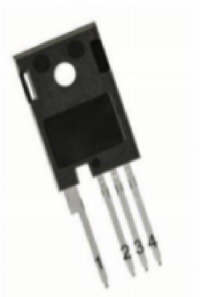
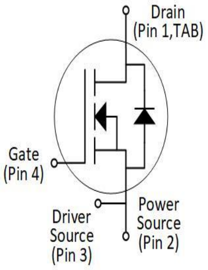
1200V Silicon Carbide Power MOSFET 1200V G1 （ N Channel Enhancement ）

Features

- High speed switching
- Very low switching losses
- IGBT-compatible driving voltage (18V 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-247-4L

Benefits

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

Halogen-Free

RoHS

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°C, $R_{th\ (j\text{-}c,max)}$)	**$R_{DS(ON),\ typ}$** (V_{GS} = 18 V, I_D = 20 A, T_J=25°C)	**$T_{j,max}$**	**Marking**	**Package**
NF3M80120K	1200 V	38 A	8 0 mΩ	175℃	NF3M80120K	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	Note1
V_{GSop}	Gate source voltage	-4 /+18	V	Recommended operational values	
I_D	Continuous drain current	38	A	V_{GS} = 18 V, T_C = 25°C	Fig.19
		27		V_{GS} = 18 V, T_C = 100°C	
I_D(pluse)	Pulsed drain current	80	A	Pulse width t_P limited by $T_{j,max}$	Fig.22
P_D	Power dissipation	214	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	0.7	°C/W		Fig.21
$R_{th(j-a)}$	Thermal resistance from junction to ambient	35			

[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 = 5mA	Fig.11
		-	2.1	-	V	V_{DS} = V_{GS}, I_D = 5mA, 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} = 18V, V_{DS} = 0V	
$R_{DS(on)}$	Current drain-source on-state resistance	-	70	85	mΩ	V_{GS} = 18V, I_D = 20A	Fig.4,5,6
		-	125	-		V_{GS} = 18V, I_D = 20A, T_J=175°C	
g_{fs}	Transconductance	-	10	-	S	V_{DS} = 20V, I_D = 20A	Fig.7
		-	9.2	-		V_{DS} = 20V, I_D = 20A, T_J=175°C	
$R_{g,int}$	Internal gate resistance	-	1.5	-	Ω	V_{AC} = 25mV, f=1MHz	
V_{SD}	Diode forward voltage	-	4.3	-	V	V_{GS} = -4V, I_{SD} = 10A	Fig.8,9,10
		-	3.8	-		V_{GS} = -4V, I_{SD} = 10A 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	-	920	-	pF	V_{DS} = 1000V, V_{GS} = 0V T_J = 25°C, V_{AC} = 25mV f=1MHz	Fig.17,18
C_{oss}	Output capacitance	-	57	-			
C_{rss}	Reverse capacitance	-	3.9	-			
E_{oss}	Coss stored energy	-	35	-	µJ		Fig.16
Q_{gs}	Gate source charge	-	7	-	nC	V_{DS} = 800V, V_{GS} = -4/18V I_D = 20A	Fig.12
Q_{gd}	Gate drain charge	-	19	-			
Q_g	Gate charge	-	40	-			

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	-	320	-	µJ	V_{DD} = 800V, V_{GS} = -4/+15V I_D = 20A, Rg = 0Ω L = 120uH	Fig.25
E_{off}	Turn off switching energy	-	49	-			
$t_{d(on)}$	Turn on delay time	-	19	-	ns		Fig.27
t_r	Rise time	-	21	-			
$t_{d(off)}$	Turn off delay time	-	15	-			
t_f	Fall time	-	17	-			

Table 7 Body diode characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
V_{SD}	Diode forward voltage	-	4.3	-	V	V_{GS} = -4V, I_{SD} = 10A	Fig.8,9,10
		-	3.8	-	V	V_{GS} = -4V, I_{SD} = 10A T_J = 175°C	
I_S	Continuous diode forward current	-	38	-	A	Tc = 25°C	Note1
t_{rr}	Reverse recovery time	-	41	-	nS	V_R = 800V, V_{GS} = -4V I_D = 20A di/dt = 700A/µS T_J = 150°C	
Q_{rr}	Reverse recovery charge	-	405	-	nC		
I_{rrm}	Peak reverse recovery current	-	20	-	A		

