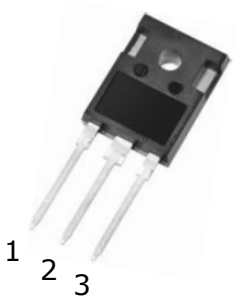
S1M040120D

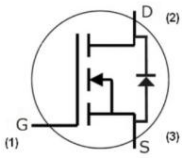
1200V Silicon Carbide Power MOSFET 1200V G1 （ N Channel Enhancement ）

Features

- High speed switching
- Very low switching losses
- IGBT-compatible driving voltage (15V for turn-on)
- Fully controllable dv/dt
- High blocking voltage with low on-resistance
- Fast intrinsic diode with low reverse recovery (Qrr)
- Temperature independent turn-off switching losses
- Halogen free, RoHS compliant



TO-247-3L



Benefits

- Cooling effort reduction
- Efficiency improvement
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency

Applications

- On-board charger/PFC
- EV battery chargers
- Booster/DC-DC converter
- Switch mode power supplies

Table 1 Key performance and package parameters

Type	V_{DS}	I_{DS} (T_C = 25℃, $R_{th\ (j\text{-}c,max)}$)	$R_{DS(ON),\ typ}$ (V_{GS} = 15 V, I_D = 33.3 A, T_J = 25℃)	$T_{j,max}$	Marking	Package
S1M040120D	1200 V	73 A	40 mΩ	175℃	S1M040120D	TO247-3L

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1、Maximum ratings

Table 2 Maximum rating (Tc = 25°C unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
$V_{DS,max}$	Drain source voltage	1200	V	V_{GS} = 0V, I_D = 100μA	
$V_{GS,max}$	Gate source voltage	-8 /+22	V	Absolute maximum values	Note1
V_{GSop}	Gate source voltage	-4 /+15	V	Recommended operational values	
I_D	Continuous drain current	73	A	V_{GS} = 15V, T_C = 25°C	Fig.19
		51		V_{GS} = 15V, T_C = 100°C	
$I_{D(pulse)}$	Pulsed drain current	120	A	Pulse width t_P limited by $T_{j,max}$	Fig.22
P_D	Power dissipation	326	W	T_C = 25°C,T_J = 175°C	Fig.20
T_J ,T_{stg}	Operating Junction and storage temperature	-55 to +175	°C		
T_L	Soldering temperature	260	°C	1.6mm (0.063”) from case for 10s	
T_M	Mounting torque	1 8.8	Nm lbf-in	M3 or 6-32 screw	

Note 1：when using MOSFET Body Diode $V_{GS,max}$ = -4 / +22V

2、Thermal characteristics

Table 3 Thermal characteristics[1]

Symbol	Parameter	Value	Unit	Test Conditions	Note
$R_{th(j-c)}$	Thermal resistance from junction to case	0.46	°C/W		Fig.21
$R_{th(j-a)}$	Thermal resistance from junction to ambient	39			

[1] Not subject to production test. Parameter verified by design/characterization.

3、Electrical characteristics

3.1 Static characteristics

Table 4 Static characteristics (Tc = 25°C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{(BR)DSS}$	Drain-source breakdown voltage	1200	-	-	V	V_{GS} = 0V, I_D = 100μA	
$V_{GS(th)}$	Gate threshold voltage	2.3	2.8	3.6	V	V_{DS} = V_{GS}, I_D = 10mA	Fig.11
		-	2.0	-	V	V_{DS} = V_{GS}, I_D = 10mA T_J = 175°C	
I_{DSS}	Zero gate voltage drain current	-	1	10	μA	V_{DS} = 1200V, V_{GS} = 0V	
I_{GSS}	Gate source leakage current	-	-	100	nA	V_{GS} = 15V, V_{DS} = 0V	
$R_{DS(on)}$	Current drain-source on-state resistance	-	40	50	mΩ	V_{GS} = 15V, I_D = 33.3A	Fig.4, 5,6
		-	62	-		V_{GS} = 15V, I_D = 33.3A, T_J = 175°C	
		-	32	40		V_{GS} = 18V, I_D = 33.3A	
		-	59	-		V_{GS} = 18V, I_D = 33.3A, T_J = 175°C	
gfs	Transconductance	-	17	-	S	V_{DS} = 20V, I_D = 33.3A	Fig.7
		-	16	-		V_{DS} = 20V, I_D = 33.3A,T_J = 175°C	
$R_{g,int}$	Internal gate resistance	-	0.9	-	Ω	V_{AC} = 25mV, f = 1MHz	
V_{SD}	Diode forward voltage	-	3.8	-	V	V_{GS} = -4V, I_{SD} = 20A	Fig.8,9, 10
		-	3.4	-		V_{GS} = -4V, I_{SD} = 20A， T_J = 175°C	

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (Tc = 25°C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
C_{iss}	Input capacitance	-	2159	-	pF	V_{DS} = 1000V, V_{GS} = 0V T_J = 25°C, V_{AC} = 25mV f = 100KHz	Fig.17,18
C_{oss}	Output capacitance	-	127	-			
C_{rss}	Reverse capacitance	-	10	-			
E_{oss}	Coss stored energy	-	79	-	μJ		Fig.16

