

HC060N065K4X

650V N-Channel Silicon Carbide Power MOSFET

V_{DS}	=	650 V
$R_{DS(on)}$	=	45 mΩ
I_D	=	78 A

Features

- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- Low on-resistance with high junction temperature
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery (Q_{rr})
- Easy to parallel
- RoHS compliant

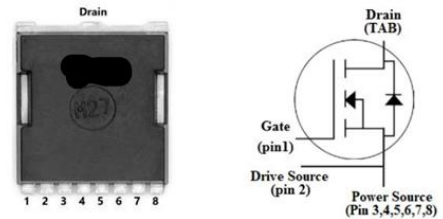
Benefits

- Higher System Efficiency
- Reduce cooling requirements
- Increased power density
- Minimize gate ringing
- Reduction of system complexity and cost

Applications

- Switch Mode Power Supplies
- DC/DC converters
- Solar Inverters
- EV charging infrastructure
- Energy storage & battery
- Battery control unit

Package



Part Number	Package	Marking
HC060N065K4X	TOLL	HC060N065K4X

Maximum Ratings, at $T_J = 25^\circ\text{C}$, unless otherwise specified

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain-Source Breakdown Voltage	650	V	$V_{GS} = 0\text{ V}$, $I_D = 100\text{ }\mu\text{A}$	
I_D	Continuous Drain Current	78	A	$V_{GS} = 20\text{ V}$, $T_C = 25\text{ }^\circ\text{C}$	Fig. 18
		55	A	$V_{GS} = 20\text{ V}$, $T_C = 100\text{ }^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	156	A	Pulse width t_p limited by T_{jmax}	
P_D	Power Dissipation	362	W	$T_C = 25\text{ }^\circ\text{C}$	Fig. 19
$V_{GS,op}$	Recommend Gate Source Voltage	-5/+20	V		
V_{GSmax}	Maximum Gate Source Voltage	-10/+25	V	AC ($f > 1\text{ Hz}$)	
T_J, T_{stg}	Operating Junction and Storage Temperature Range	-55 to +175	$^\circ\text{C}$		
T_L	Soldering Temperature	260	$^\circ\text{C}$		

Electrical Characteristics, at $T_J = 25^\circ\text{C}$, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
Static							
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	650	--	--	V	$V_{GS}=0\text{ V}$, $I_D=100\text{ }\mu\text{A}$	
I_{DSS}	Zero Gate Voltage Drain Current	--	10	100	μA	$V_{DS}=650\text{ V}$, $V_{GS}=0\text{ V}$	
I_{GSS}	Gate-Source Leakage	--	5	250	nA	$V_{GS}=20\text{ V}$	
$V_{GS(th)}$	Gate-Source Threshold Voltage	2	--	4	V	$I_D=5\text{ mA}$, $V_{GS}=V_{DS}$	Fig. 11
$R_{DS(on)}$	Drain-Source On-State Resistance	--	45	80	m Ω	$V_{GS}=20\text{ V}$, $I_D=13.2\text{ A}$	Fig. 7
		--	52	--	m Ω	$V_{GS}=18\text{ V}$, $I_D=13.2\text{ A}$	
Dynamic							
C_{iss}	Input Capacitance	--	1129	--	pF	$V_{GS}=0\text{ V}$, $V_{DS}=600\text{ V}$ $f=1.0\text{ MHz}$, $V_{AC}=25\text{ mV}$	Fig. 17
C_{oss}	Output Capacitance	--	114	--			
C_{rss}	Reverse Transfer Capacitance	--	6.5	--			
E_{oss}	C_{oss} Stored Energy	--	25	--	μJ		Fig. 16
Q_g	Total Gate Charge	--	62	--	nC	$V_{DS}=400\text{ V}$ $I_D=13.2\text{ A}$ $V_{GS}=-5/+20\text{ V}$	Fig. 12
Q_{gs}	Gate-Source Charge	--	18	--			
Q_{gd}	Gate-Drain Charge	--	33	--			
$t_{d(on)}$	Turn-on Delay Time	--	132.6	--	ns	$V_{DS}=400\text{ V}$ $V_{GS}=-5/+20\text{ V}$ $I_D=13.2\text{ A}$ $R_{G(ext)}=2.5\text{ }\Omega$	
t_r	Turn-on Rise Time	--	42.7	--			
$t_{d(off)}$	Turn-off Delay Time	--	21.3	--			
t_f	Turn-off Fall Time	--	14.5	--			
$R_{G(int)}$	Internal Gate Resistance	--	2.8	--	Ω	$f=1.0\text{ MHz}$, $V_{AC}=25\text{ mV}$	

Body Diode Characteristics, at $T_J = 25^\circ\text{C}$, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
I_S	Continuous Diode Forward Current	--	--	78	A		
$I_{S(pulse)}$	Diode pulse Current	--	156	--	A		
V_{SD}	Diode Forward Voltage	--	3.0	--	V	$V_{GS} = 0\text{ V}, I_S = 6.6\text{ A}$	Fig. 8, 9, 10
t_{rr}	Reverse Recovery Time	--	23	--	ns	$I_S = 13.2\text{ A}, V_{DS} = 400\text{ V}$ $V_{GS} = -5\text{ V}$ $di/dt = 2100\text{ A}/\mu\text{s}$	
Q_{rr}	Reverse Recovery Charge	--	132	--	nC		
I_{rrm}	Peak Reverse Recovery Current	--	13	--	A		

