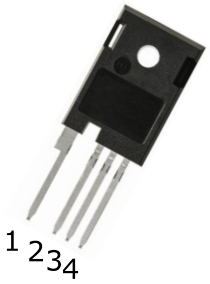
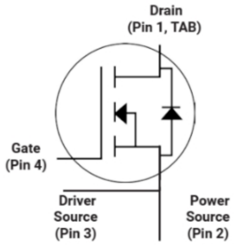
1200V Silicon Carbide Power MOSFET 1200V G1 （ N Channel Enhancement ）

Features

- High speed switching
- Very low switching losses
- High blocking voltage with low on-resistance
- Temperature independent turn-off switching losses
- Halogen free, RoHS compliant



TO-247-4L



Benefits

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

Halogen-Free

RoHS

Applications

- EV motor drive
- PV string inverters
- Solar power optimizer
- Switch mode power supplies

Table 1 Key performance and package parameters

Type	**V_{DS}**	**I_{DS}** (T_C=25°C, $R_{th\ (j\text{-}c,max)}$)	**$R_{DS(ON),\ typ}$** (V_{GS} = 18 V, I_D = 100 A, T_J=25°C)	**$T_{j,max}$**	**Marking**	**Package**
NF3M14120K	1200 V	152 A	14 mΩ	175℃	NF3M14120K	TO247-4L

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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} = 0 V, I_D = 100 µA	
$V_{GS,max}$	Gate source voltage	-8 /+22	V	Absolute maximum values	
V_{GSop}	Gate source voltage	-4 /+18	V	Recommended operational values	
I_D	Continuous drain current	152	A	V_{GS} = 18 V, T_C = 25°C	Fig.19
		108		V_{GS} = 18 V, T_C = 100°C	
I_D(pluse)	Pulsed drain current	340	A	Pulse width t_P limited by $T_{j,max}$	Fig.22
P_D	Power dissipation	625	W	T_C=25°C,T_J=175°C	Fig.20
T_J ,T_{stg}	Operating Junction and storage temperature	-40 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	

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	0.24	°C/W		Fig.21
$R_{th(j-a)}$	Thermal resistance from junction to ambient	33			

[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	4	V	V_{DS} = V_{GS}, I_D = 28mA	Fig.11
		-	2.0	-	V	V_{DS} = V_{GS}, I_D = 28mA, T_J=175°C	
I_{DSS}	Zero gate voltage drain current	-	1	100	µA	V_{DS} = 1200V, V_{GS} = 0V	
I_{GSS}	Gate source leakage current	-	-	100	nA	V_{GS} = 18V, V_{DS} = 0V	
$R_{DS(on)}$	Current drain-source on-state resistance	-	17	21	mΩ	V_{GS} = 15V, I_D = 100A	Fig.4,5,6
		-	28	-		V_{GS} = 15V, I_D = 100A, T_J=175°C	
		-	14	18		V_{GS} = 18V, I_D = 100A	
		-	27	-		V_{GS} = 18V, I_D = 100A, T_J=175°C	
g_{fs}	Transconductance	-	71	-	S	V_{DS} = 20V, I_D = 100A	Fig.7
		-	63	-		V_{DS} = 20V, I_D = 100A, T_J=175°C	
$R_{g,int}$	Internal gate resistance	-	0.9	-	Ω	V_{AC} = 25mV, f=1MHz	
V_{SD}	Diode forward voltage	-	4.0	-	V	V_{GS} = -4V, I_{SD} = 50A	Fig.8,9,10
		-	3.5	-		V_{GS} = -4V, I_{SD} = 50A, 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	-	5469	-	pF	V_{DS} = 1000V, V_{GS} = 0V T_J = 25°C, V_{AC} = 25mV f=100KHz	Fig.17,18
C_{oss}	Output capacitance	-	235	-			
C_{rss}	Reverse capacitance	-	17.5	-			
E_{oss}	Coss stored energy	-	150	-	µJ		Fig.16

Q_{gs}	Gate source charge	-	54	-	nC	V_{DS} = 800V, V_{GS} =-4/+18V I_D = 100A	Fig.12
Q_{gd}	Gate drain charge	-	45	-			
Q_g	Gate charge	-	230	-			

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	-	812	-	µJ	V_{DS} = 800V, V_{GS} = -4/+18V I_D = 100A, Rg = 2.5Ω, L = 120uH	Fig.26
E_{off}	Turn off switching energy	-	383	-			
$t_{d(on)}$	Turn on delay time	-	19	-	ns		Fig.27, 28
t_r	Rise time	-	29	-			
$t_{d(off)}$	Turn off delay time	-	42	-			
t_f	Fall time	-	9.3	-			

Table 7 Body diode characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode forward voltage	-	4.0	-	V	V_{GS} = -4V, I_{SD} = 50A	Fig.8,9, 10
		-	3.5	-	V	V_{GS} = -4V, I_{SD} = 50A T_J = 175°C	
I_S	Continuous diode forward current	-	152	-	A	V_{GS} = -4V, Tc = 25°C	
t_{rr}	Reverse recovery time	-	66	-	nS	V_R = 800V, V_{GS} = -4V I_D = 100A di/dt = 3000A/µS, T_J = 175°C	
Q_{rr}	Reverse recovery charge	-	1830	-	nC		
I_{rrm}	Peak reverse recovery current	-	52	-	A		