Q_{gs}	Gate source charge	-	16	-	nC	V_{DS} = 800V, V_{GS} = -4/+15V I_D = 33.3A	Fig.12
Q_{gd}	Gate drain charge	-	36	-			
Q_g	Gate charge	-	76	-			

3.3 Switching characteristics

Table 6 Dynamic characteristics(Tc = 25°C unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
E_{on}	Turn on switching energy	-	934	-	μJ	V_{DS} = 800V, V_{GS} = -4/+15V I_D = 33.3A, Rg = 2.5Ω L = 120uH	Fig.26
E_{off}	Turn off switching energy	-	60	-			
$t_{d(on)}$	Turn on delay time	-	40	-	ns		Fig.27
t_r	Rise time	-	16	-			
$t_{d(off)}$	Turn off delay time	-	23	-			
t_f	Fall time	-	8.8	-			

Table 7 Body diode characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode forward voltage	-	3.8	-	V	V_{GS} = -4V, I_{SD} = 20A	Fig.8,9,10
		-	3.4	-	V	V_{GS} = -4V, I_{SD} = 20A T_J = 175°C	
I_S	Continuous diode forward current	-	76	-	A	V_{GS} = -4V, Tc = 25°C	Note1
t_{rr}	Reverse recovery time	-	40	-	nS	V_R = 800V, V_{GS} = -4V I_D = 33.3A di/dt = 1947A/μS T_J = 175°C	
Q_{rr}	Reverse recovery charge	-	640	-	nC		
I_{rrm}	Peak reverse recovery current	-	32	-	A		