Thermal Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Note
$R_{\theta JC}$	Thermal Resistance from Junction to Case	--	0.414	--	$^\circ\text{C}/\text{W}$	Fig. 20

Typical Performance

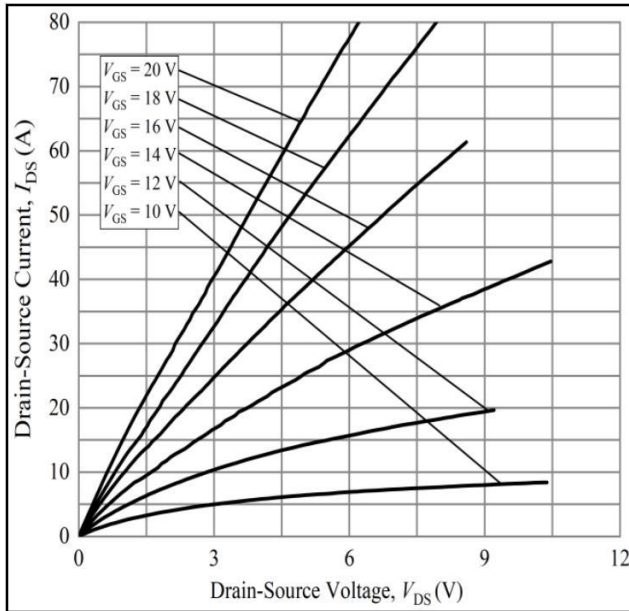


Figure 1: Typical Output Characteristics at $T_j = -55\text{ }^{\circ}\text{C}$

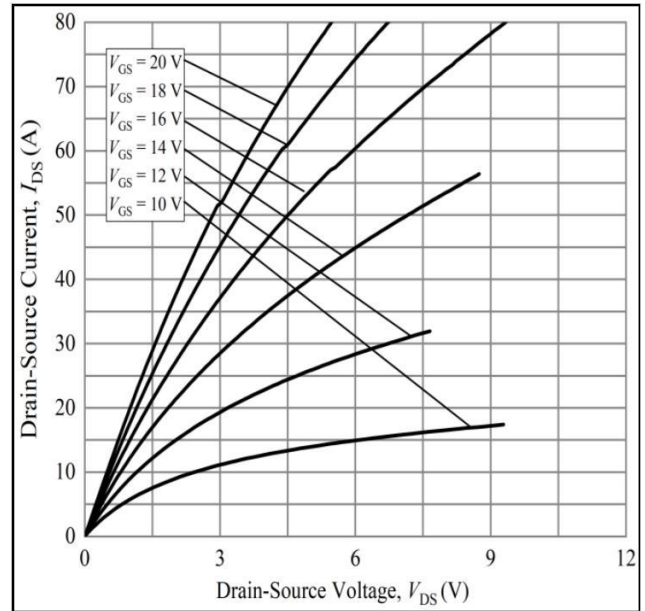


Figure 2: Typical Output Characteristics at $T_j = 25\text{ }^{\circ}\text{C}$

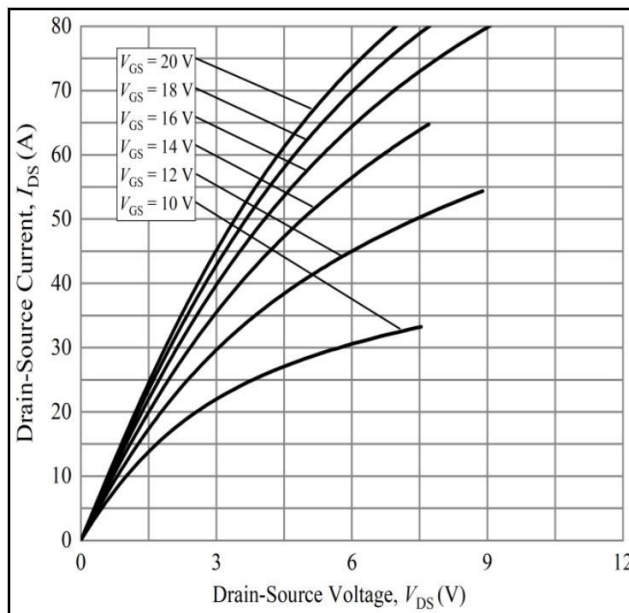