Note 1: When using SiC Body Diode the maximum recommended VGS = -4 V

4、Electrical characteristic diagrams

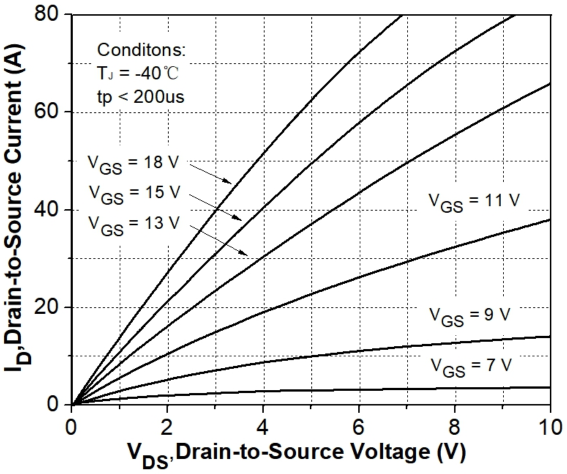


Figure 1. Output characteristics T_J = -40 ºC

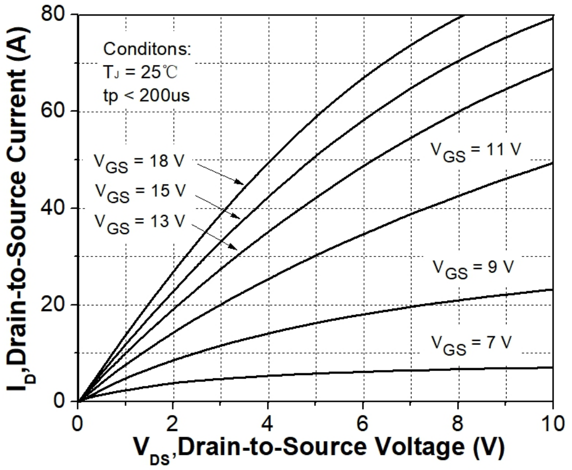


Figure 2. Output characteristics T_J = 25 ºC

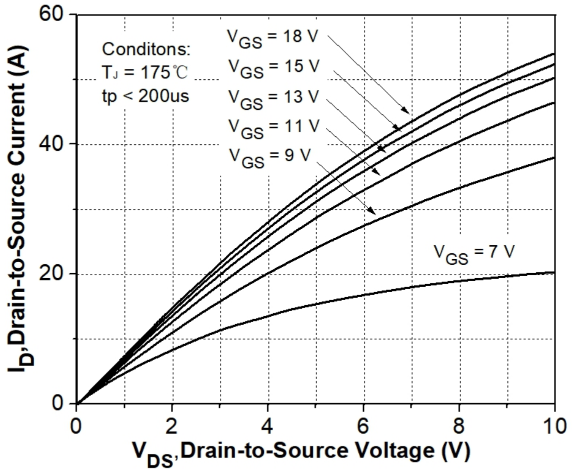


Figure 3. Output characteristics T_J = 175 ºC

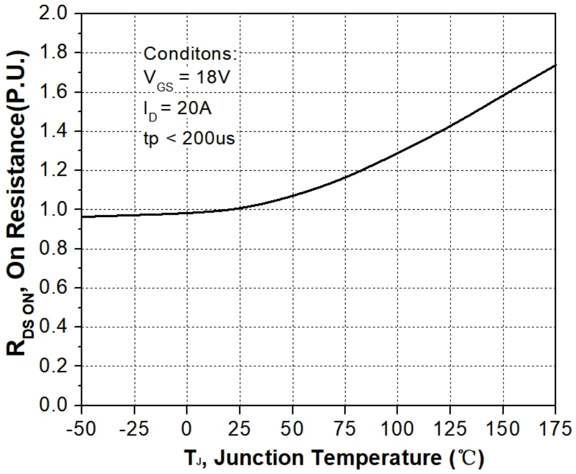