Note 1: When using SiC Body Diode the maximum recommended V_{GS} = -4 V

4、Electrical characteristic diagrams

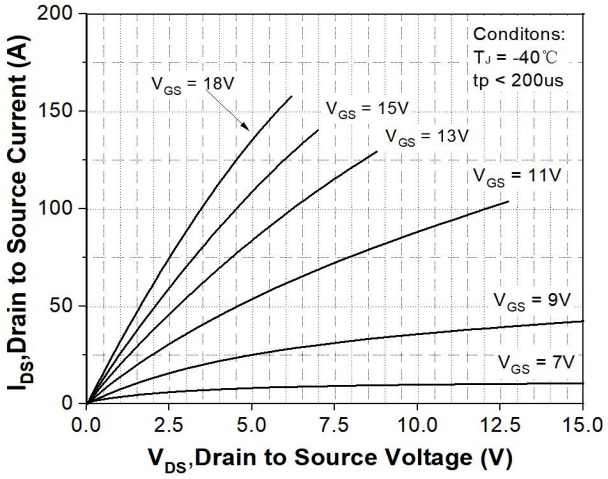


Figure 1. Output characteristics T_J = -40 ºC

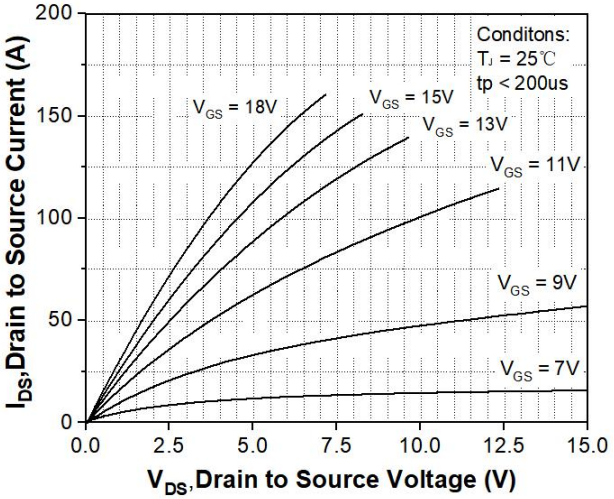


Figure 2. Output characteristics T_J = 25 ºC

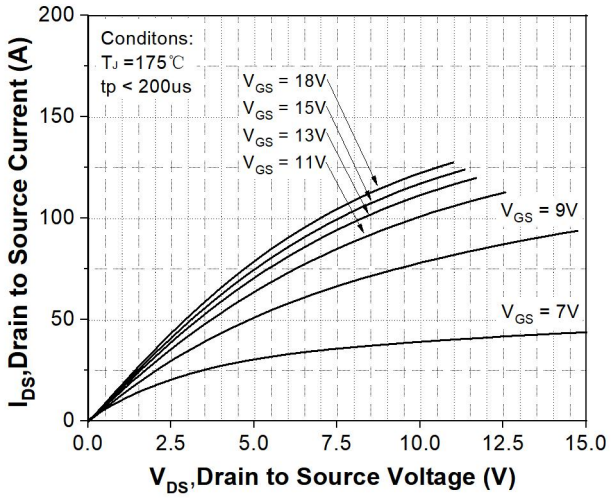


Figure 3. Output characteristics T_J = 175 ºC

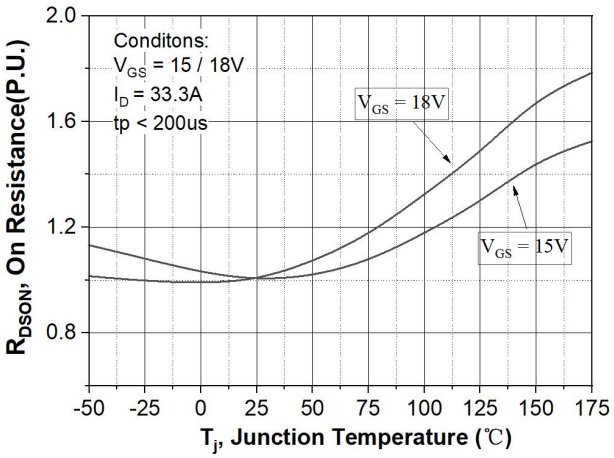


Figure 4. Normalized on-resistance vs. temperature

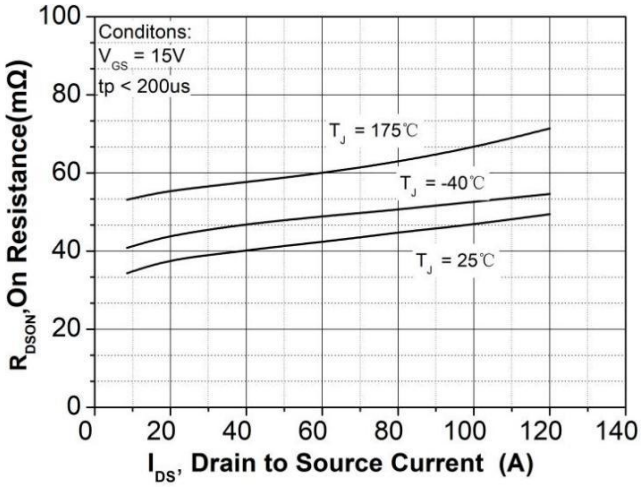


Figure 5. On-resistance vs. drain current for various temperatures

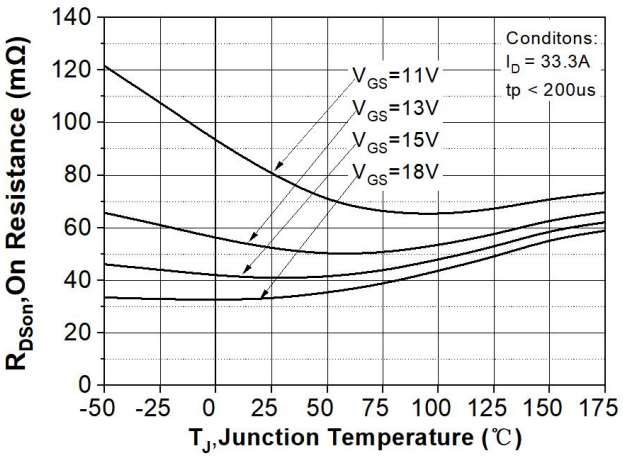