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

4、Electrical characteristic diagrams

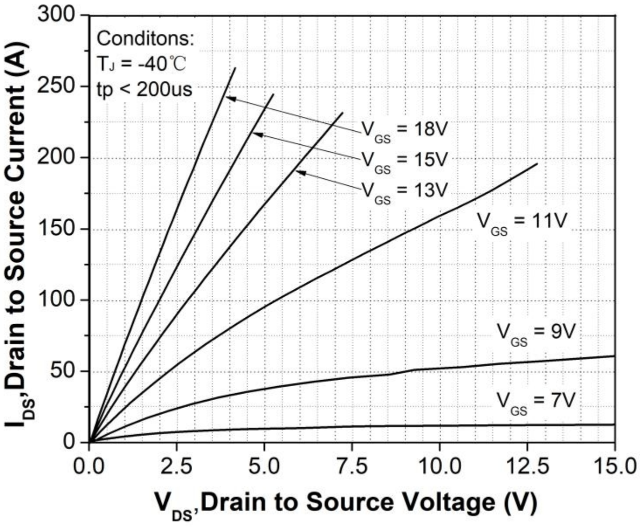


Figure 1. Output characteristics T_J = -40 ºC

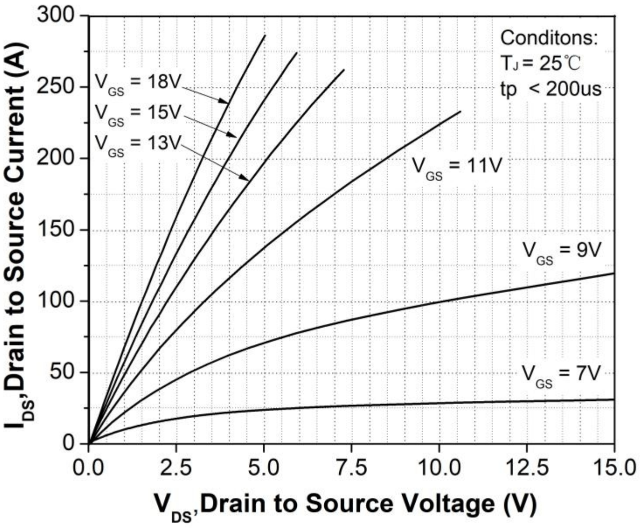


Figure 2. Output characteristics T_J = 25 ºC

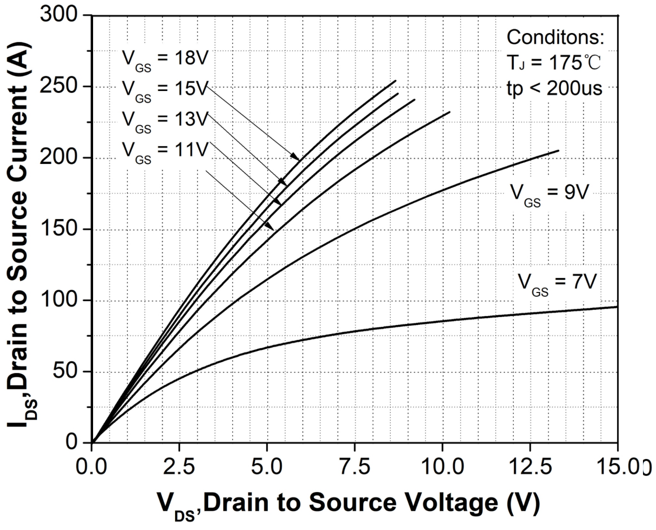


Figure 3. Output characteristics T_J = 175 ºC

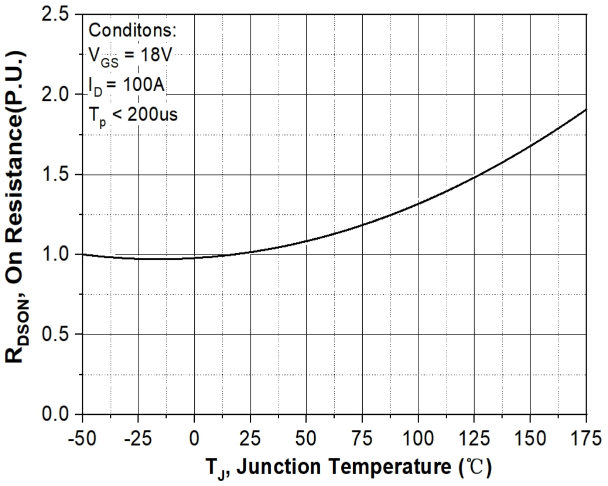


Figure 4. Normalized on-resistance vs. temperature