Figure 4. Normalized on-resistance vs. temperature

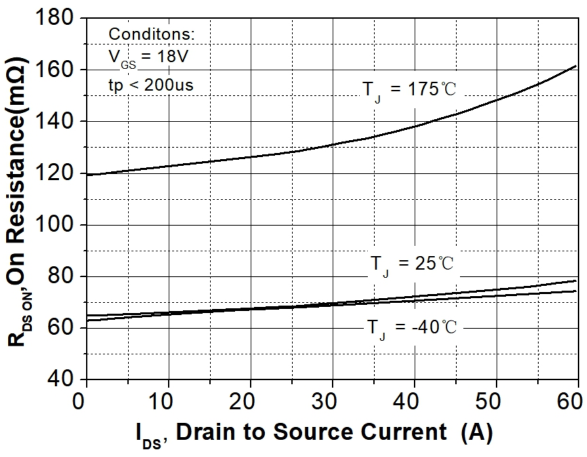


Figure 5. On-resistance vs. drain current

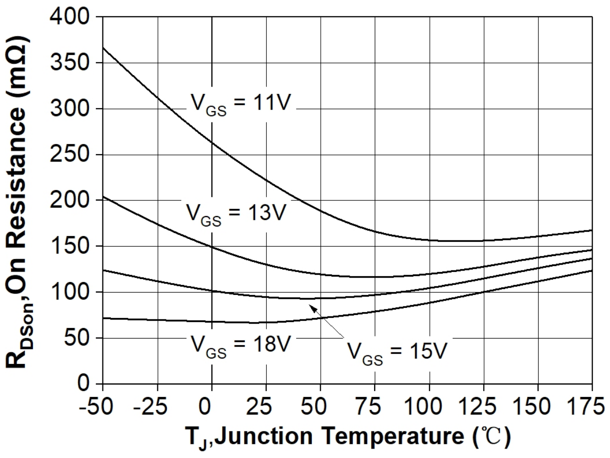


Figure 6. On-resistance vs. temperature

for various gate voltage

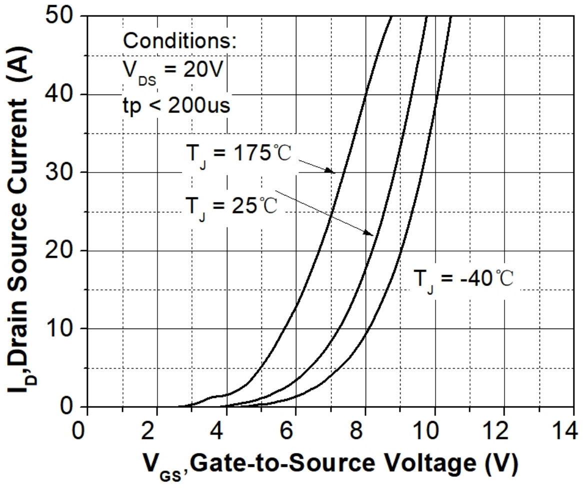


Figure 7. Transfer characteristic for

various junction temperatures

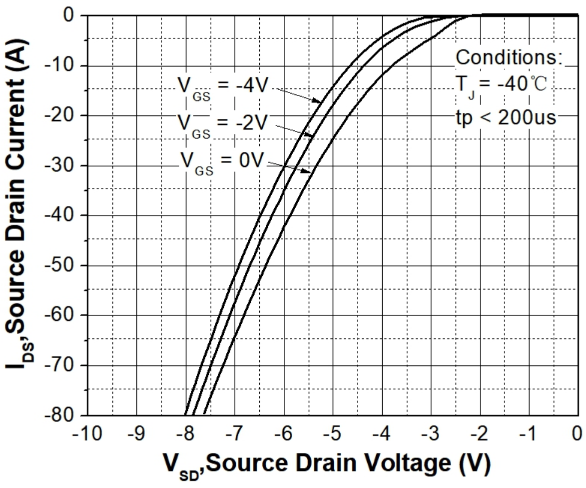


Figure 8. Body diode characteristic at $T_J = -40$ ºC