Figure 6. On-resistance vs. temperature for various gate voltage

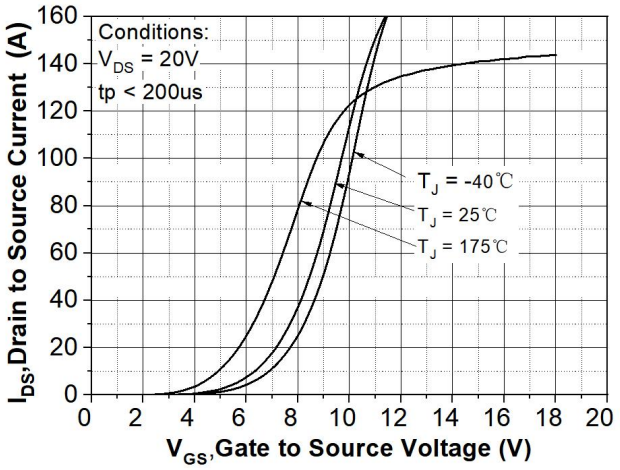


Figure 7. Transfer characteristic for various junction temperatures

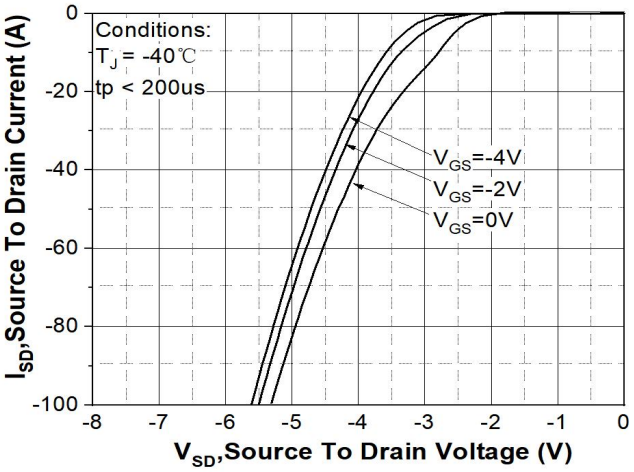


Figure 8. Body diode characteristic at T_J = -40 ºC

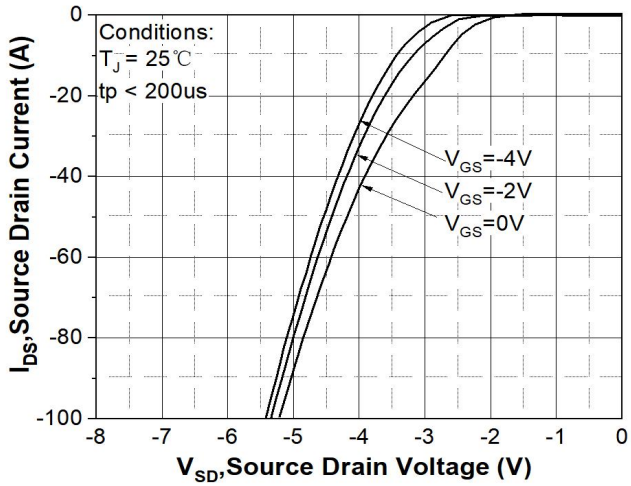


Figure 9. Body diode characteristic at T_J = 25 ºC

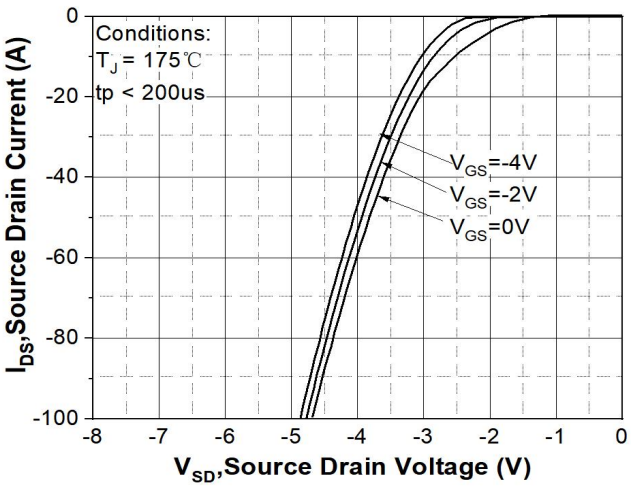


Figure 10. Body diode characteristic at T_J = 175ºC

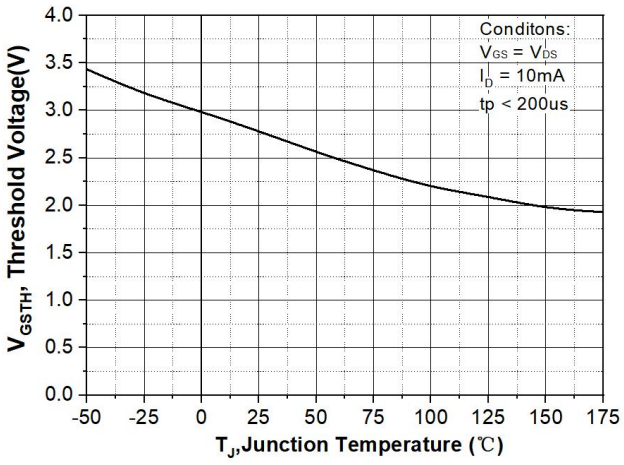


Figure 11. Threshold voltage vs. temperature

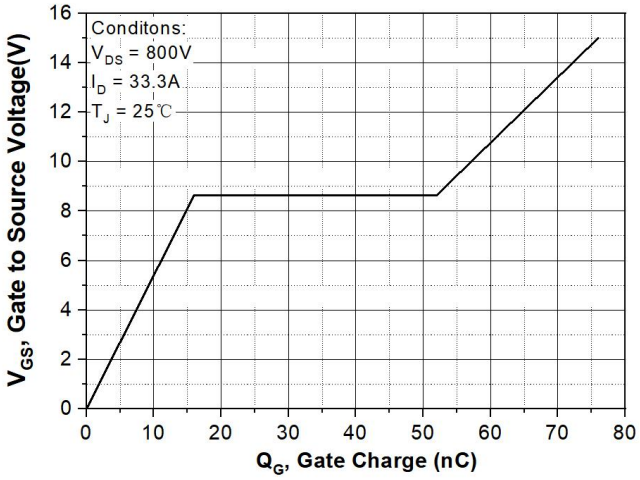