Figure 3: Typical Output Characteristics at $T_j = 175\text{ }^{\circ}\text{C}$

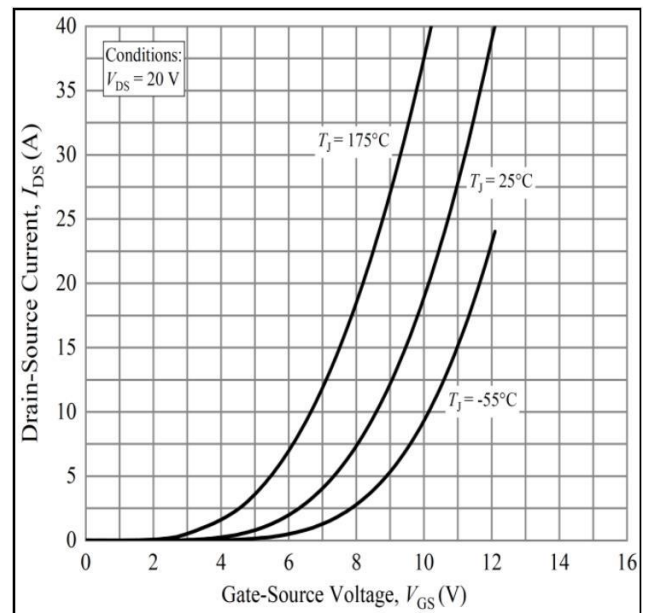


Figure 4: Typical Transfer Characteristics for Various Temperature

Typical Performance

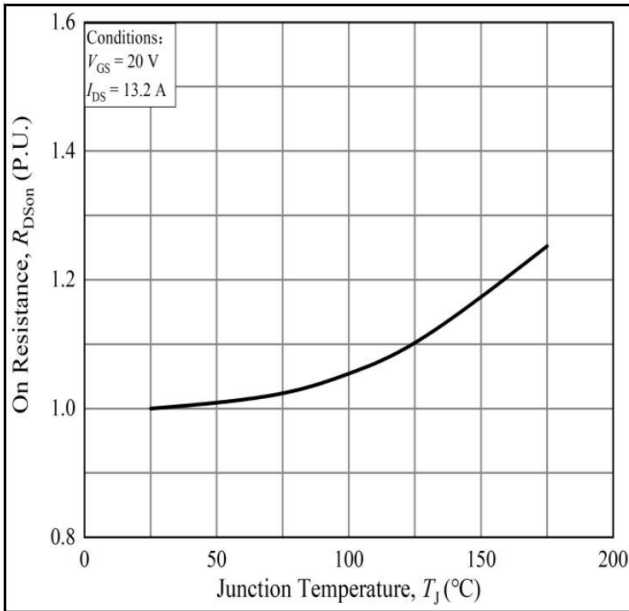


Figure 5: Normalized On-Resistance vs. Temperature

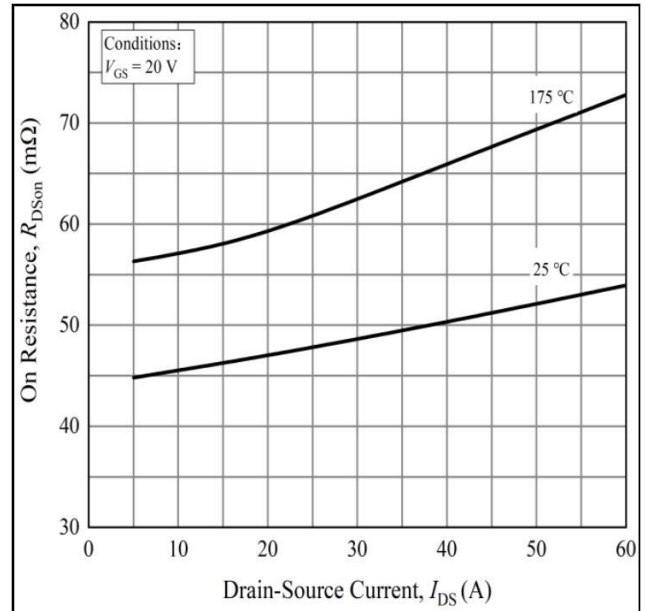


Figure 6: On-Resistance vs. Drain Current for Gate Various Temperatures

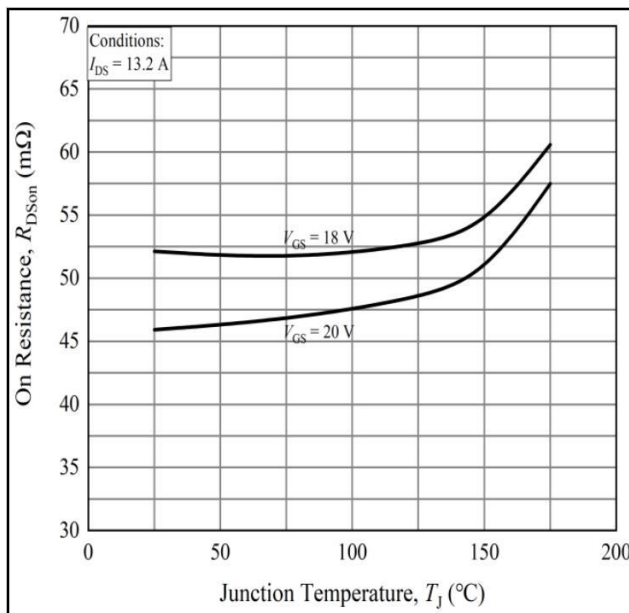


