1200V N-Channel Silicon Carbide Power MOSFET

Product Summary

V_{DS}	=	1200 V
$R_{DS(on)}$	=	40 mΩ
$T_{J,max}$	=	175 ℃

Features

- 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 (Qrr)
- Easy to parallel
- RoHS compliant

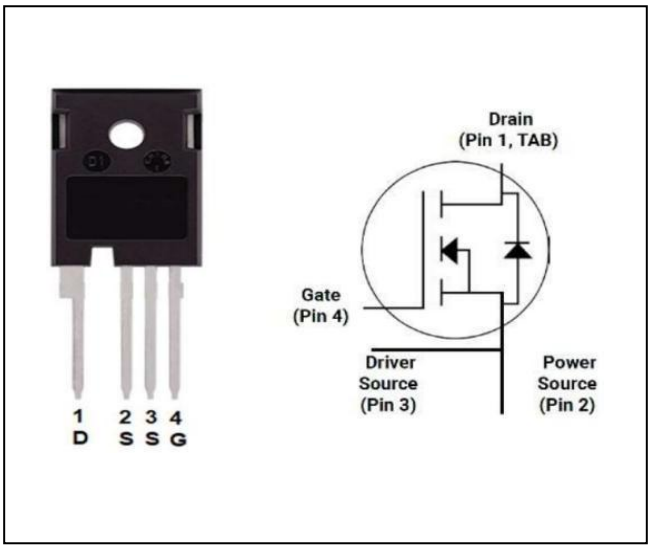
Benefits

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

Applications

- Switch Mode Power Supplies
- DC/DC converters
- Solar Inverters
- Battery Chargers
- Motor Drives

Package



Part Number	Package	Marking
TK3M40120K	TO-247-4	NF3M40120K

Maximum Ratings （Tc = 25 ℃ unless otherwise specified）

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain-Source Breakdown Voltage	1200	V	V_{GS}=0 V, I_D=100 μA	
I_D	Continuous Drain Current	75	A	V_{GS}=20 V, T_C=25 ℃	Fig. 18
P_D	Power Dissipation	330	W	T_c=25 ℃	Fig. 19
$V_{GS,op}$	Recommend Gate Source Voltage	-5/+20	V		
V_{GSmax}	Maximum Gate Source Voltage	-10/+25	V	AC（f＞1Hz)	Note 1
T_J, T_{stg}	Operating Junction and Storage Temperature Range	-55 to +175	℃		
T_L	Soldering Temperature	260	℃		

Electrical Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
Static							
BV_{DS}	Drain-Source Breakdown Voltage	1200	--	--	V	V_{GS}=0 V, I_D=100 μA	
I_{DSS}	Zero Gate Voltage Drain Current	--	11	100	μA	V_{DS}=1200 V, V_{GS}=0 V	
I_{GSS}	Gate-Source Leakage	--	10	250	nA	V_{GS}=20 V	
$V_{GS(th)}$	Gate-Source Threshold Voltage	2	--	4	V	I_D=10 mA, V_{GS}=V_{DS}	Fig. 11
$R_{DS(on)}$	Drain-Source On-Resistance	--	40	55	mΩ	V_{GS}=20 V, I_D=40 A	Fig. 6
Dynamic							
C_{iss}	Input Capacitance	--	2193	--	pF	V_{GS}=0 V, V_{DS}=1000 V f=1.0 MHz, V_{AC}=25 mV	Fig. 17
C_{oss}	Output Capacitance	--	153	--			
C_{rss}	Reverse Transfer Capacitance	--	8	--			
E_{OSS}	C_{OSS} Stored Energy	--	83	--	μJ		Fig. 16
Q_g	Total Gate Charge	--	99	--	nC	V_{DS}=800 V I_D=40 A V_{GS}=-5/+20 V	Fig. 12
Q_{gs}	Gate-Source Charge	--	32	--			
Q_{gd}	Gate-Drain Charge	--	29	--			
$t_{d(on)}$	Turn-on Delay Time	--	13	--	ns	V_{DS}=800 V V_{GS}=-5/+20 V I_D=40 A $R_{G(ext)}$=2.5 Ω	
t_r	Turn-on Rise Time	--	30	--			
$t_{d(off)}$	Turn-off Delay Time	--	27	--			
t_f	Turn-off Fall Time	--	12	--			
$R_{G(int)}$	Internal Gate Resistance	--	2.0	--	Ω	f=1.0 MHz, V_{AC}=25 mV	

Body Diode Characteristics ,at T_J=25℃， unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
I_S	Continuous Diode Froward Current	--	--	75	A		Note 1
V_{SD}	Diode Froward Voltage	--	4.0	--	V	V_{GS}=0 V, I_S=20 A	Fig. 8, 9, 10
t_{rr}	Reverse Recovery Time	--	28	--	ns	I_S=20 A, V_{DS}=800 V V_{GS}=-5 V di/dt=2100 A/us	Note 1
Q_{rr}	Reverse Recovery Charge	--	232	--	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	/	0.39	/	℃/W	Fig. 20