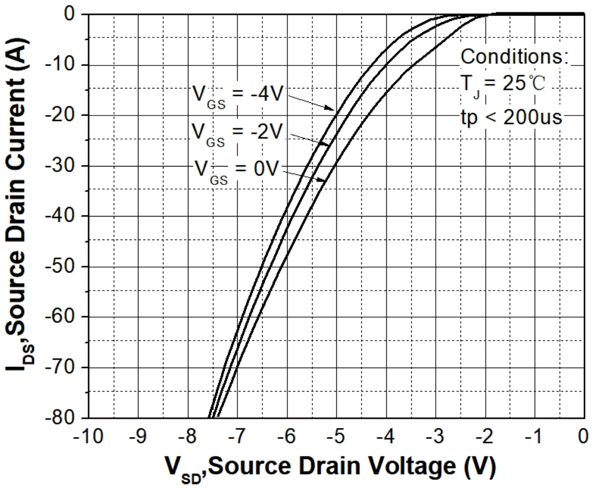


Figure 9. Body diode characteristic at $T_J = 25$ ºC

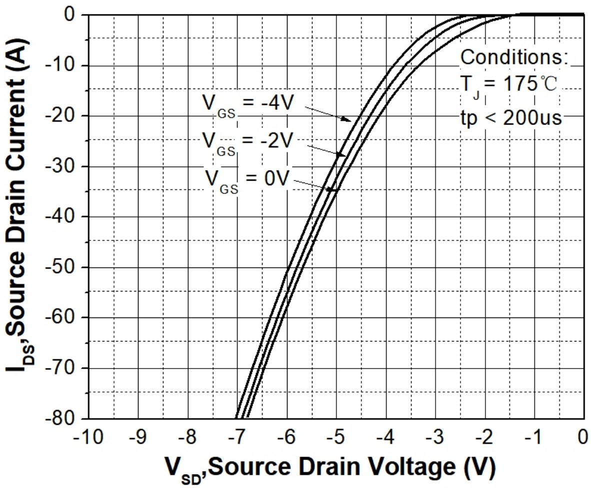


Figure 10. Body diode characteristic at $T_J = 175$ºC

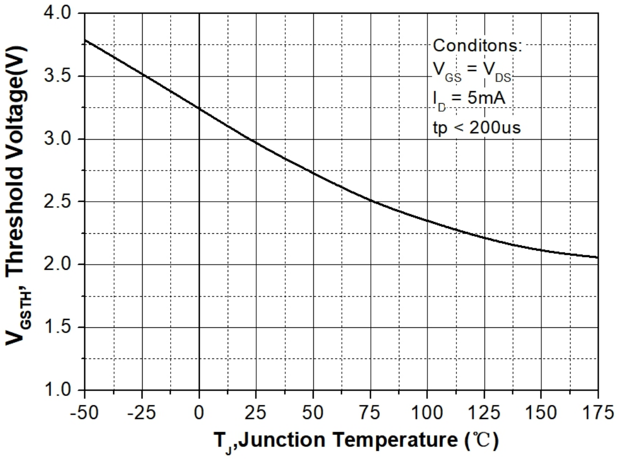


Figure 11. Threshold voltage vs. temperature

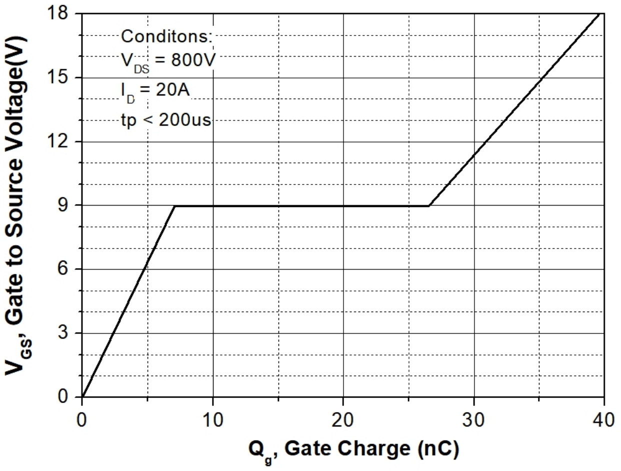


Figure 12. Gate charge characteristic

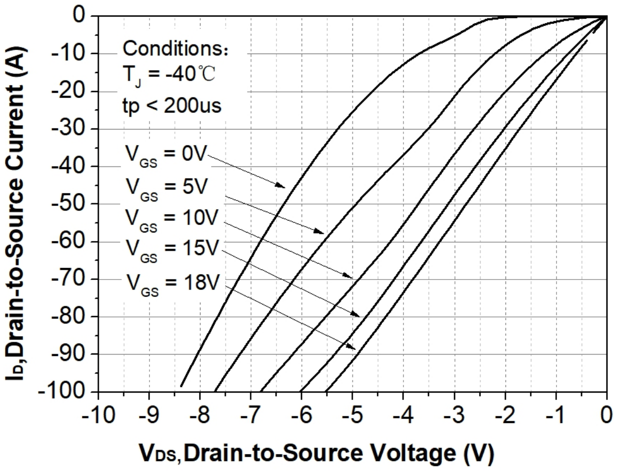