Figure 12. Gate charge characteristic

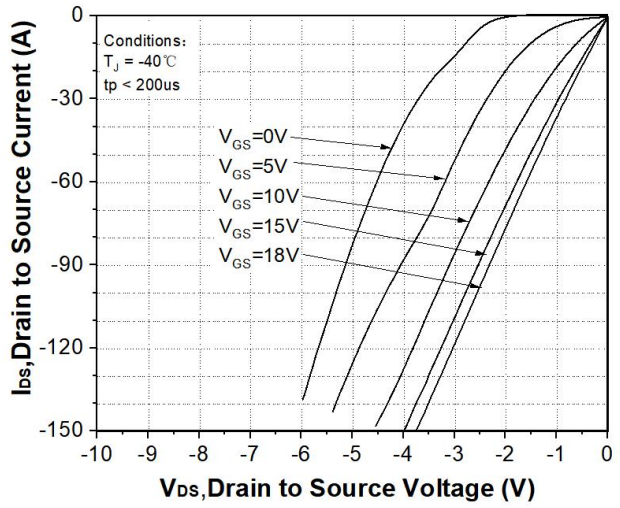


Figure 13. 3rd quadrant characteristic at T_J = -40 ºC

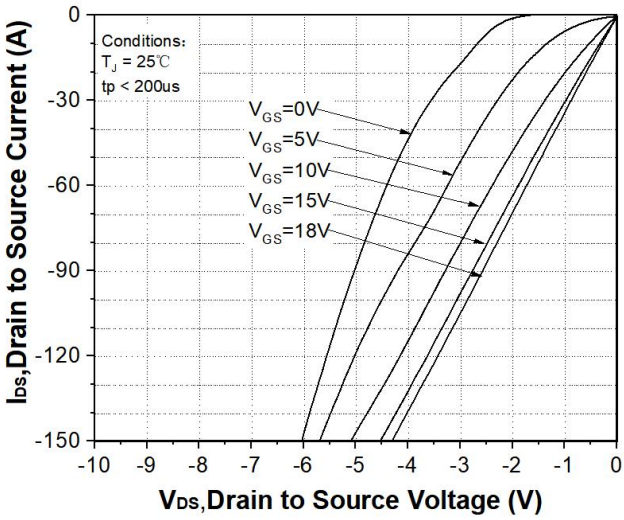


Figure 14. 3rd quadrant characteristic at T_J = 25 ºC

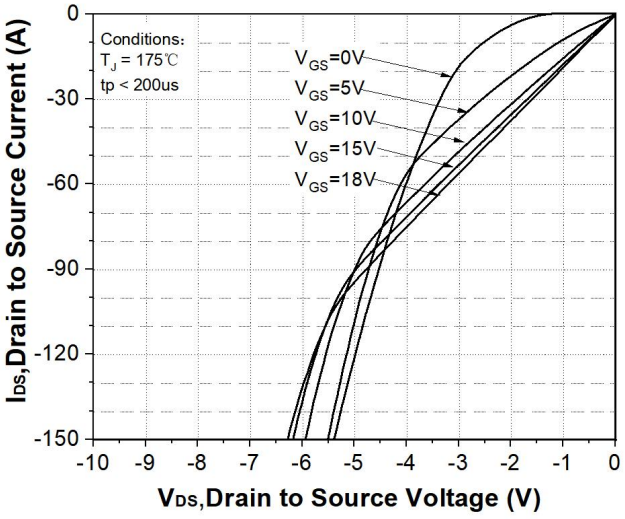


Figure 15. 3rd quadrant characteristic at T_J = 175 ºC

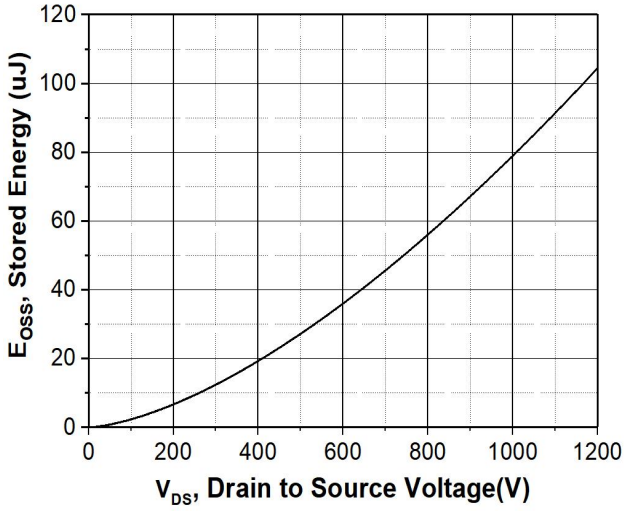


Figure 16. Output capacitor stored energy

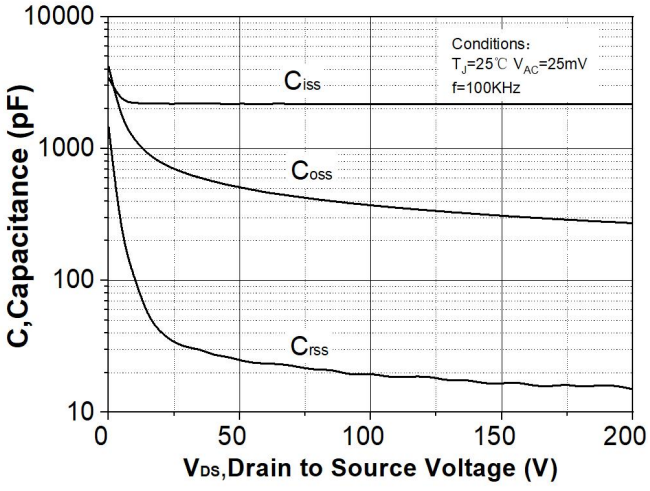


Figure 17. Capacitances vs. drain-source voltage (0 - 200V)

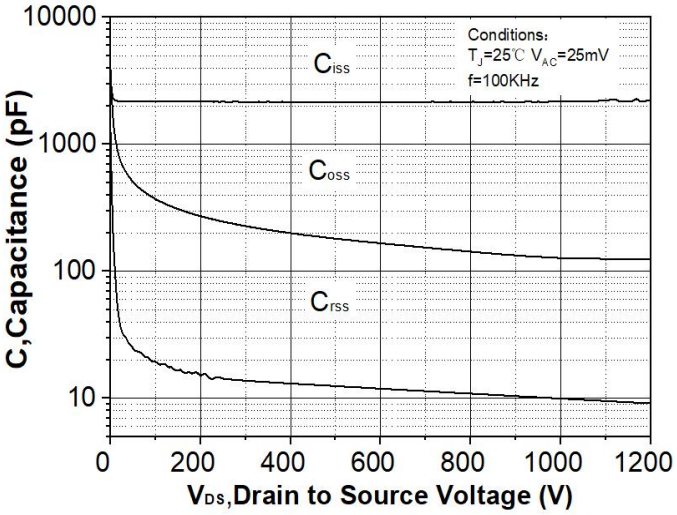


Figure 18. Capacitances vs. drain-source voltage (0 - 1200V)