Typical Performance

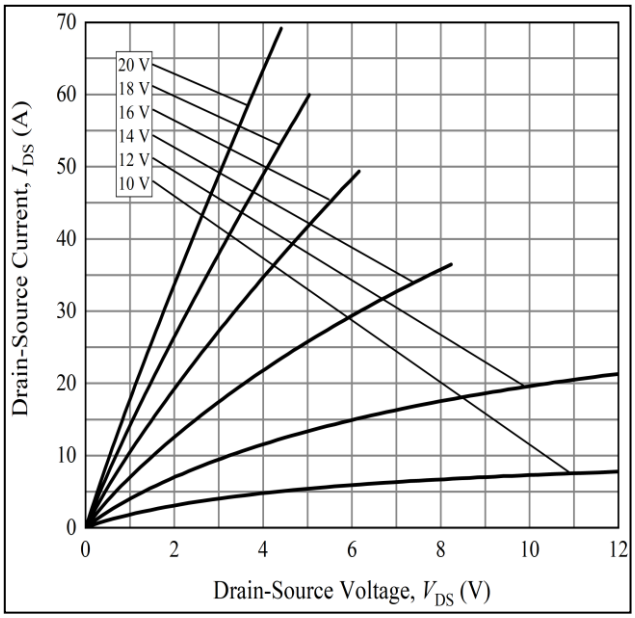


Figure 1: Typical Output Characteristics at T_J=-55 ℃

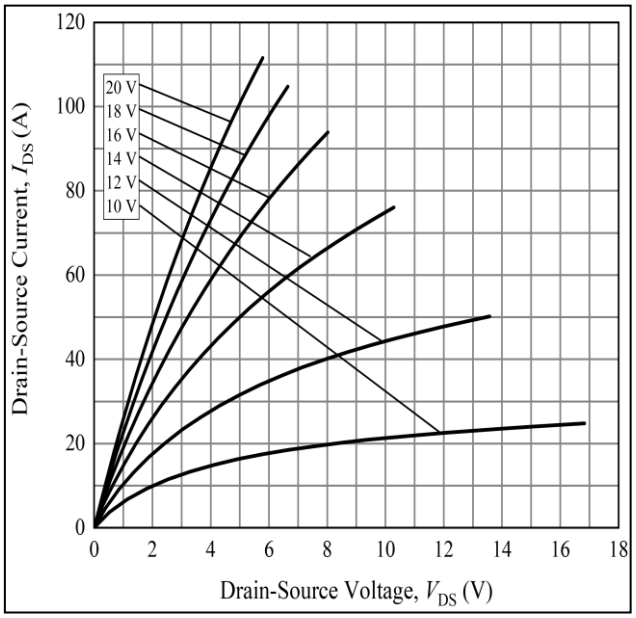


Figure 2: Typical Output Characteristics at T_J=25 ℃

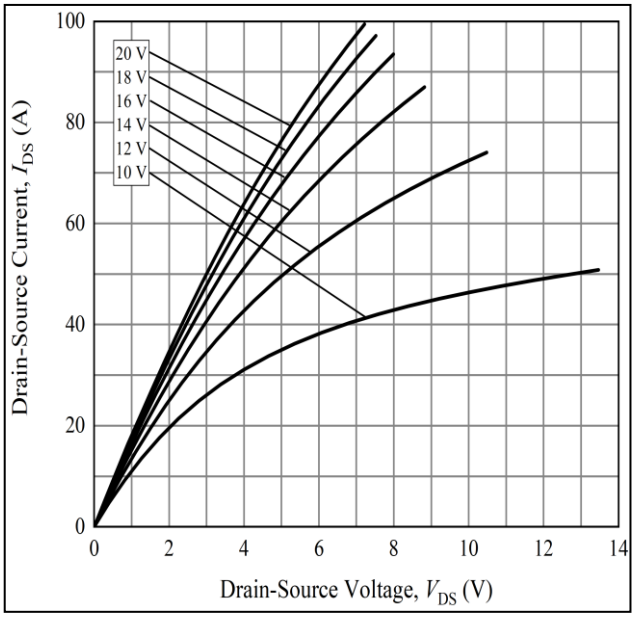


Figure 3: Typical Output Characteristics at T_J=175 ℃

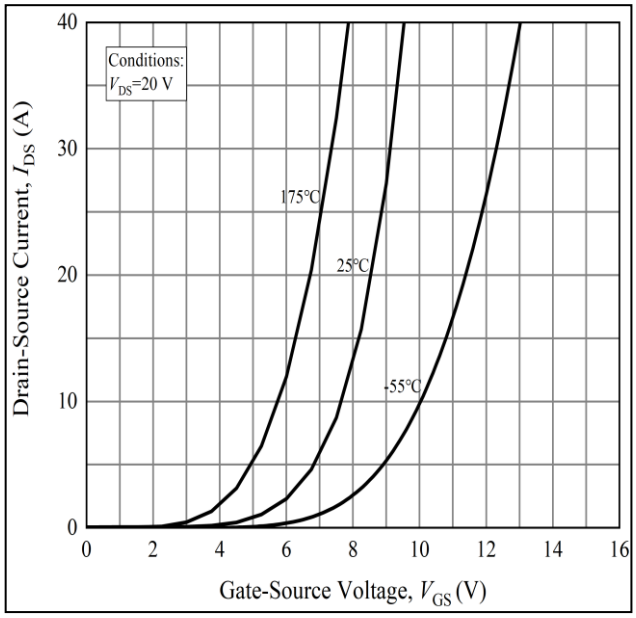


Figure 4: Typical Transfer Characteristics for Various Temperature