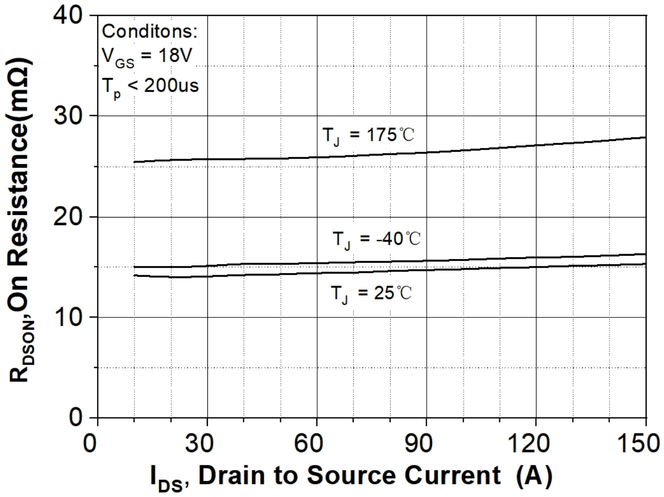


Figure 5. On-resistance vs. drain current

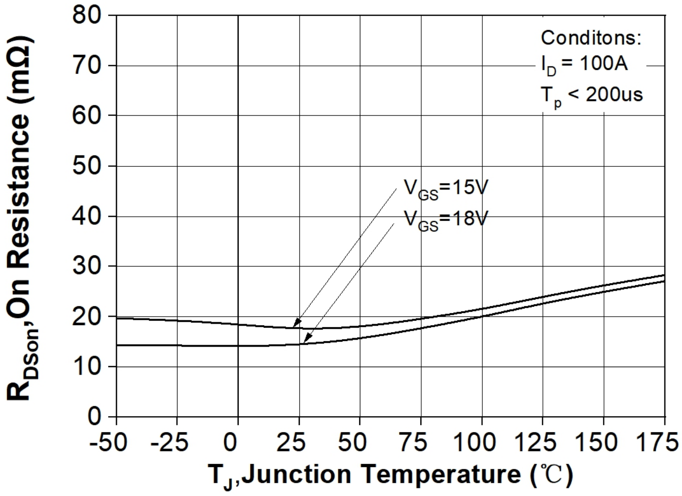


Figure 6. On-resistance vs. temperature for various gate voltage

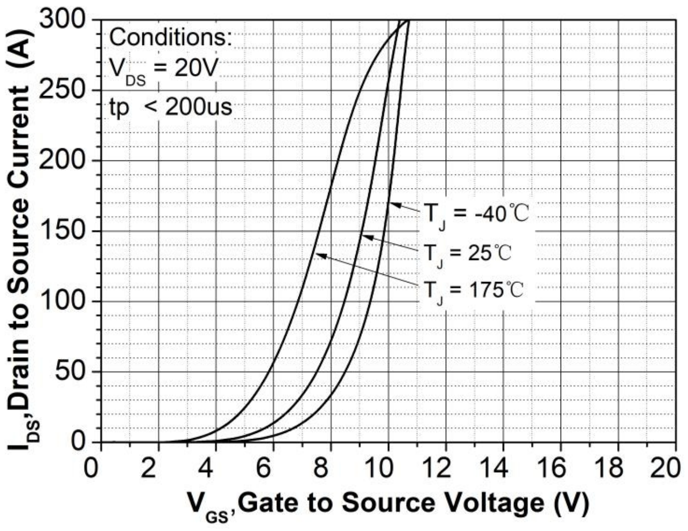


Figure 7. Transfer characteristic for various junction temperatures

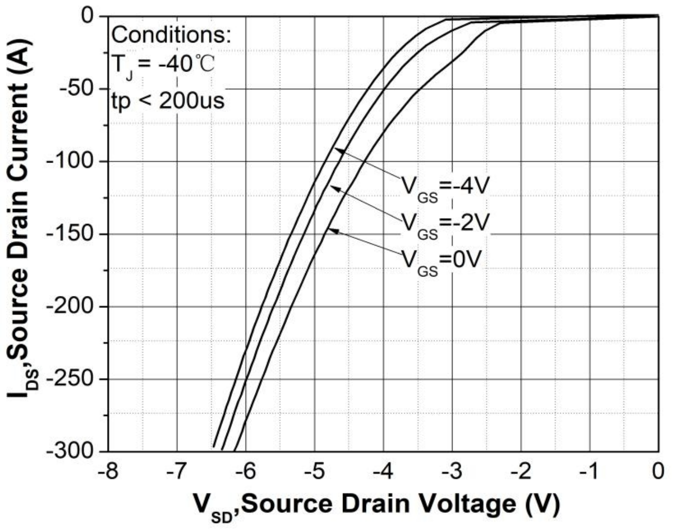


Figure 8. Body diode characteristic at T_J = -40 ºC

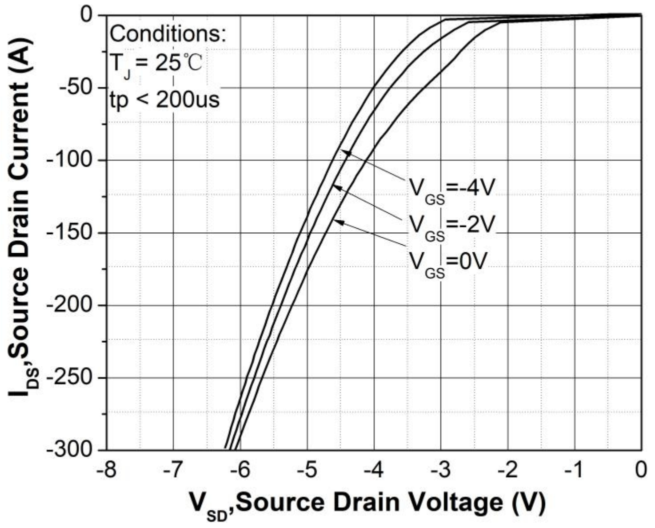


