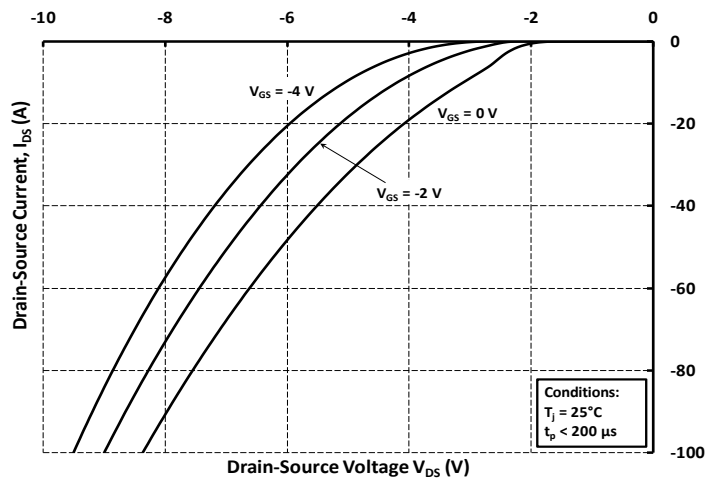


Figure 9. Body Diode Characteristic at 25 °C

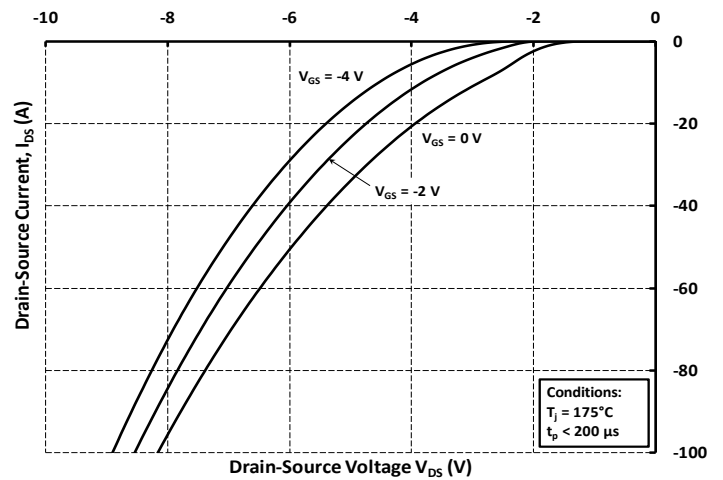


Figure 10. Body Diode Characteristic at 175 °C

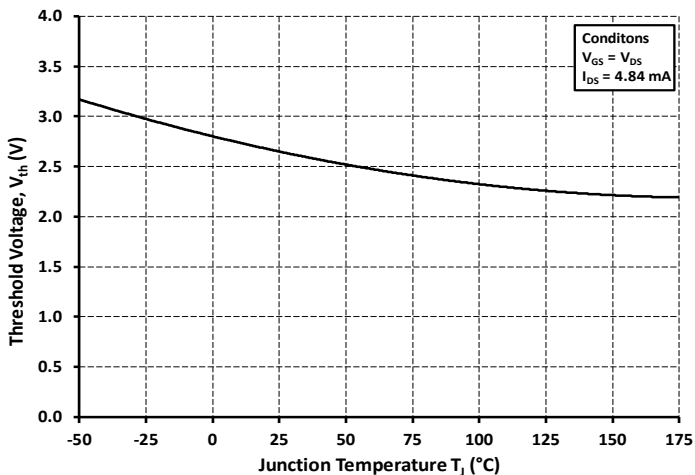


Figure 11. Threshold Voltage vs. Temperature

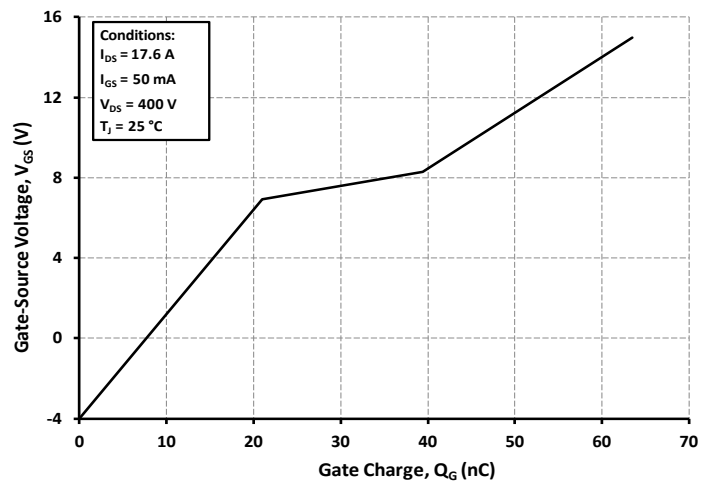