Figure 7: On-Resistance vs. Temperature for Gate Various Voltage

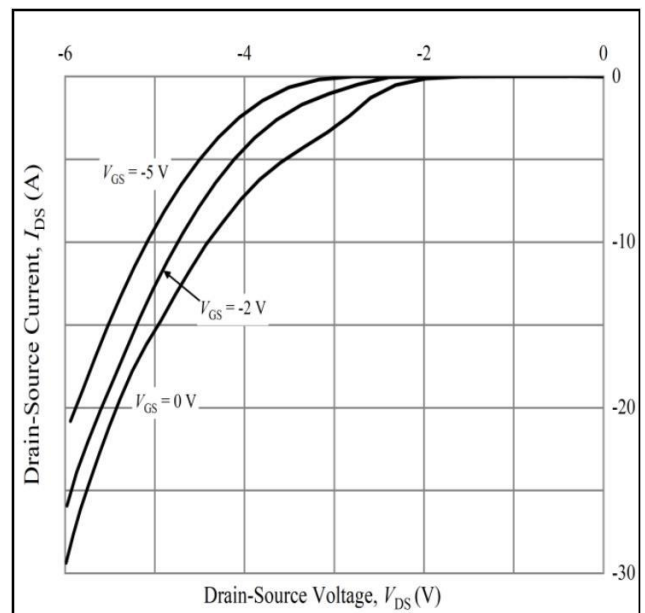


Figure 8: Typical Body Diode Characteristics at $T_J = -55\text{ }^{\circ}\text{C}$

Typical Performance

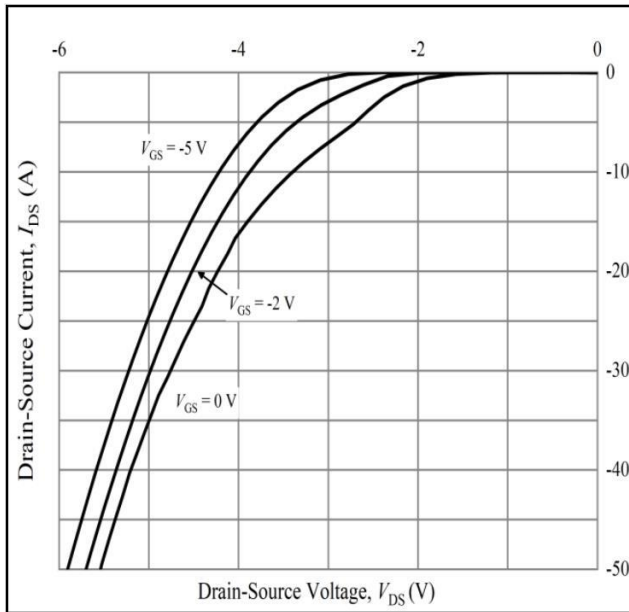


Figure 9: Typical Body Diode Characteristics at $T_j = 25\text{ }^{\circ}\text{C}$

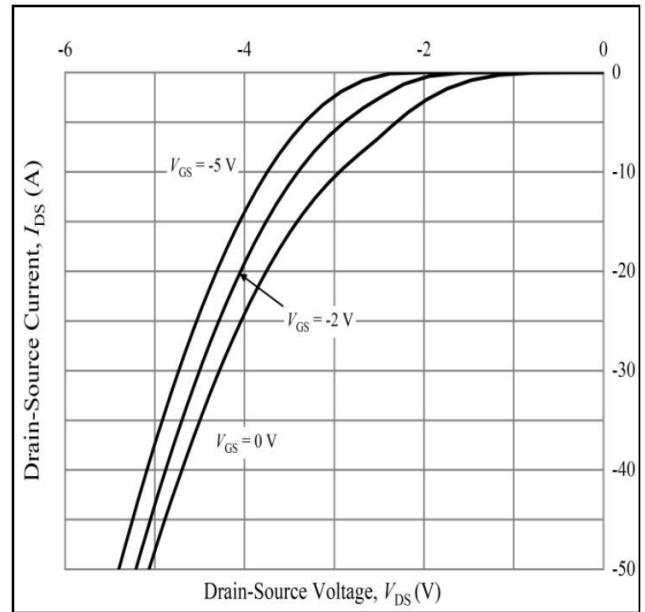


Figure 10: Typical Body Diode Characteristics at $T_j = 175\text{ }^{\circ}\text{C}$