Figure 9. Body diode characteristic at T_J = 25 ºC

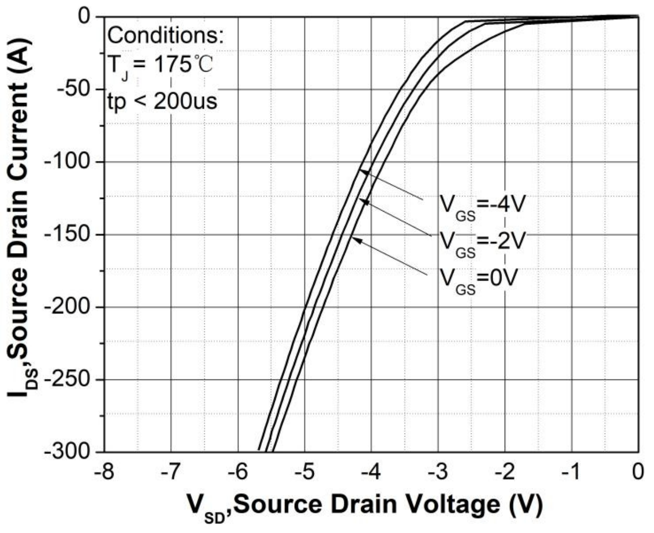


Figure 10. Body diode characteristic at T_J = 175ºC

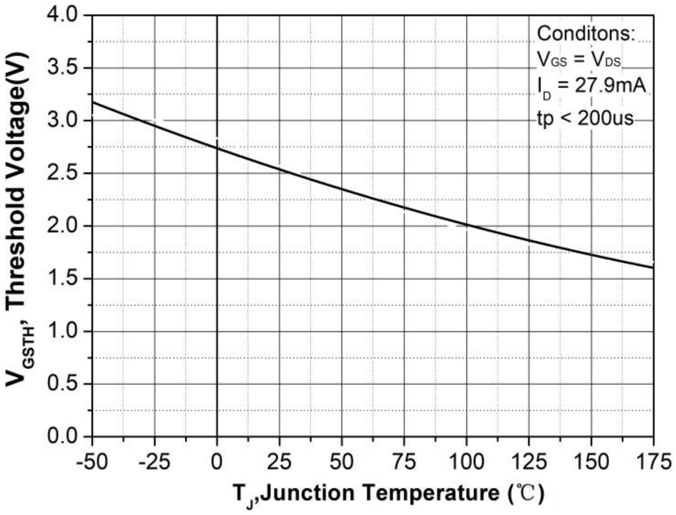


Figure 11. Threshold voltage vs. temperature

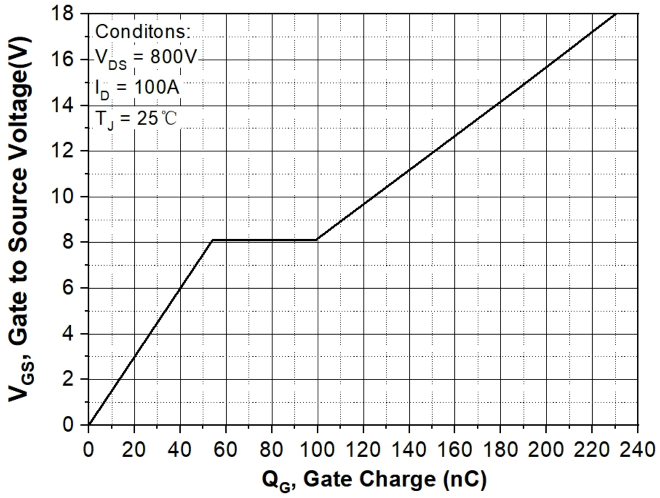


Figure 12. Gate charge characteristic

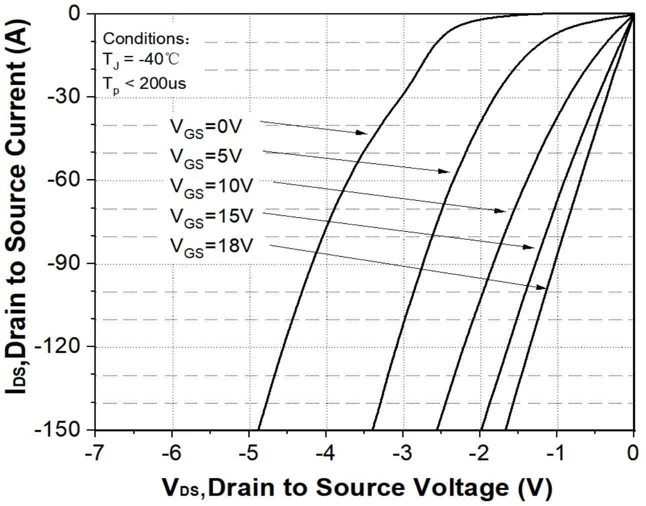


Figure 13. 3rd quadrant characteristic at T_J = -40 ºC

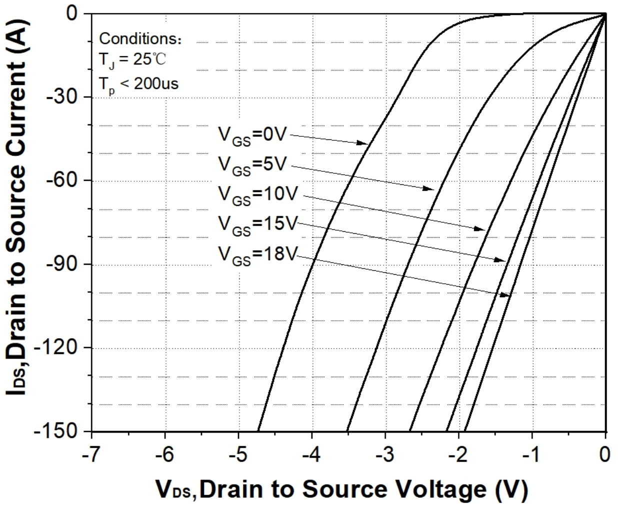