Figure 12. Gate Charge Characteristics

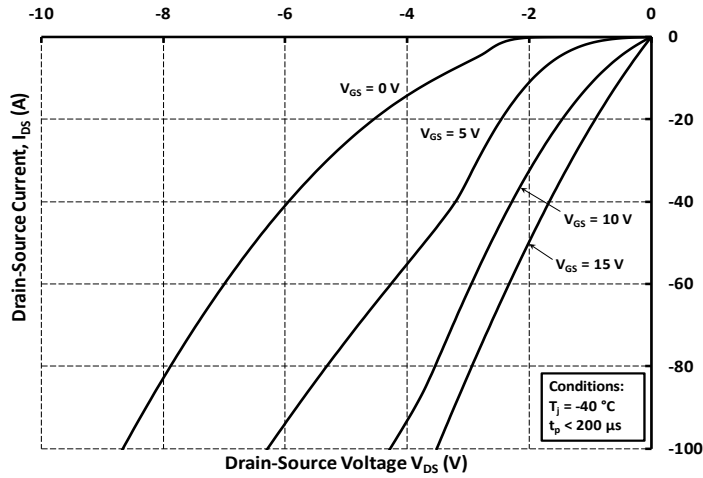


Figure 13. 3rd Quadrant Characteristic at -40 °C

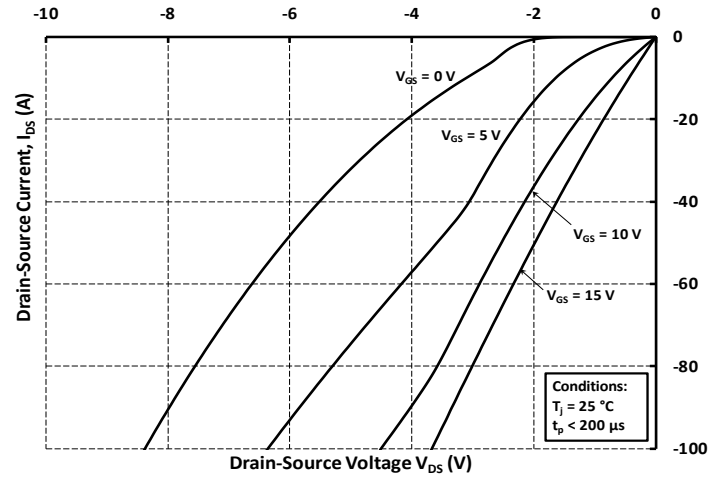


Figure 14. 3rd Quadrant Characteristic at 25 °C

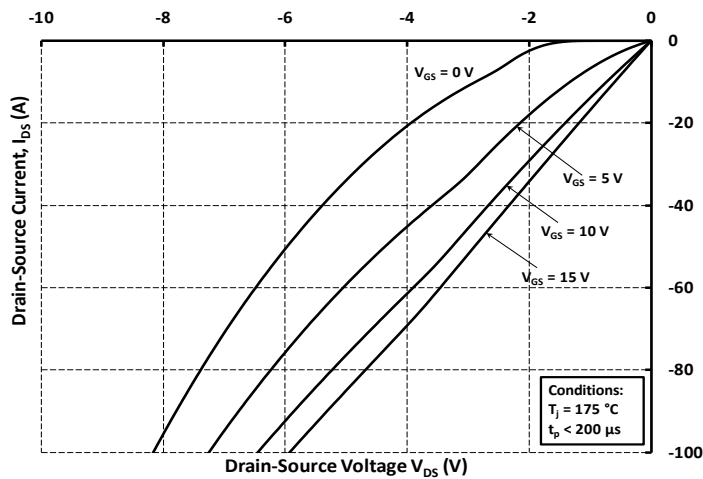


Figure 15. 3rd Quadrant Characteristic at 175 °C