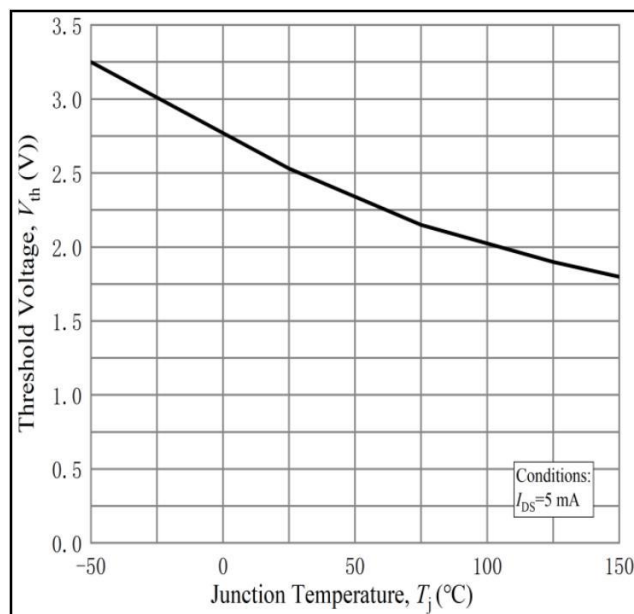


Figure 11: Typical Threshold Voltage vs. Temperature

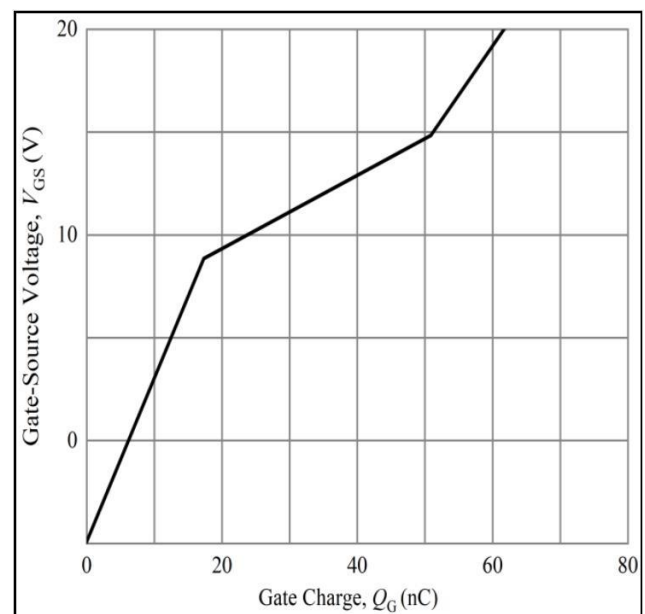


Figure 12: Typical Gate Charge Characteristics at $T_j = 25\text{ }^{\circ}\text{C}$

Typical Performance

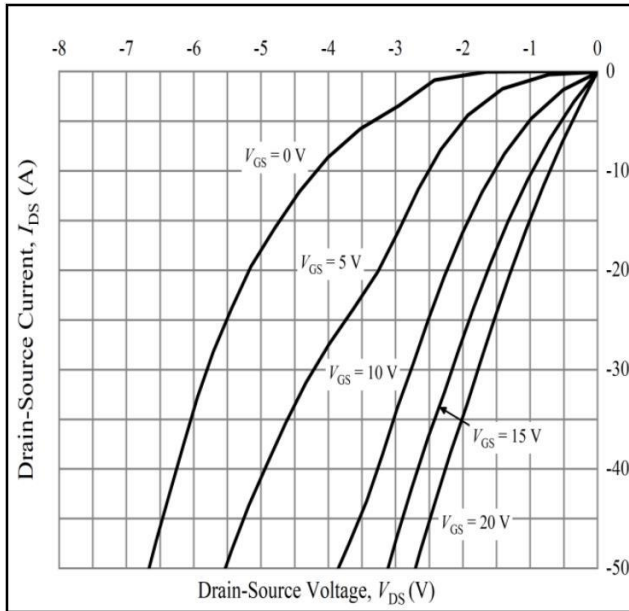


Figure 13: Typical 3rd Quadrant Characteristics
at $T_j = -55\text{ }^{\circ}\text{C}$

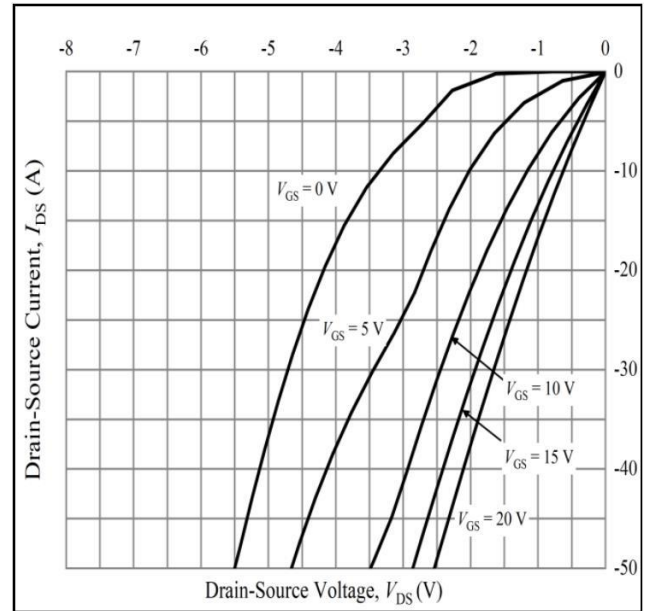


Figure 14: Typical 3rd Quadrant Characteristics at
 $T_j = 25\text{ }^{\circ}\text{C}$