Figure 14. 3rd quadrant characteristic at T_J = 25 ºC

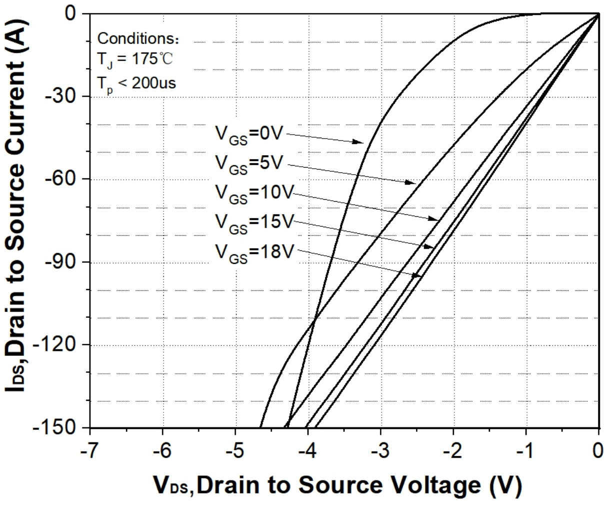


Figure 15. 3rd quadrant characteristic at T_J = 175 ºC

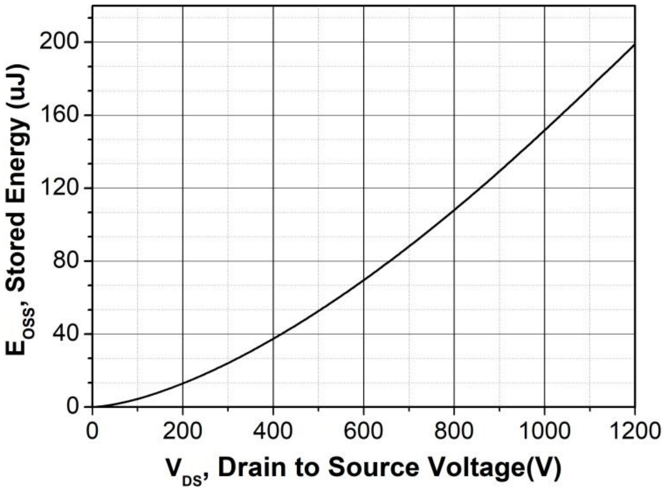


Figure 16. Output capacitor stored energy

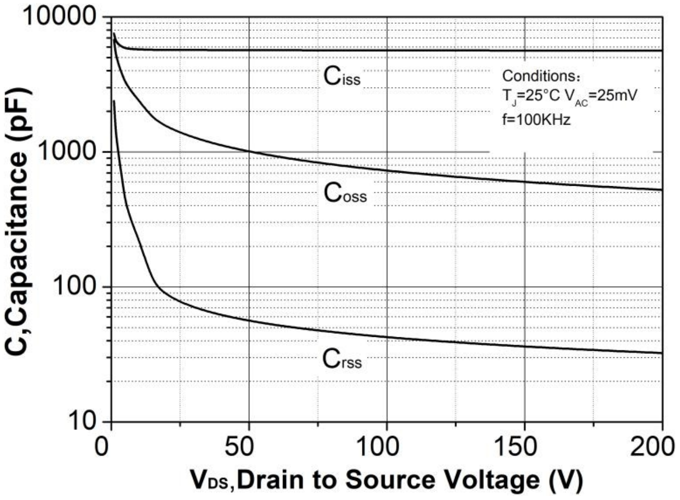


Figure 17. Capacitances vs. drain-source voltage (0 - 200V)

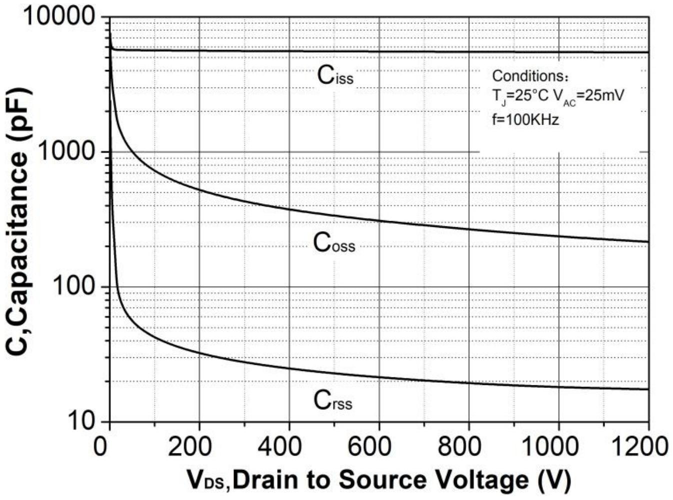


Figure 18. Capacitances vs. drain-source voltage (0 - 1200V)