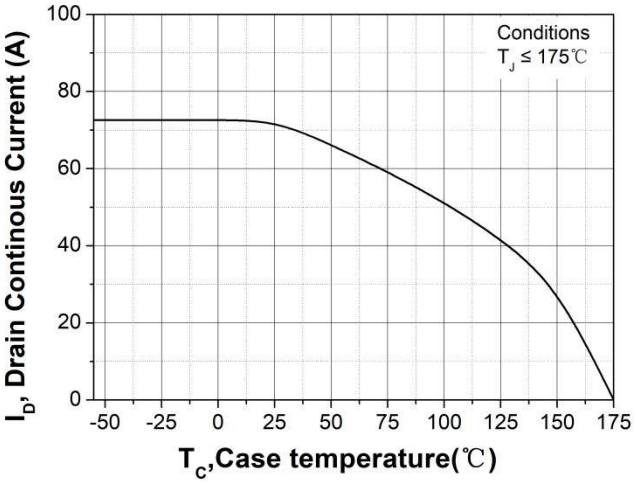


Figure 19. Continuous drain current derating vs. case temperature

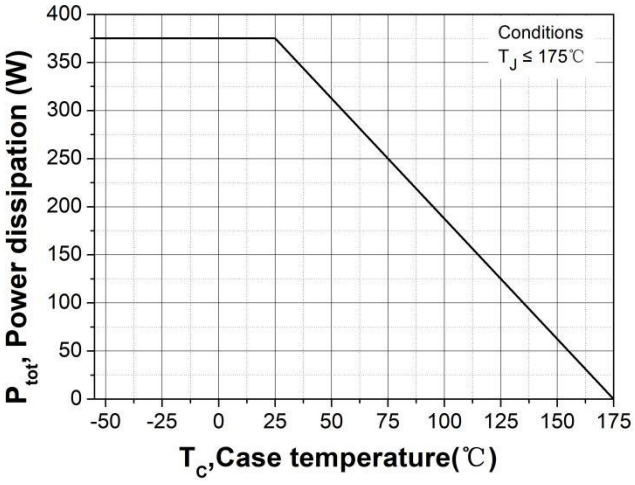


Figure 20. Maximum power dissipation derating vs. case temperature

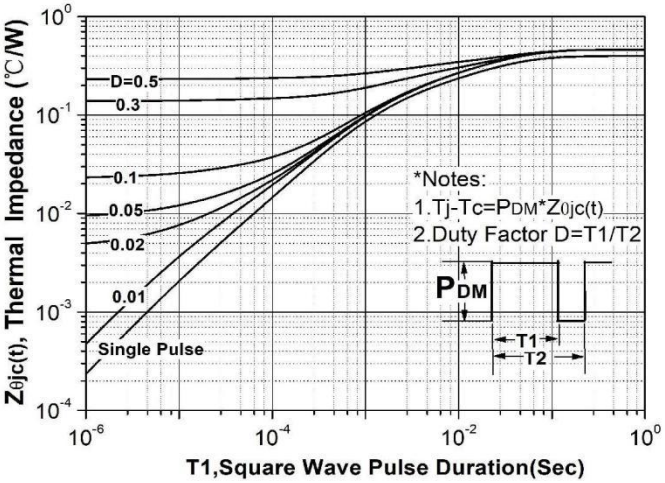


Figure 21. Transient thermal impedance (junction - case)

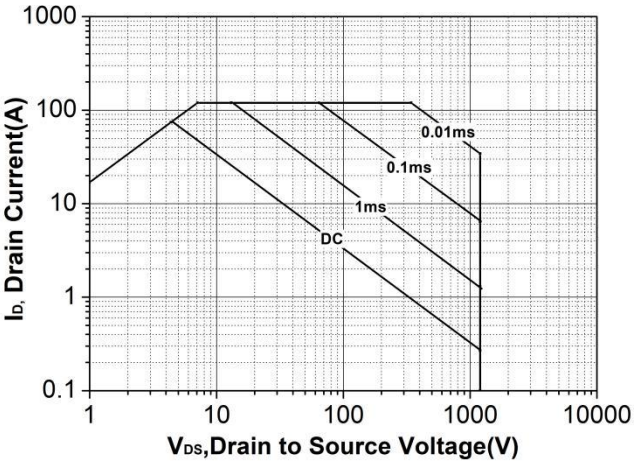


Figure 22. Safe operating area

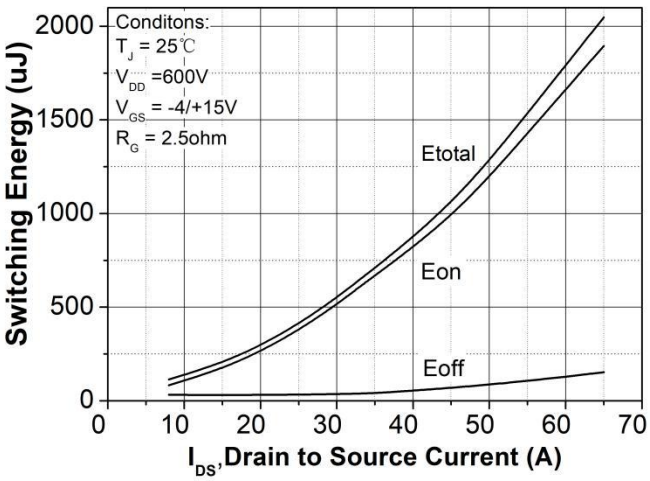


Figure 23. Clamped Inductive switching energy vs. drain current (V_{DD} = 600V)