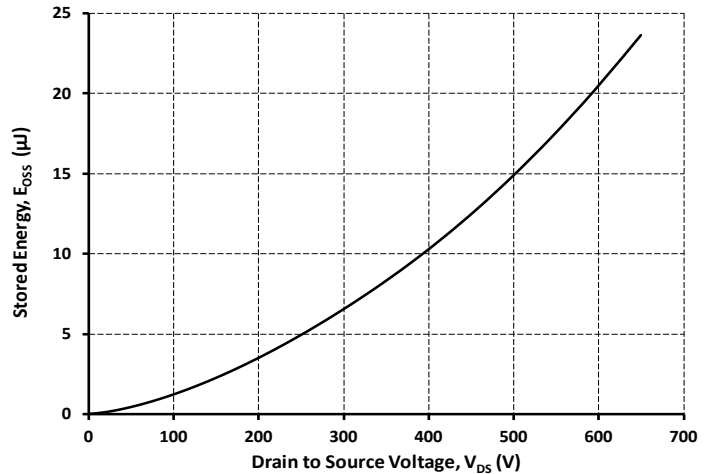


Figure 16. Output Capacitor Stored Energy

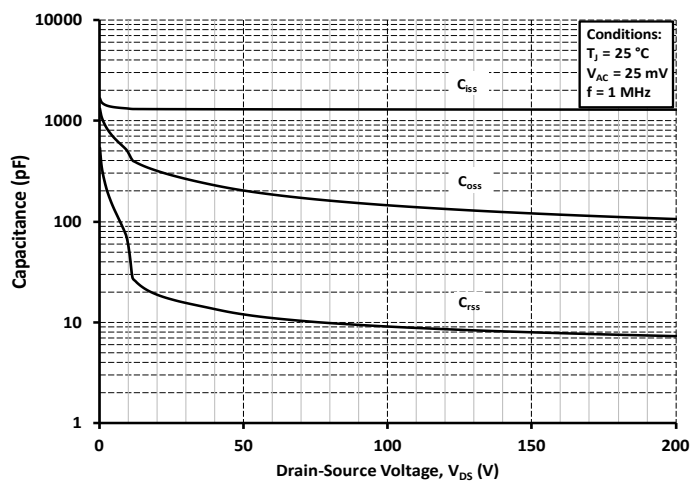


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

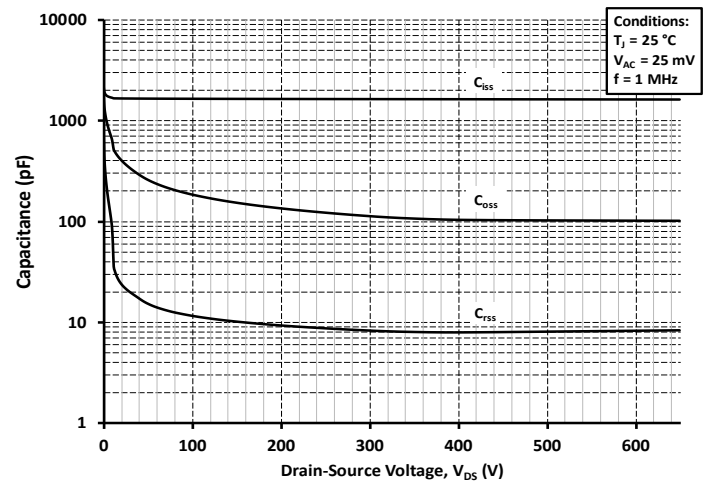


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 650V)