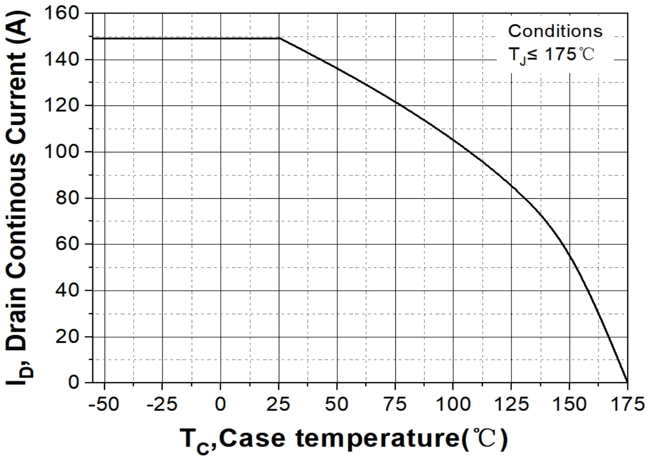


Figure 19. Continuous drain current derating vs.case temperature

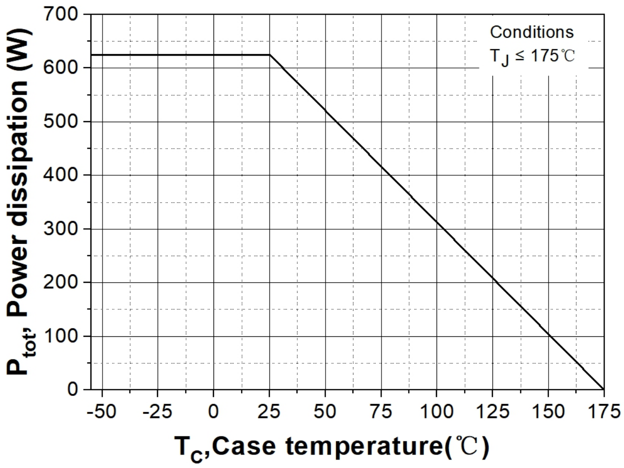


Figure 20. Maximum power dissipation derating vs. case temperature

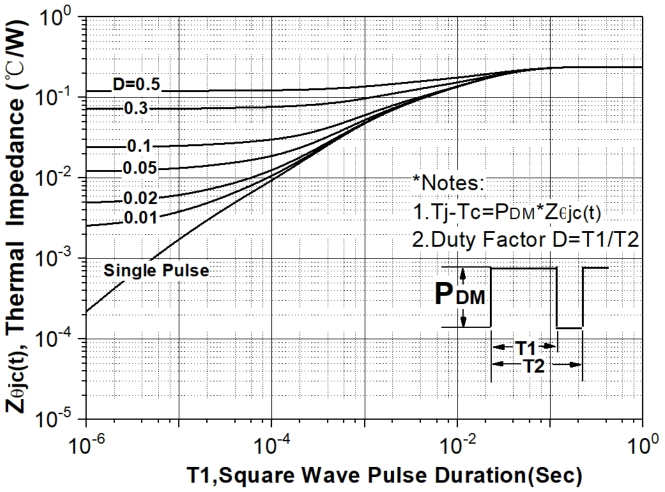


Figure 21. Transient thermal impedance (junction - case)

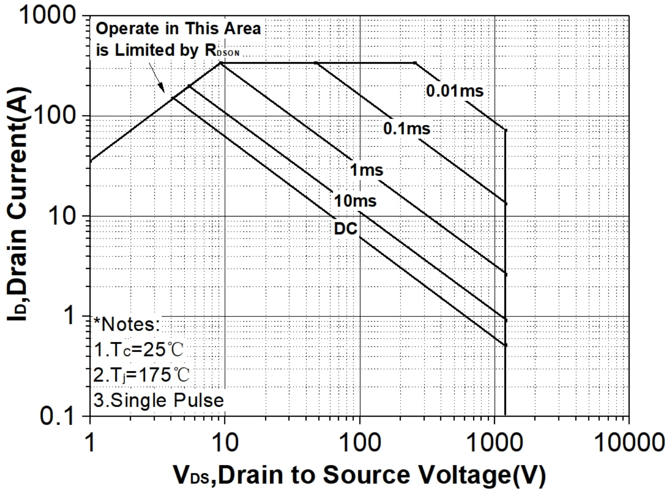


Figure 22. Safe operating area

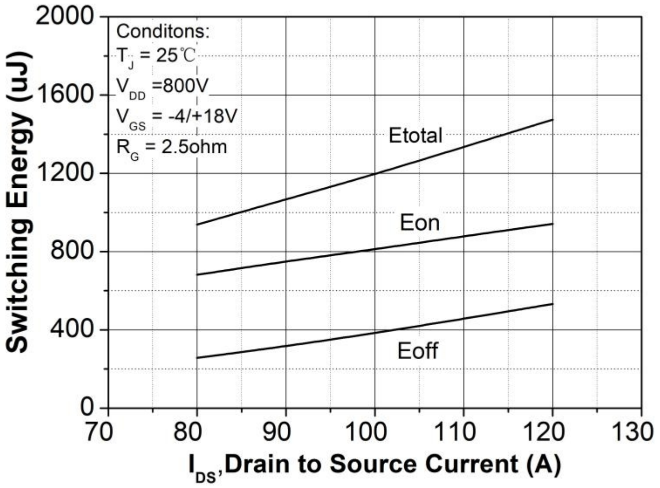


Figure 23. Clamped Inductive switching energy vs. drain current (V_{DD} = 800V)