Typical Performance

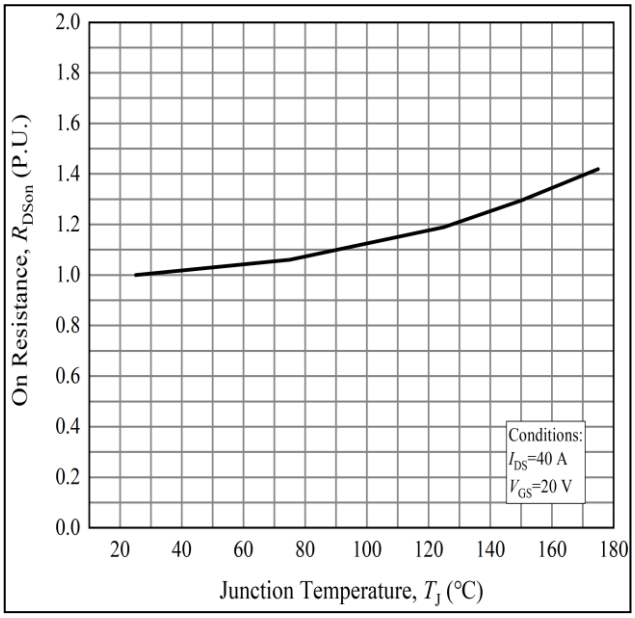


Figure 5: Normalized On-Resistance vs. Temperature

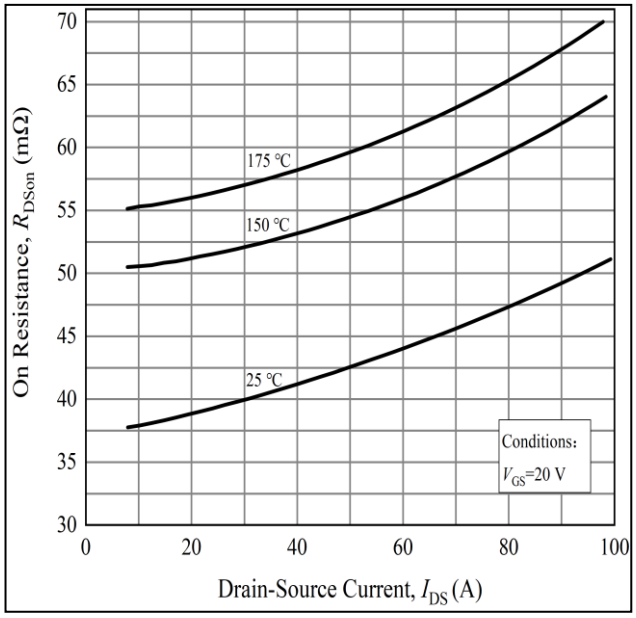


Figure 6: On-Resistance vs. Drain Current for Gate Various Temperatures

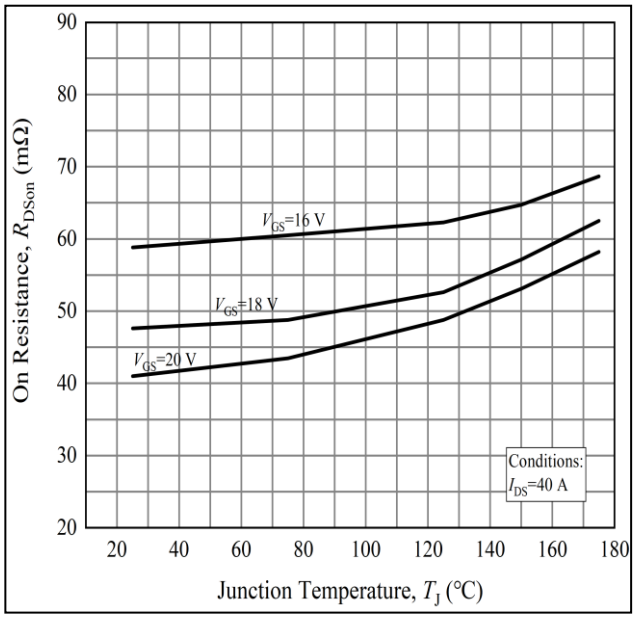


Figure 7: On-Resistance vs. Temperature for Various Voltage

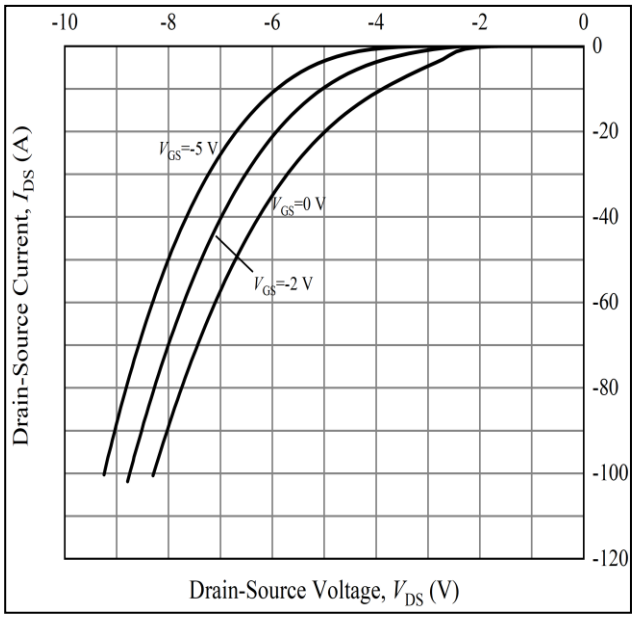


Figure 8: Typical Body Diode Characteristics at T_J=-55 °C