Figure 13. 3rd quadrant characteristic at T_J = -40 ºC

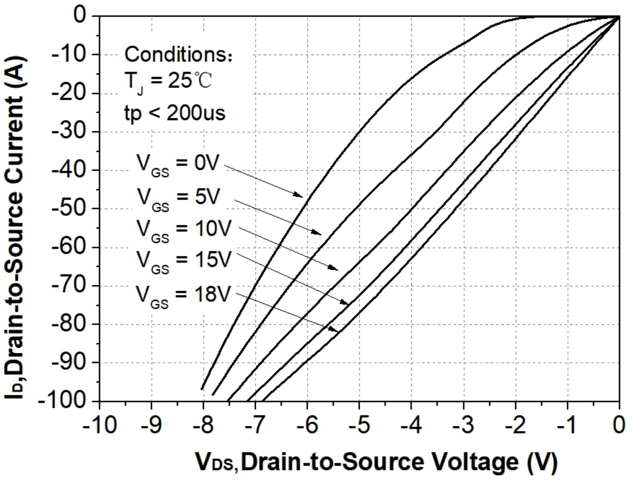


Figure 14. 3rd quadrant characteristic at T_J = 25 ºC

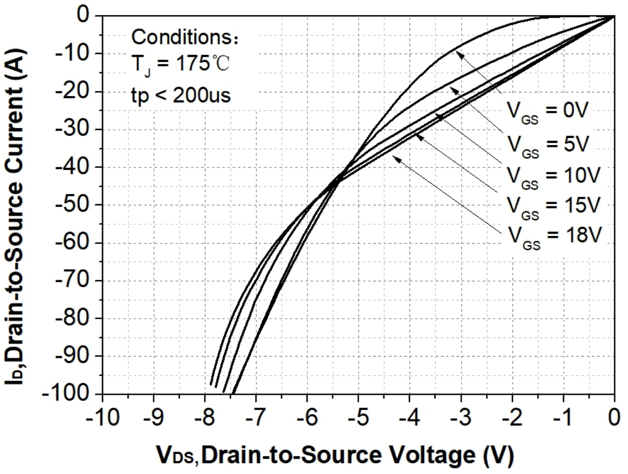


Figure 15. 3rd quadrant characteristic at T_J = 175 ºC

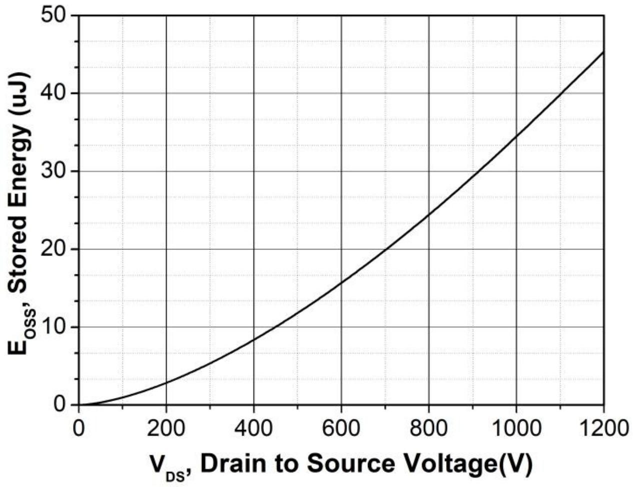


Figure 16. Output capacitor stored energy

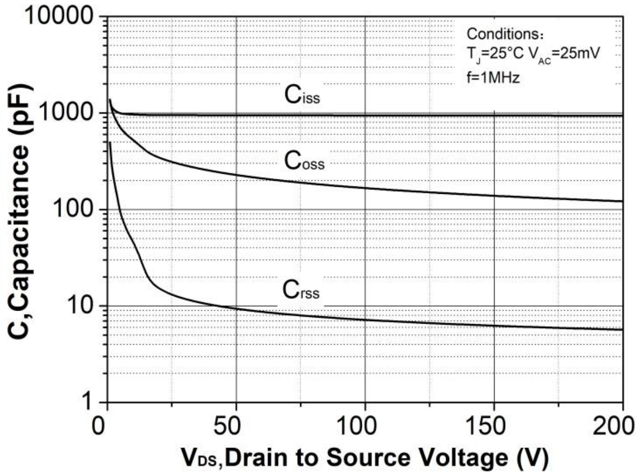


Figure 17. Capacitances vs. drain-source voltage (0 - 200V)