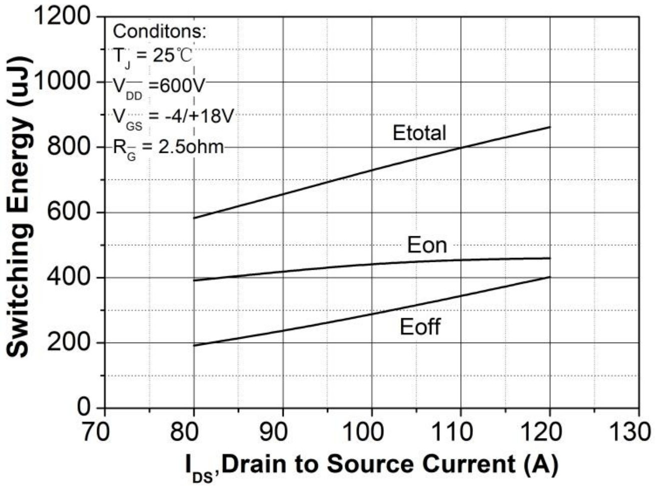


Figure 24. Clamped inductive switching energy vs. drain current (V_{DD} = 600V)

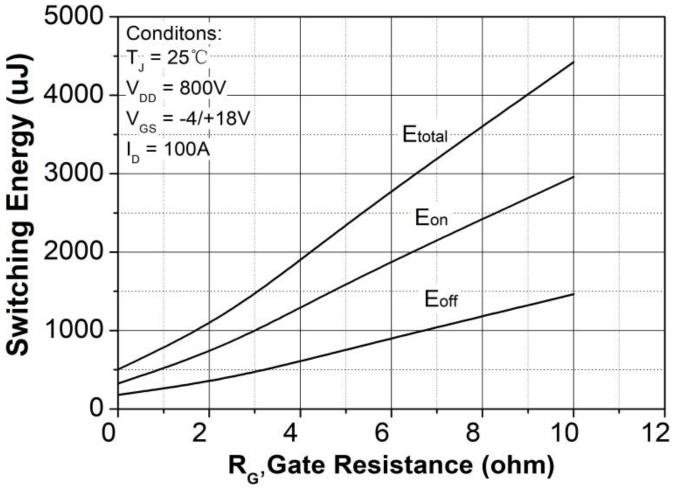


Figure 25. Clamped inductive switching energy vs. R_G(ext)

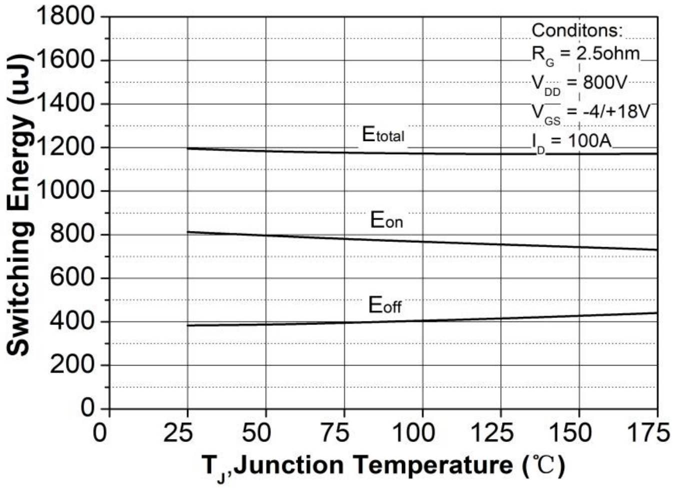


Figure 26. Clamped inductive switching energy vs. temperature

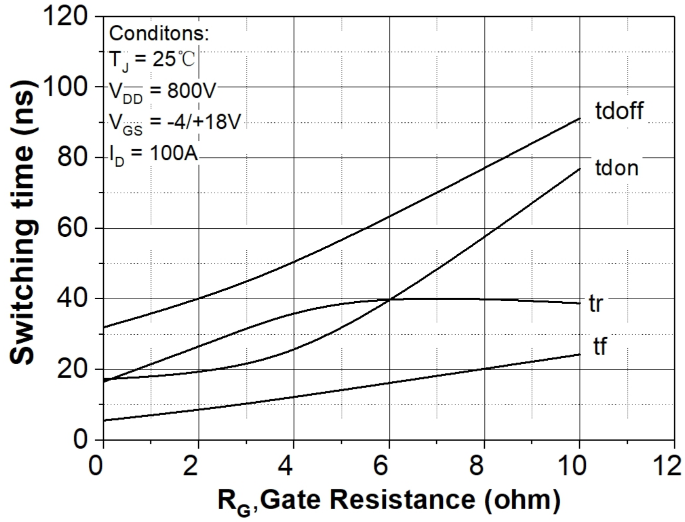
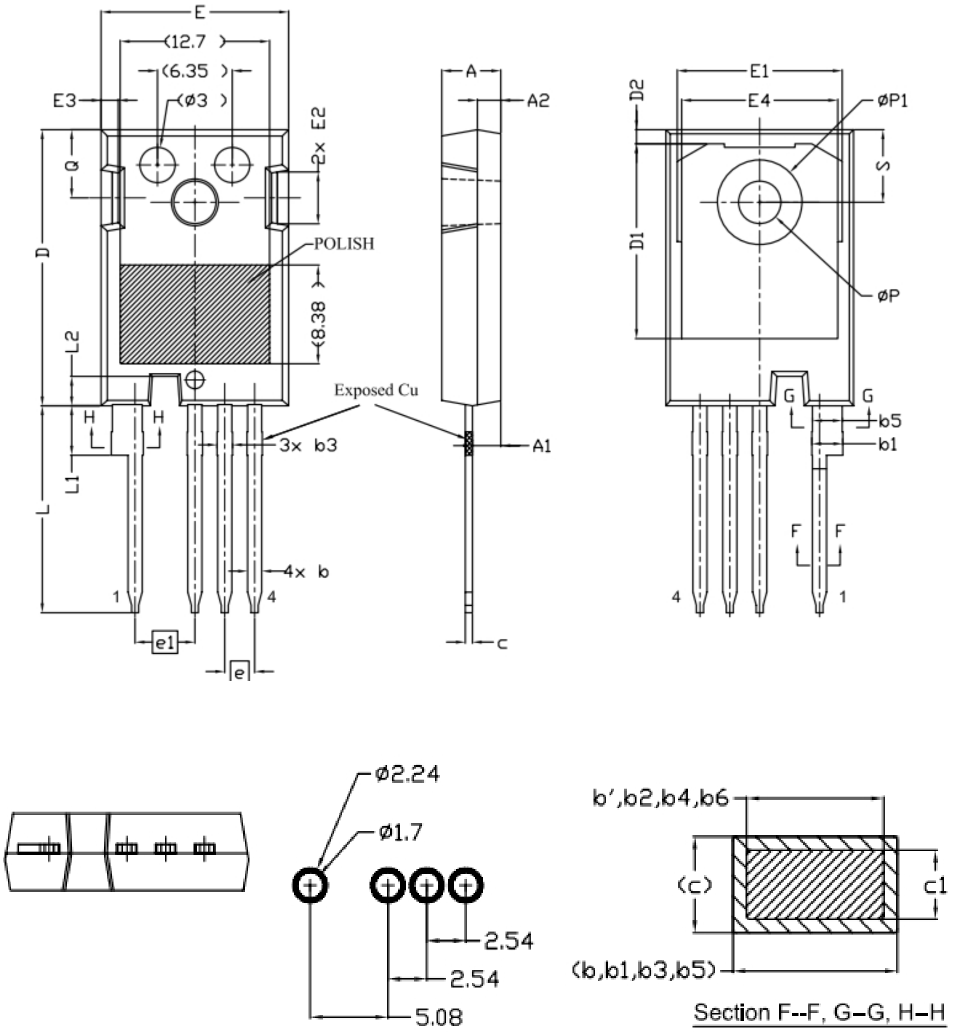