Typical Performance

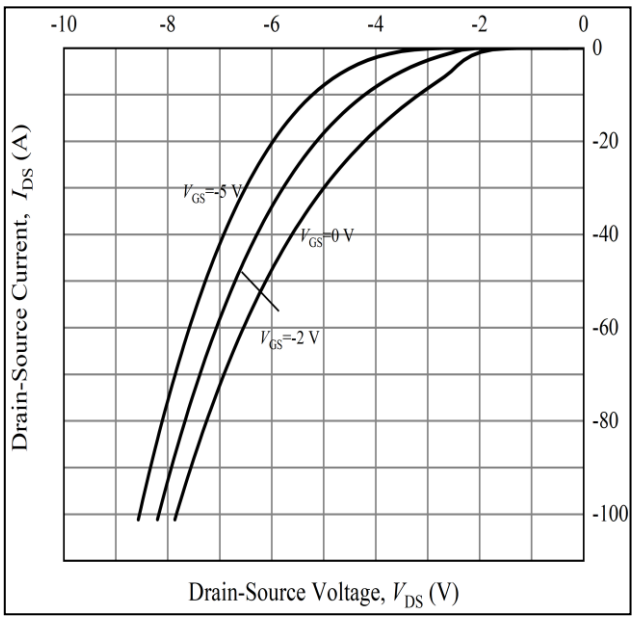


Figure 9: Typical Body Diode Characteristics at T_J=25 ℃

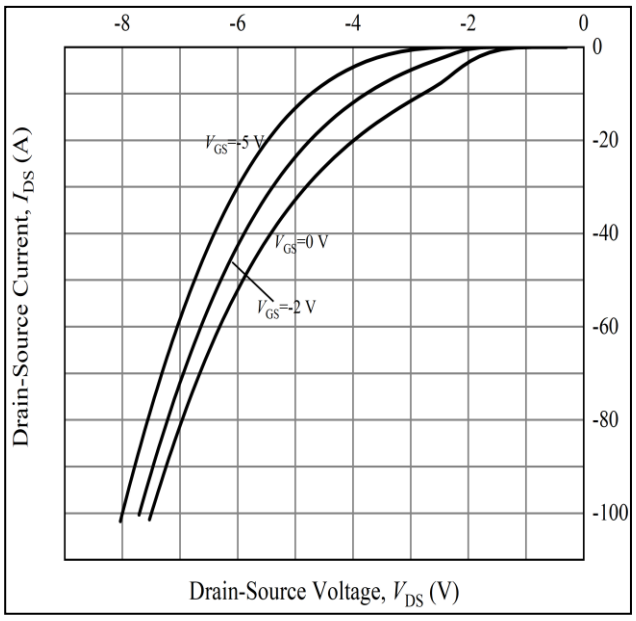


Figure 10: Typical Body Diode Characteristics at T_J=175 ℃

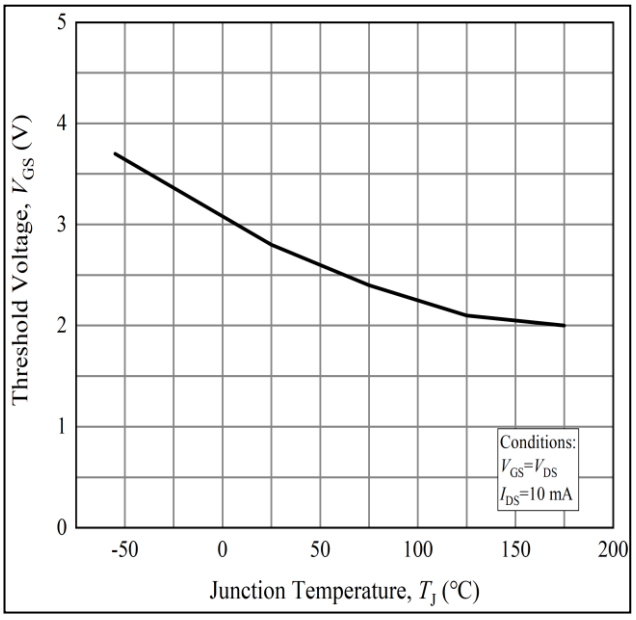


Figure 11: Typical Threshold Voltage vs. Temperature

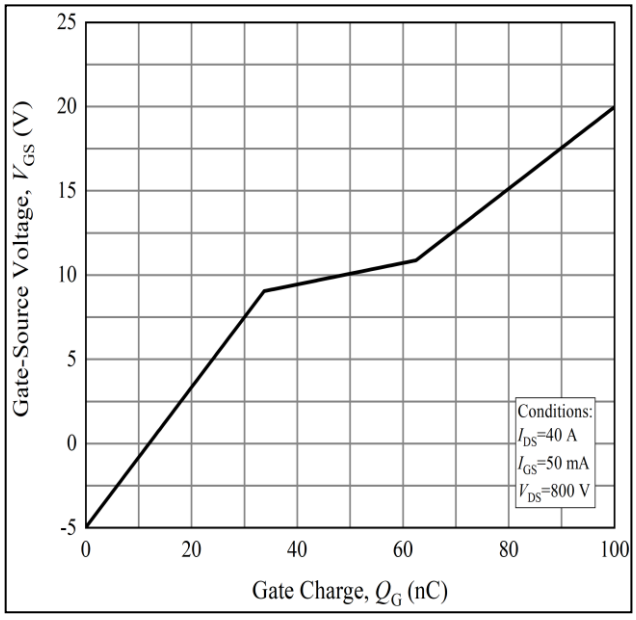


Figure 12: Typical Gate Charge Characteristics at T_J=25 ℃