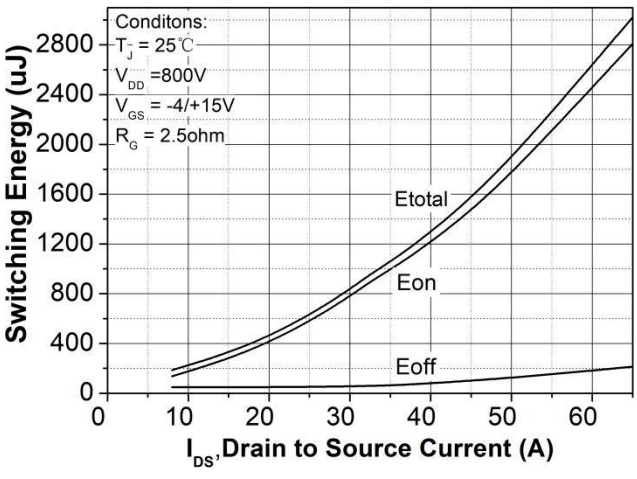


Figure 24. Clamped inductive switching energy vs. drain current (V_{DD} = 800V)

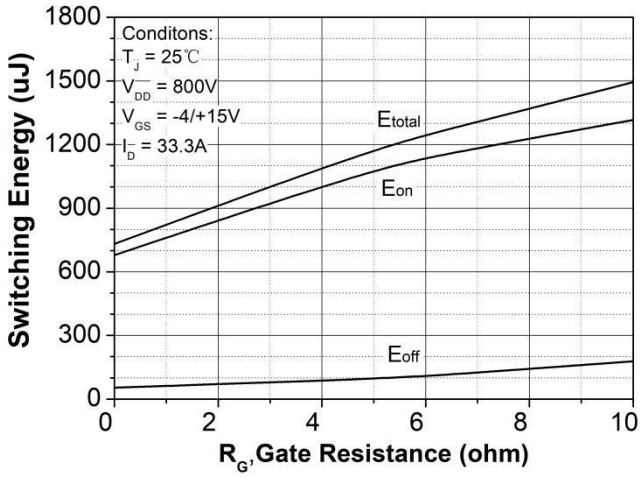


Figure 25. Clamped inductive switching energy vs. R_G(ext)

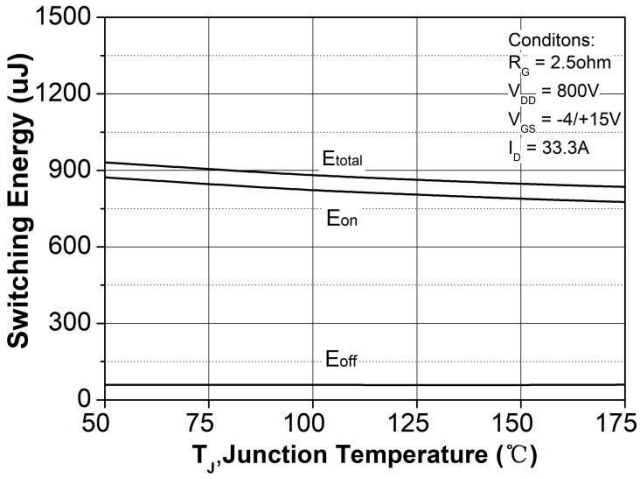


Figure 26. Clamped inductive switching energy vs. temperature

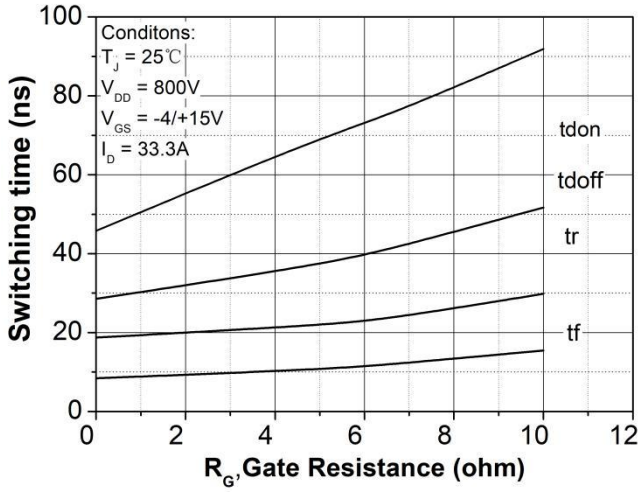
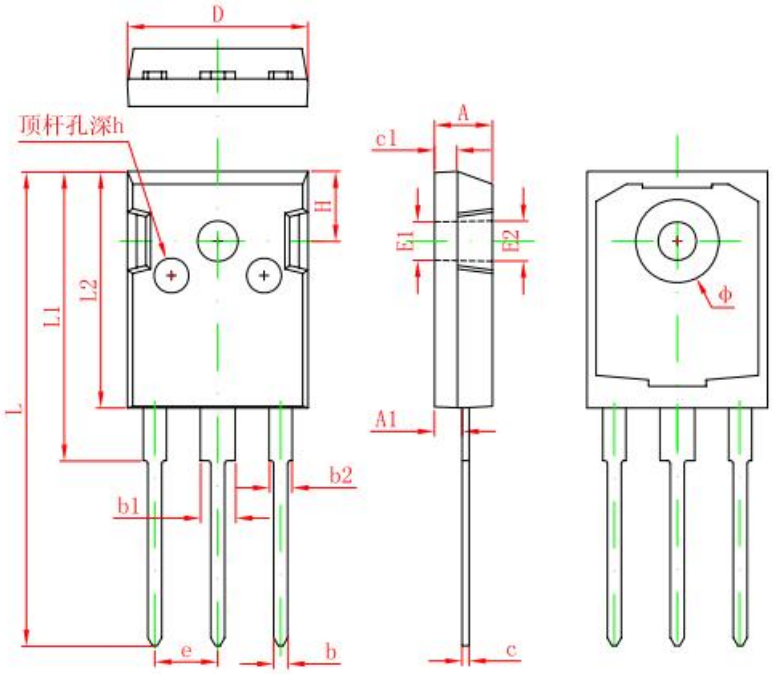