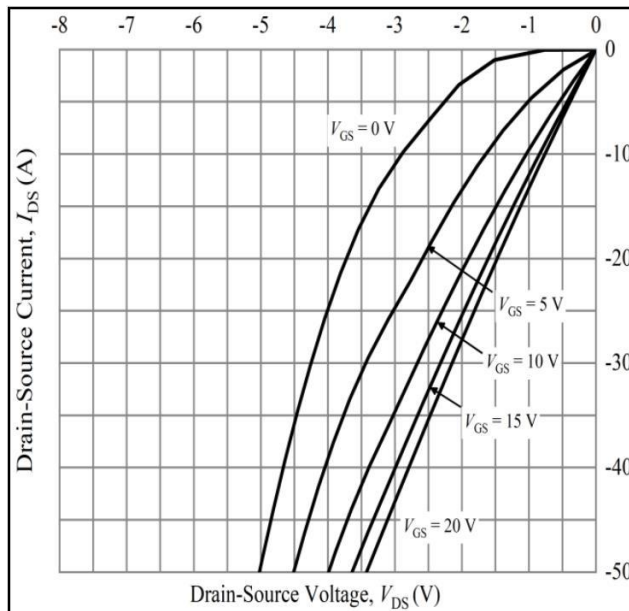


Figure 15: Typical 3rd Quadrant Characteristics
at $T_j = 175\text{ }^{\circ}\text{C}$