Typical Performance

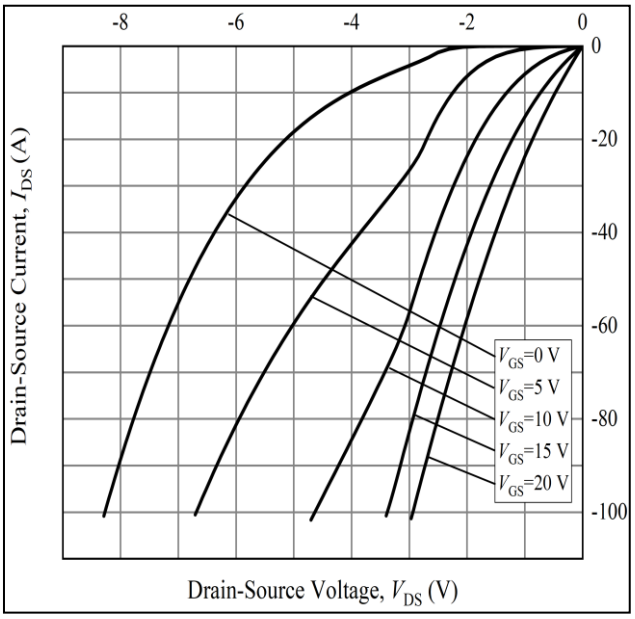


Figure 13: Typical 3rd Quadrant Characteristics T_J=-55 °C

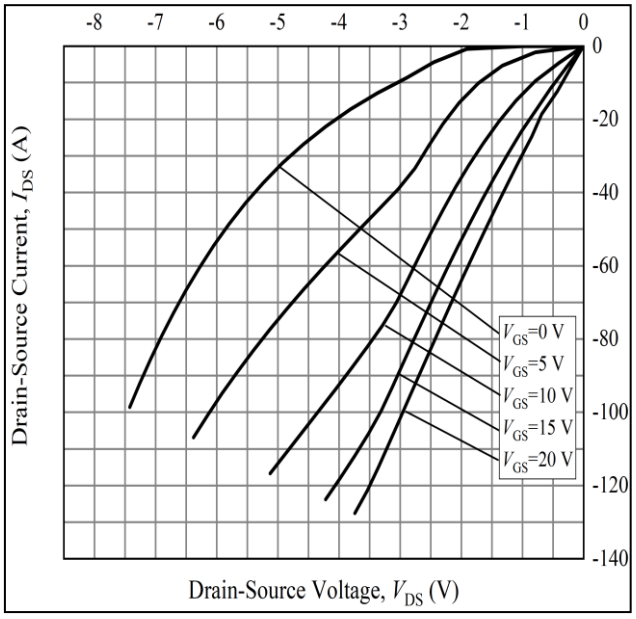


Figure 14: Typical 3rd Quadrant Characteristics at T_J=25 °C

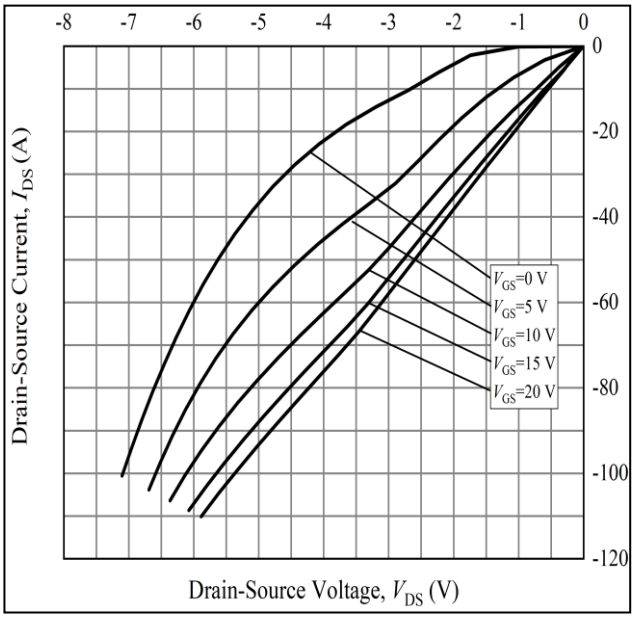


Figure 15: Typical 3rd Quadrant Characteristics at T_J=175 °C

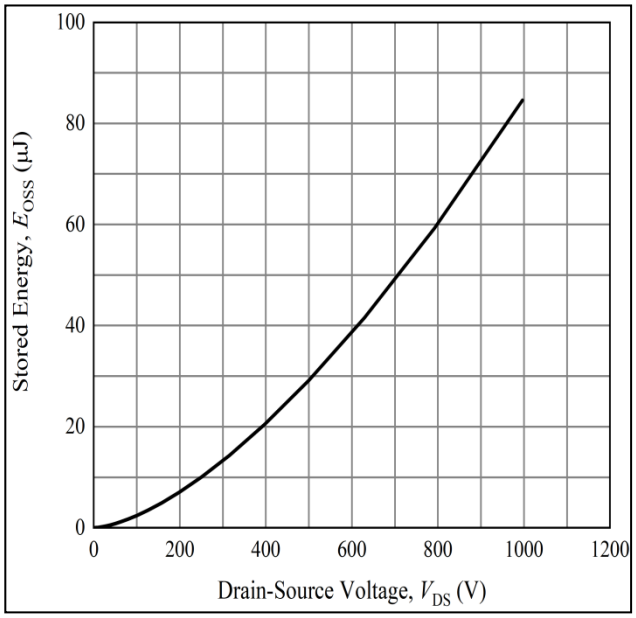


Figure 16: Typical Output Capacitor Stored Energy