Figure 27. Switching times vs. R_G(ext)

5、Package drawing (TO-247-4L)



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	4,83	5,02	5,21
A1	2,29	2,41	2,54
A2	1,91	2,00	2,16
b'	1,07	1,20	1,28
b	1,07	1,20	1,33
b1	2,39	2,67	2,94
b2	2,39	2,67	2,84
b3	1,07	1,30	1,60
b4	1,07	1,30	1,50
b5	2,39	2,53	2,69
b6	2,39	2,53	2,64
c	0,55	0,60	0,68
c1	0,55	0,60	0,65
D	23,30	23,45	23,60
D1	16,25	16,55	17,65
D2	0,95	1,19	1,25
E	15.75	15.94	16.13
E1	13.10	14.02	14.15
E2	3.68	4.40	5.10
E3	1.00	1.45	1.90
E4	12.38	13.26	13.43
e	2.54 BSC		
e1	5.08 BSC		
L	17.31	17.57	17.82
L1	3.97	4.19	4.37
L2	2.35	2.50	2.65
ØP	3.51	3.61	3.65
ØP1	7.19 REF.		
Q	5.49	5.79	6.00
S	6.04	6.17	6.30

6、Test conditions

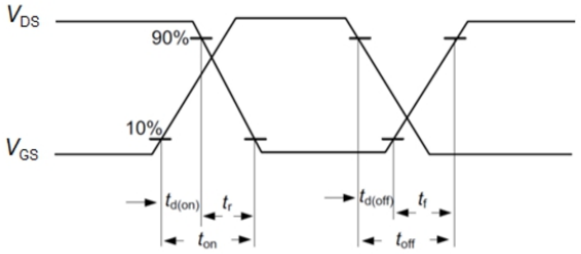


Figure A. Definition of switching times

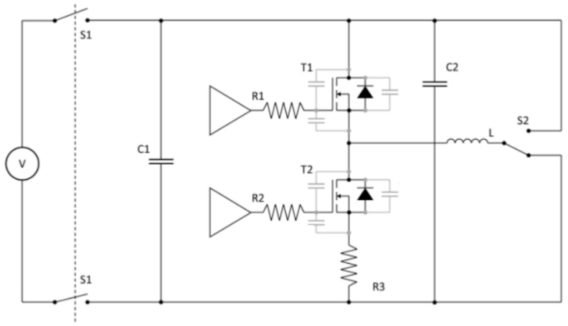


Figure B. Dynamic test circuit

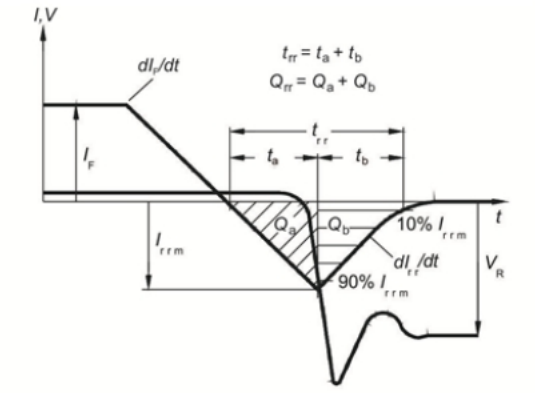


Figure C. **Definition of diode switching characteristics**

Figure C. Definition of body diode switching characteristics