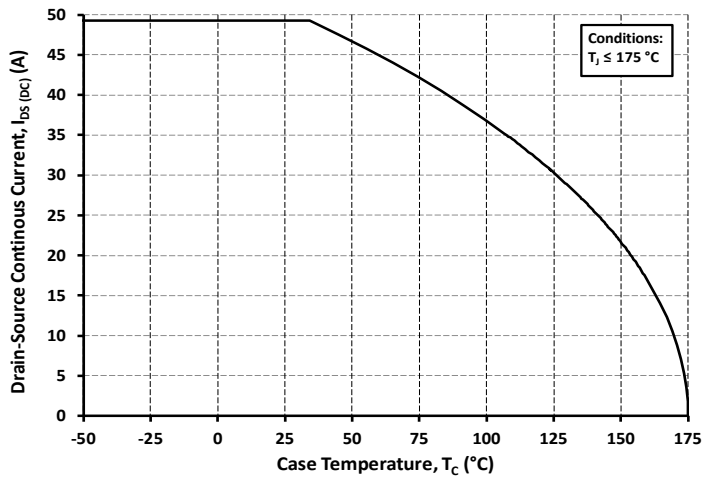


Figure 19. Continuous Drain Current Derating vs. Case Temperature

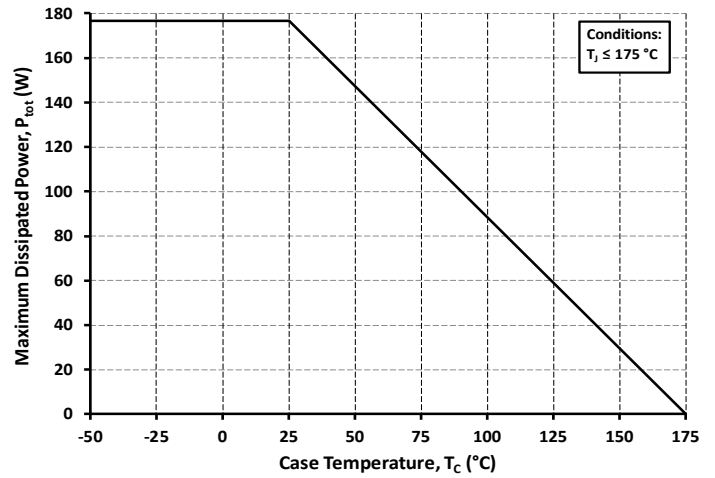


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

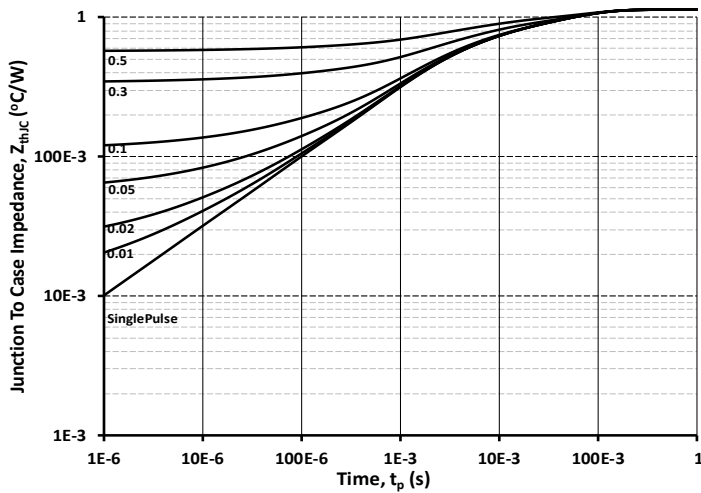


Figure 21. Transient Thermal Impedance (Junction - Case)