Typical Performance

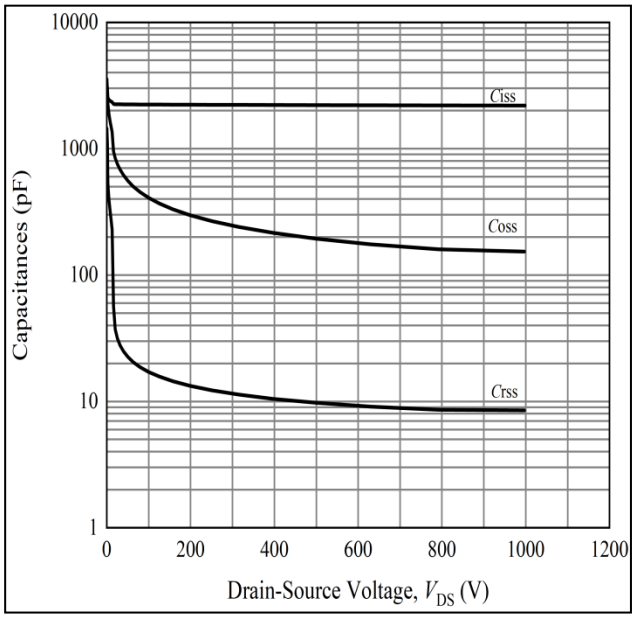


Figure 17: Typical Capacitances vs. Drain-Source Voltage

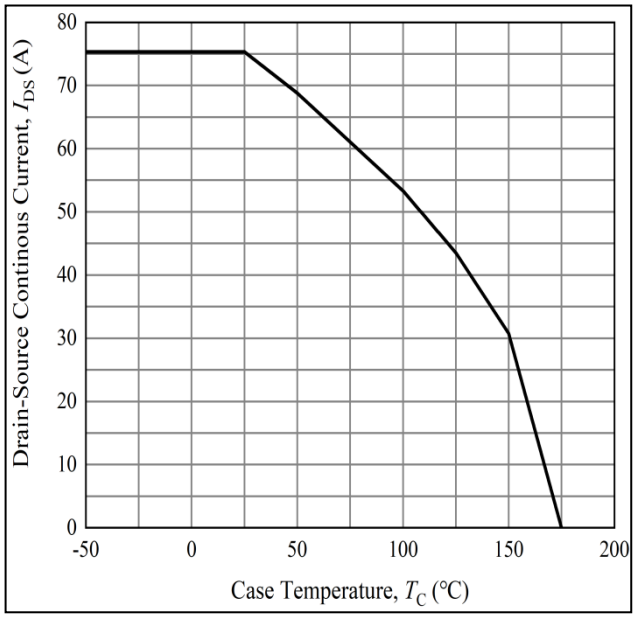


Figure 18: Continuous I_{DS} Current Derating Curve

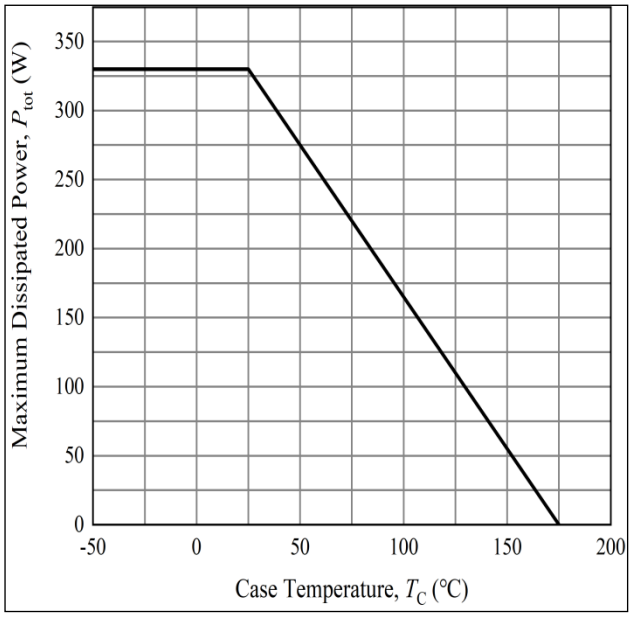


Figure 19: Power Dissipation Derating Curve

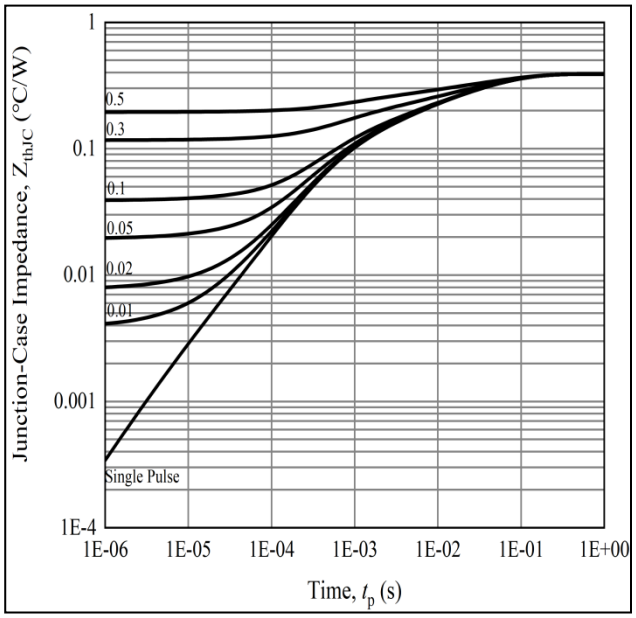


Figure 20: Typical Transient Thermal Impedance (Junction – Case) with Duty Cycle