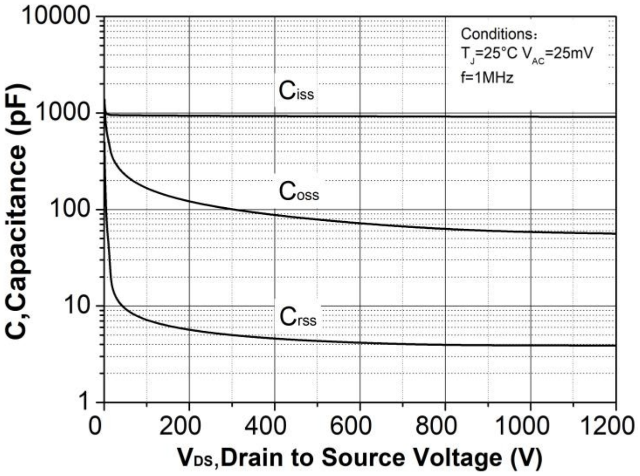


Figure 18. Capacitances vs. drain-source voltage (0 - 1200V)

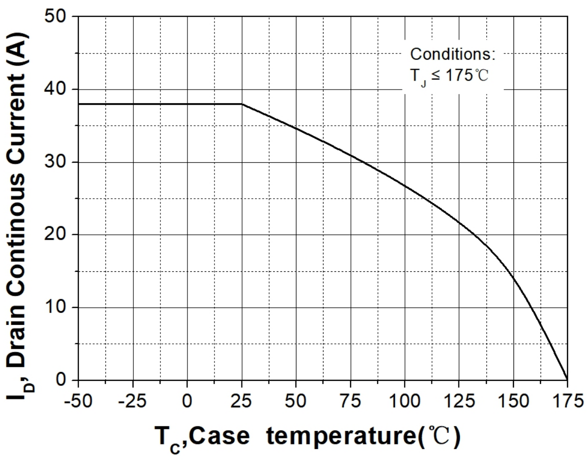


Figure 19. Continuous drain current derating vs. case temperature

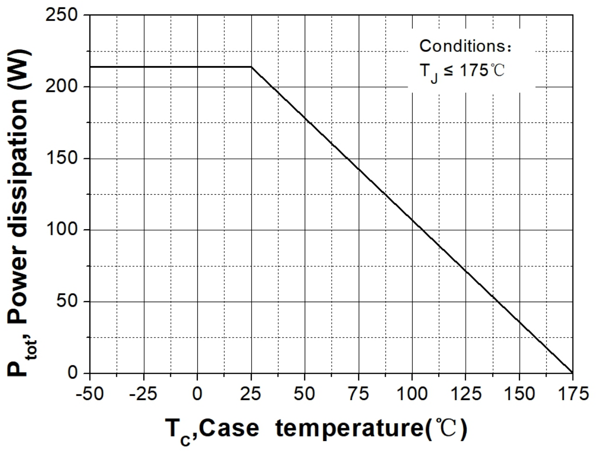


Figure 20. Maximum power dissipation derating vs. case temperature

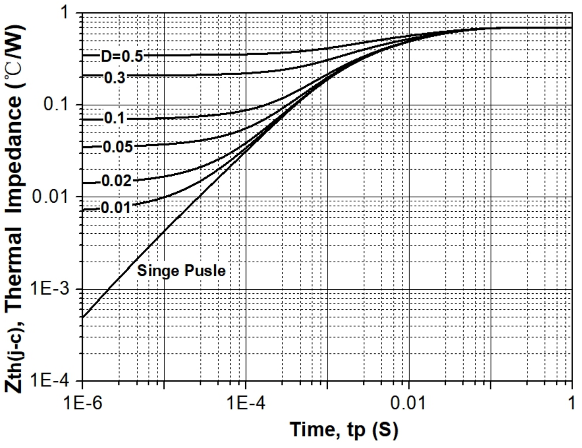


Figure 21. Transient thermal impedance (junction - case)