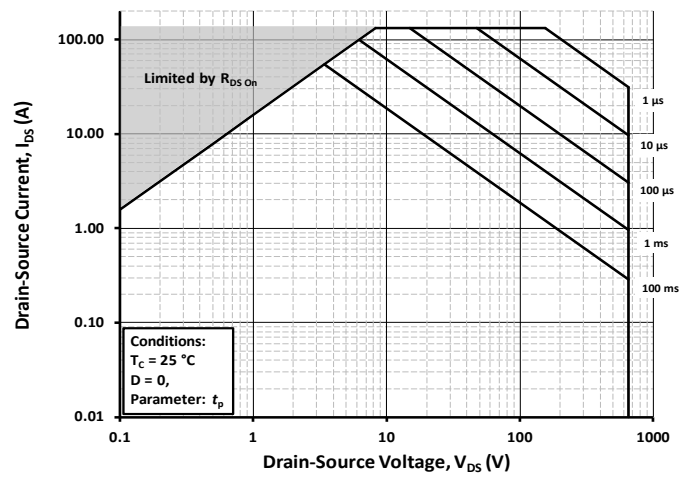


Figure 22. Safe Operating Area

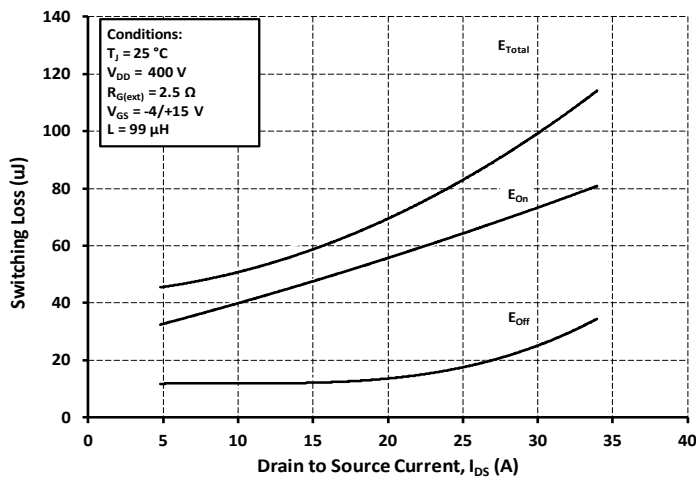


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD} = 400V$)