Figure 27. Switching times vs. R_G(ext)

5、Package drawing (TO-247-3L)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.850	5.150	0.191	0.200
A1	2.200	2.600	0.087	0.102
b	1.000	1.400	0.039	0.055
b1	2.800	3.200	0.110	0.126
b2	1.800	2.200	0.071	0.087
c	0.500	0.700	0.020	0.028
c1	1.900	2.100	0.075	0.083
D	15.450	15.750	0.608	0.620
E1	3.500 REF		0.138 REF	
E2	3.600 REF		0.142 REF	
L	40.900	41.300	1.610	1.626
L1	24.800	25.100	0.976	0.988
L2	20.300	20.600	0.799	0.811
Φ	7.100	7.300	0.280	0.287
e	5.450 TYP		0.215 TYP	
H	5.980 REF		0.235 REF	
h	0.000	0.300	0.000	0.012

6、Test conditions

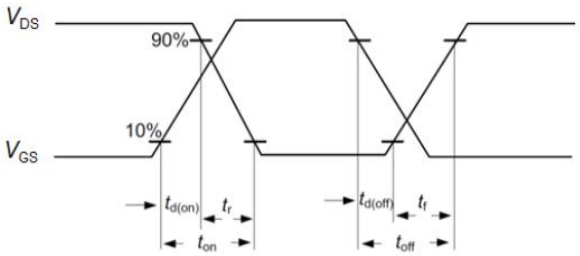


Figure A. Definition of switching times

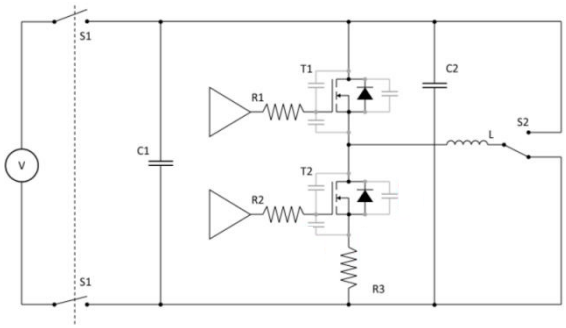


Figure B. Dynamic test circuit

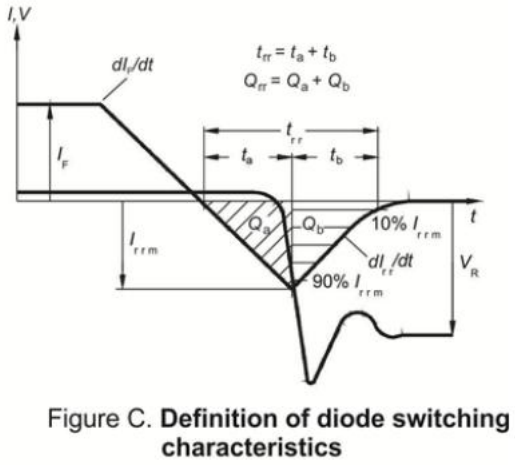


Figure C. **Definition of diode switching characteristics**

Figure C. Definition of body diode switching characteristics

Revision history

Document version	Date of release	Description of changes
V01_00	2022-12-30	——
V02_00	2023-09-15	——

Attention

1. **Rohs compliance**

The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/ EC (RoHS2), as implemented January 2, 2013.

2. **REACH compliance**

REACh substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future, please contact a Sichain representative to insure you get the most up-to-date REACh SVHC Declaration. REACh banned substance information (REACh Article 67) is also available upon request.

3. With respect to information regarding the application of the product, Sichain hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

4. Any information given in this documents subject to customer's compliance with its obligations and any applicable legal requirements, norms and standards concerning any use of the product of Sichain in any customer's applications.

5. Specifications of any and all 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.

6. Due to technical requirements products may contain dangerous substances. For information on the types in question please contact Sichain office.

7. Except as otherwise explicitly approved by Sichain in a written document signed by authorized representatives of Sichain, Sichain' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

8. For use of our products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a Sichain representatives, for example but not limited to: transportation equipment,primary communication equipment,traffic lights,fire/crime prevention, safety equipment, medical systems, and power transmission systems.