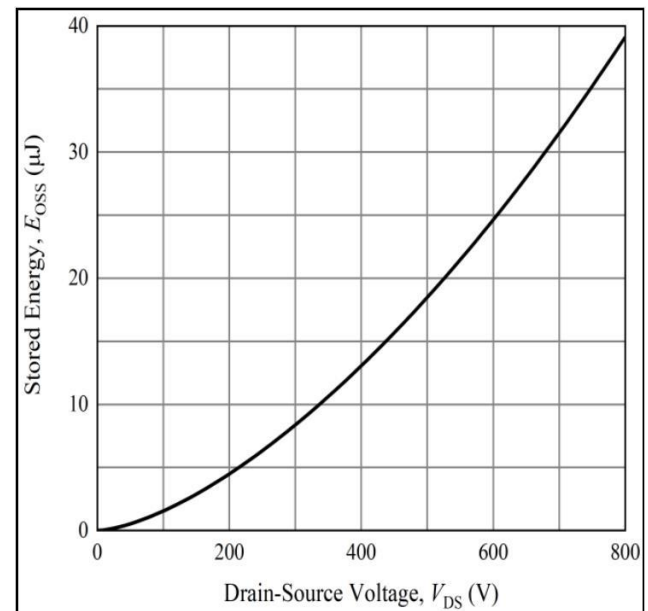


Figure 16: Typical Output Capacitor Stored Energy

Typical Performance

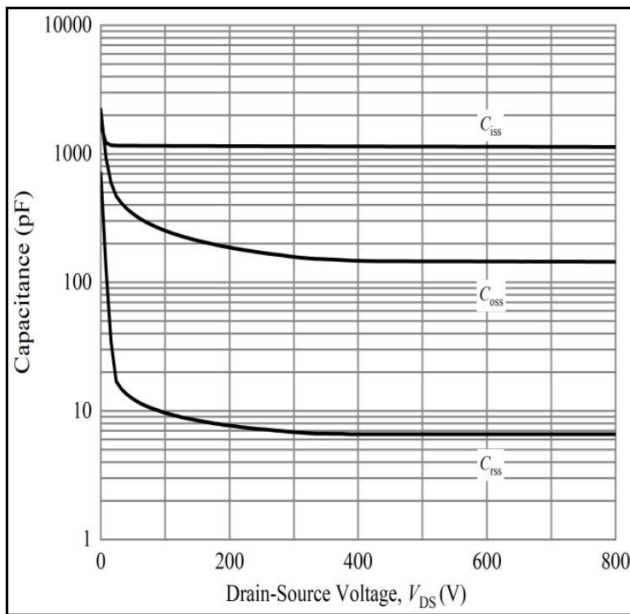


Figure 17: Typical Capacitances vs. Drain-Source Voltage

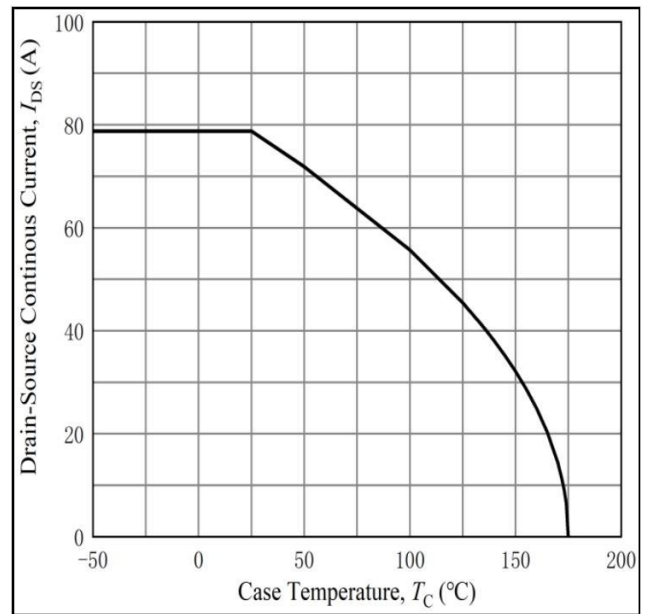


Figure 18: Continuous I_{DS} Current Derating Curve

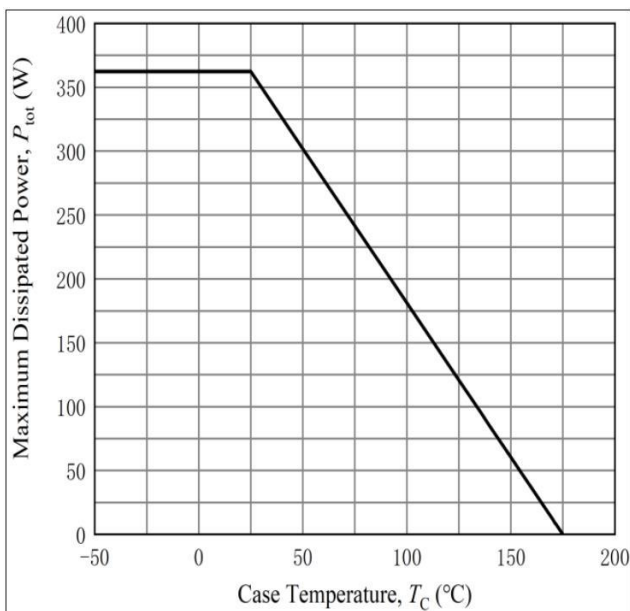


Figure 19: Power Dissipation Derating Curve

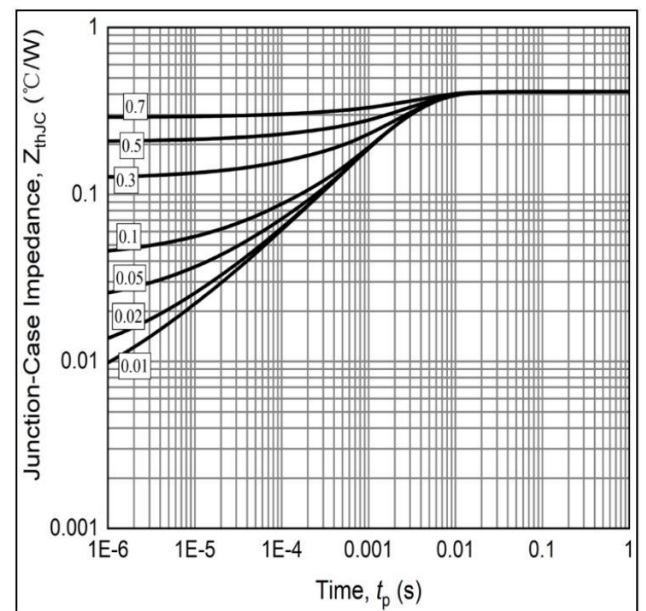


Figure 20: Typical Transient Thermal Impedance (Junction – Case) with Duty Cycle

Typical Performance

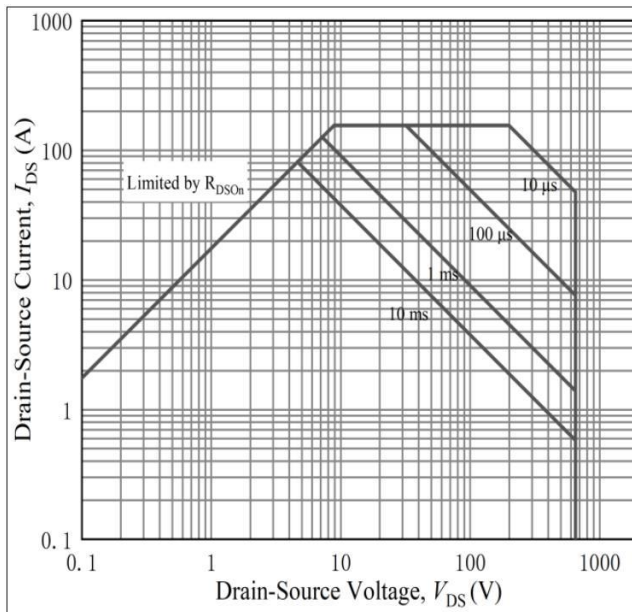


Figure 21: Safe Operating Area

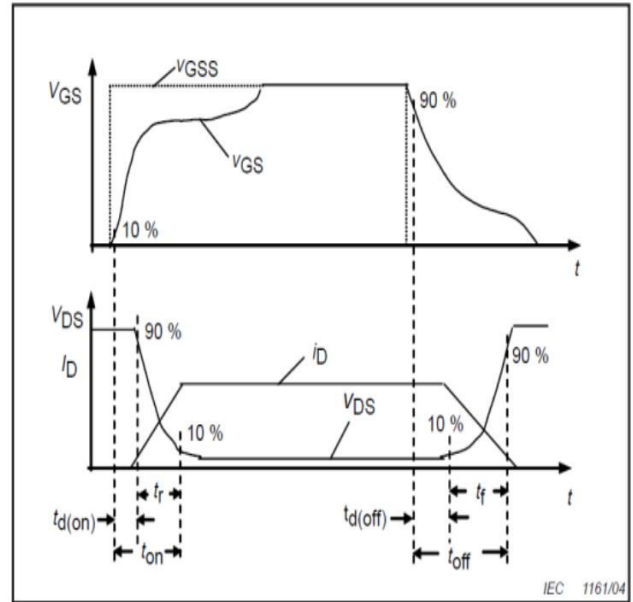


Figure 22: Resistive Switching Time Description

Test Circuit Schematic

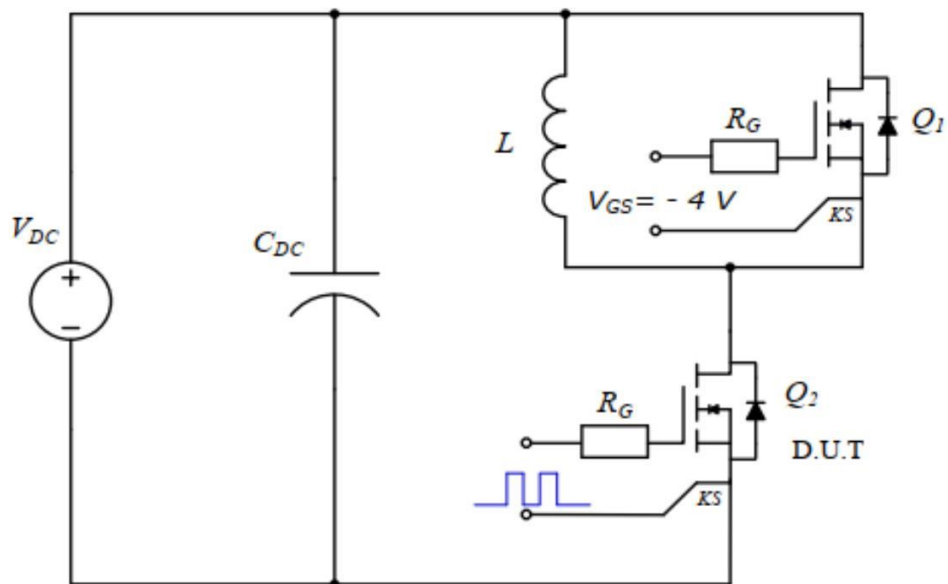
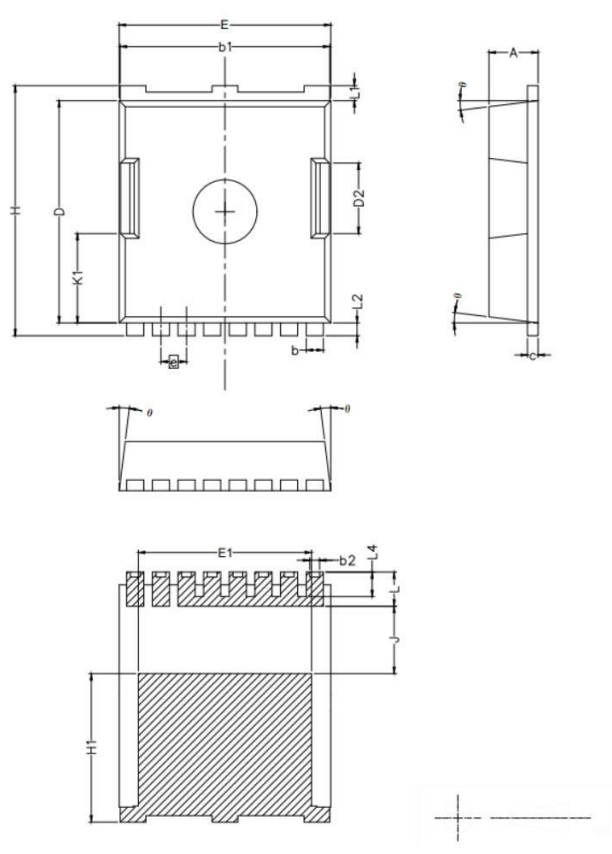


Figure 23: Clamped Inductive Switching Waveform Test Circuit

Package Dimensions

Package: TOLL



SYMBOL	MIN	MAX	NOTES
A	2.20	2.40	1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994. 2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES. 3.0 COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL. 4.0 RADIUS ON TERMINAL IS OPTIONAL.
b	0.70	0.90	
b1	9.70	9.90	
b2	0.42	0.50	
c	0.40	0.60	
D	10.28	10.58	
D2	3.10	3.50	
E	9.70	10.10	
E1	7.90	8.30	
e	1.20 BSC		
H	11.48	11.88	
H1	6.75	7.15	
N	8		
J	3.00	3.30	
K1	3.98	4.38	
L	1.40	1.80	
L1	0.60	0.80	
L2	0.50	0.70	
L4	1.00	1.30	
θ	4°	10°	

Revision History

Document Version	Description of Changes
Rev.1.0	Released
Rev.1.1	Characteristic Updated
Rev.1.2	Characteristic Updated
Rev.1.3	Characteristic Updated, Graph Updated