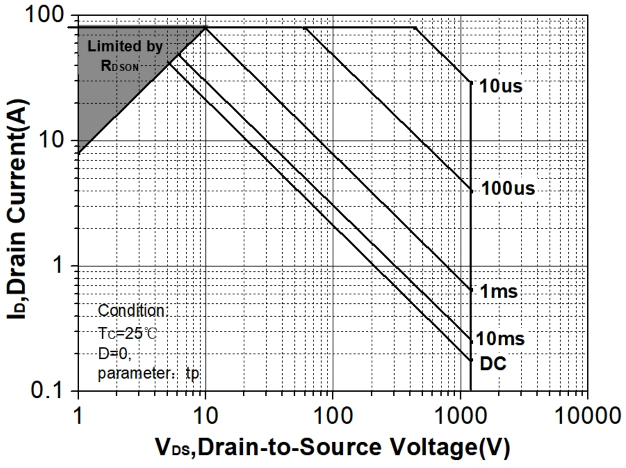


Figure 22. Safe operating area

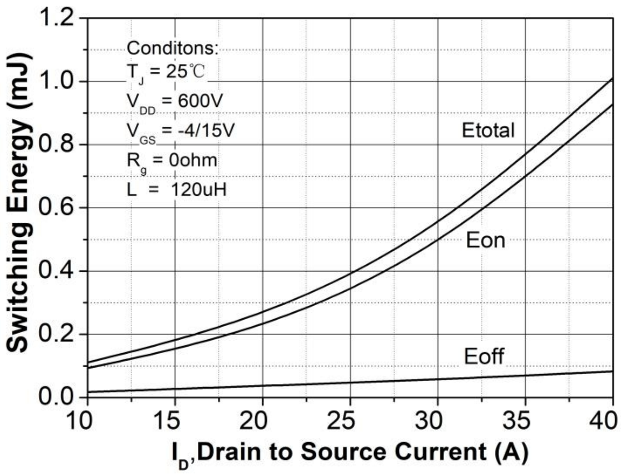


Figure 23. Clamped Inductive switching energy vs. drain current (V_{DD} = 600V)

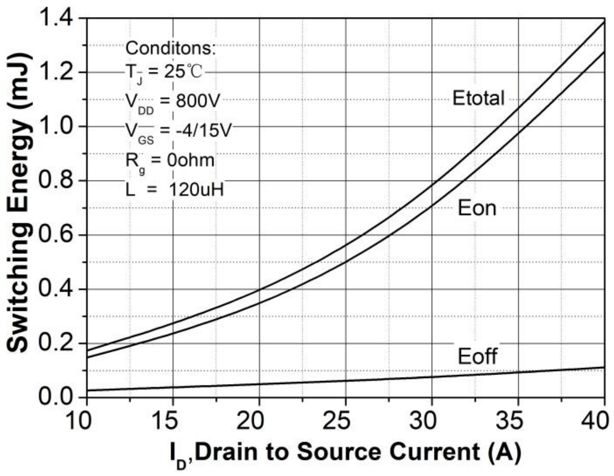


Figure 24. Clamped inductive switching energy vs. drain current (V_{DD} = 800V)

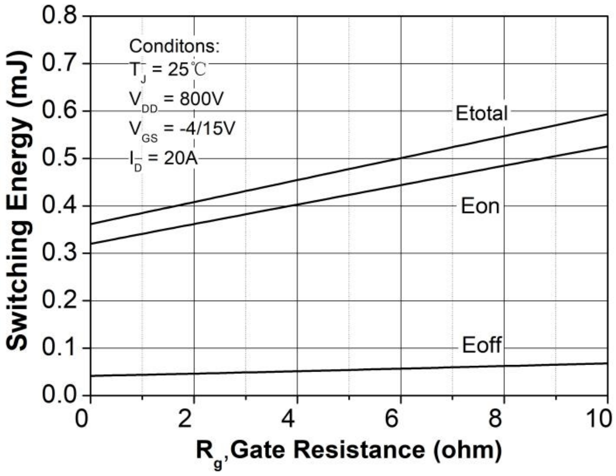


Figure 25. Clamped inductive switching energy vs. R_G(ext)