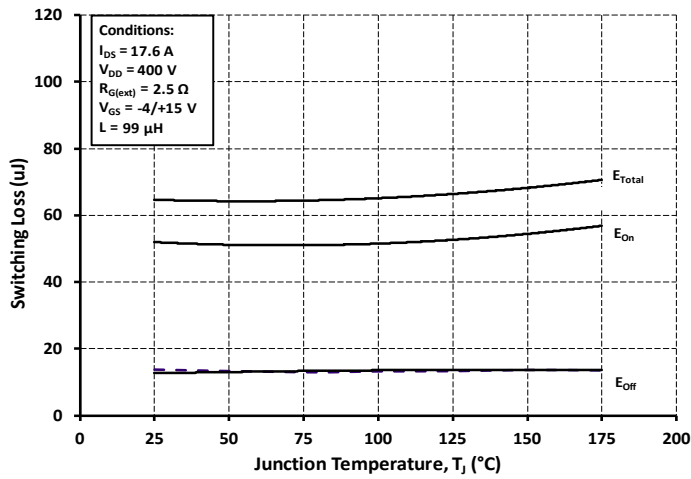


Figure 24. Clamped Inductive Switching Energy vs. Temperature

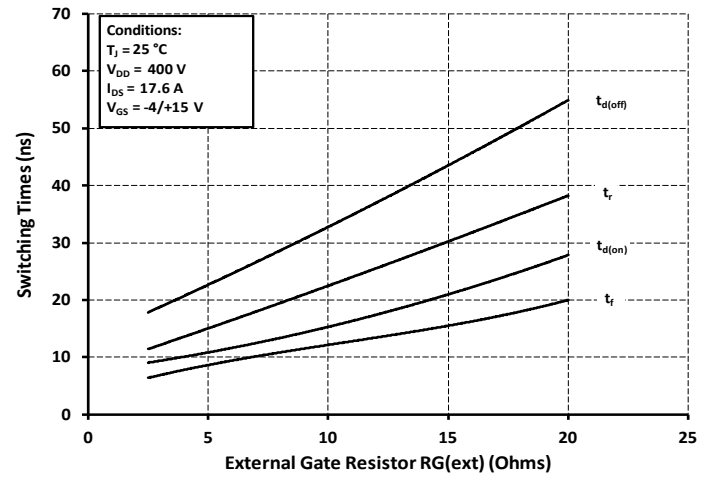


Figure 25. Switching Times vs. $R_{G(ext)}$



Test Circuit Schematic

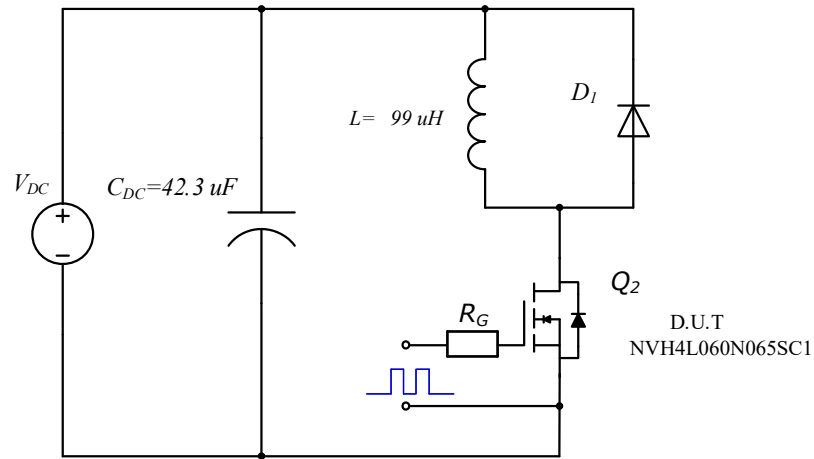


Figure 26. Clamped Inductive Switching Waveform Test Circuit

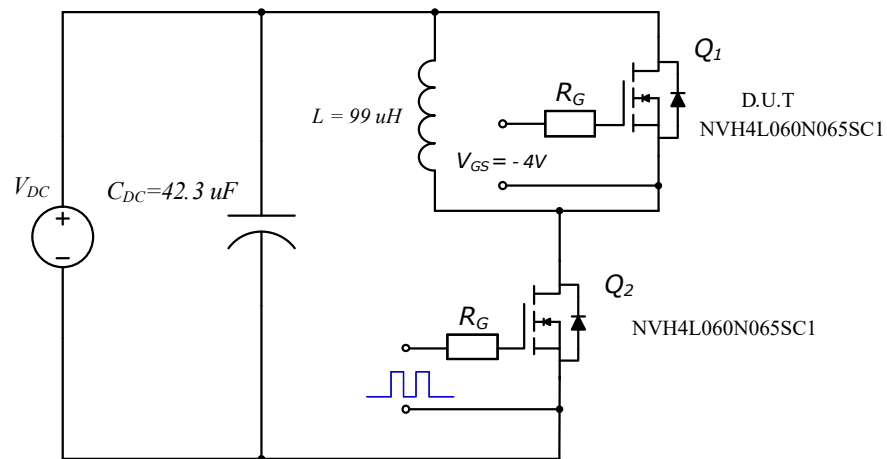


Figure 27. Body Diode Recovery Test Circuit

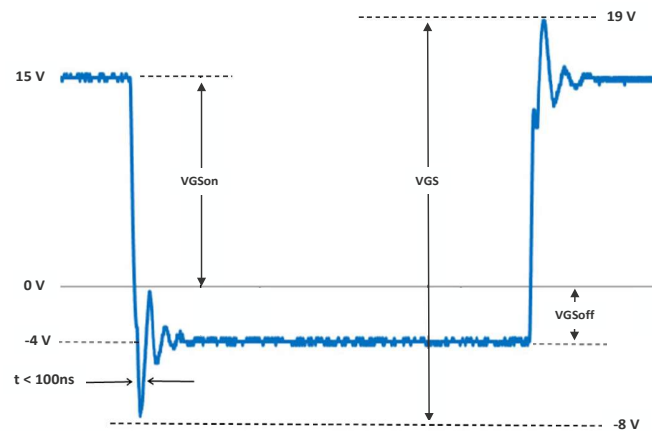
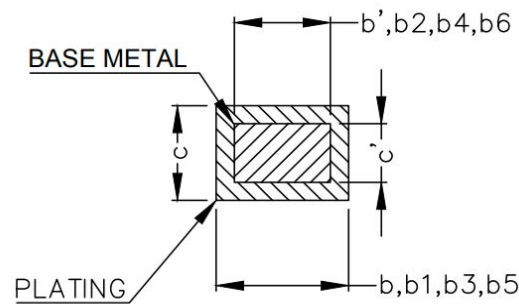


Figure 28. V_{GS} Waveform Example



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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