Typical Performance

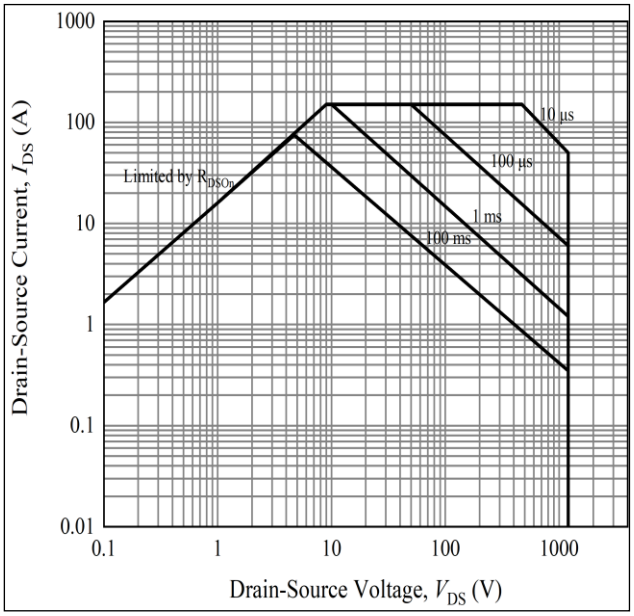


Figure 21: Safe Operate Area

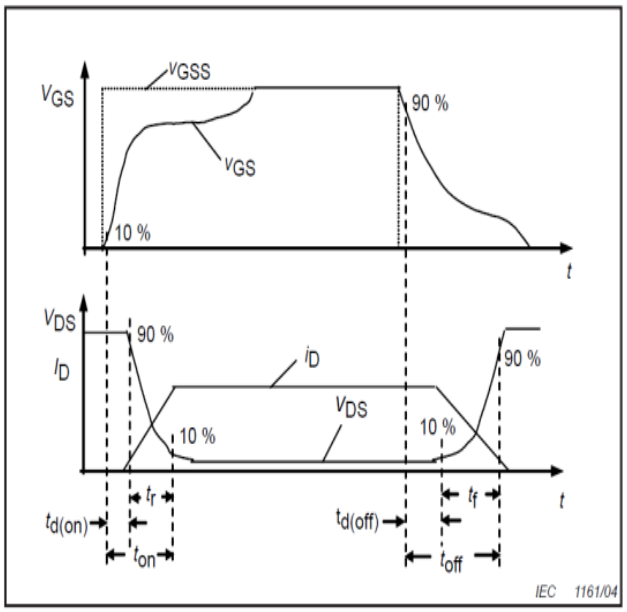
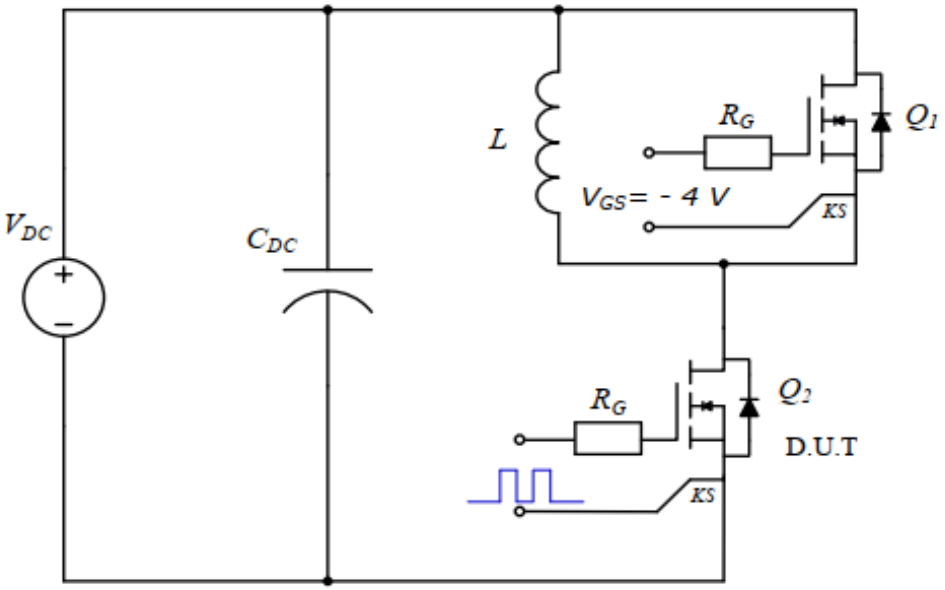


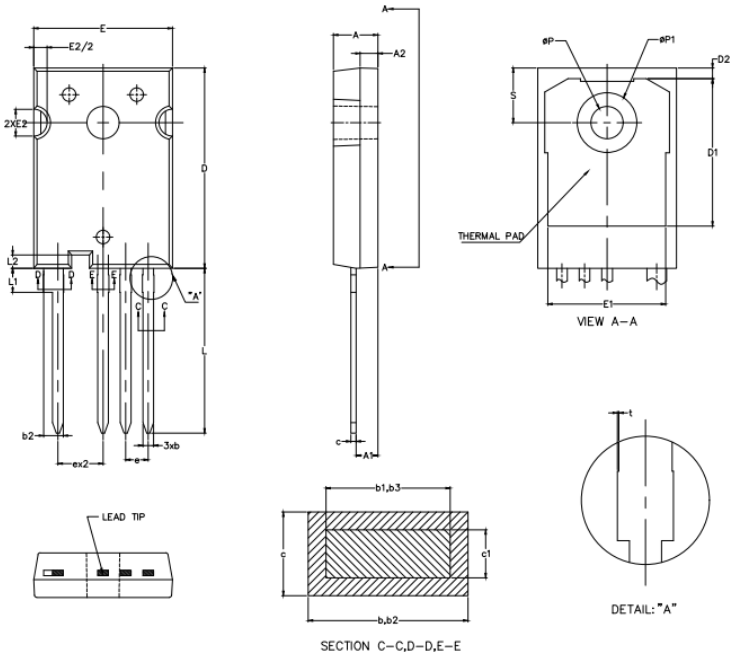
Figure 22: Resistive Switching Time Description

Test Circuit Schematic



Package Dimensions

Package：TO-247-4



SYMBOLS	DIMENSIONS			
	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.15	1.22	0.045	0.048
b2	2.16	2.26	0.085	0.089
b3	2.15	2.22	0.085	0.087
c	0.59	0.66	0.023	0.026
c1	0.58	0.62	0.023	0.024
D	22.40	22.60	0.882	0.890
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
E	15.75	15.90	0.620	0.626
E1	13.26	——	0.552	——
E2	2.90	3.10	0.114	0.122
e	2.54BSC		0.1BSC	
L	18.30	18.60	0.720	0.732
L1	——	2.80	——	0.110
L2	——	1.50	——	0.059
øP	3.50	3.70	0.138	0.146
øP1	——	7.40	——	0.291
S	6.05	6.25	0.238	0.246
t	0.00	0.15	0.000	0.006