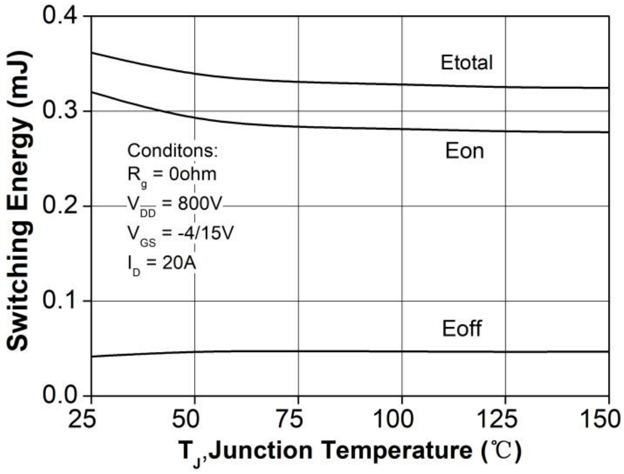


Figure 26. Clamped inductive switching energy vs. temperature

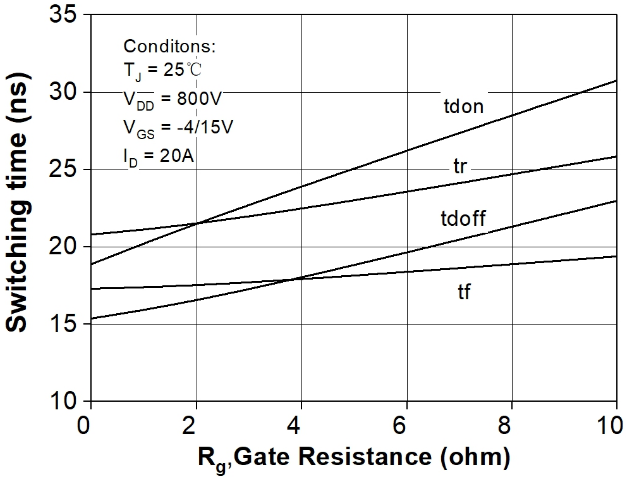


Figure 27. Switching times vs. R_G(ext)

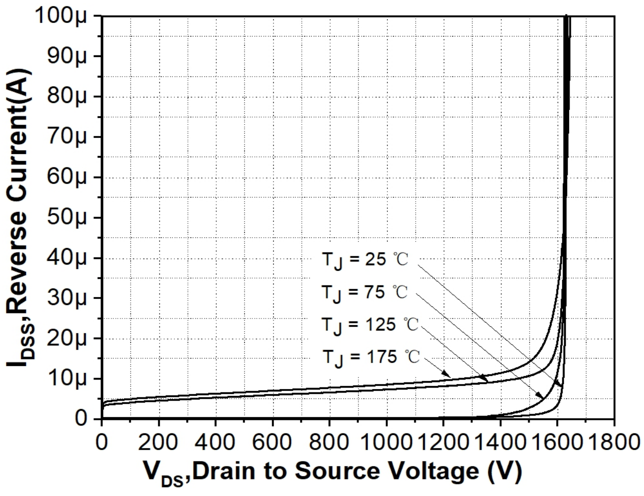
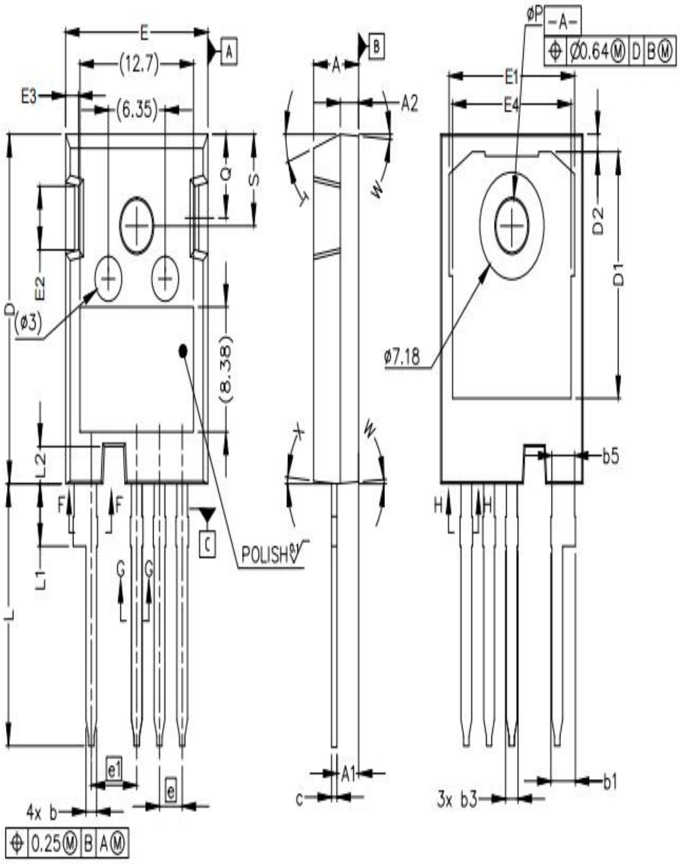
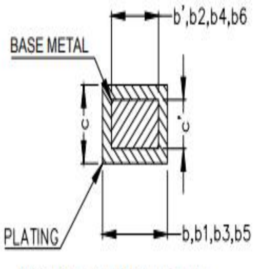


Figure 28. Reverse characteristics vs.T_J

5、Package drawing (TO-247-4L)





SECTION "F-F", "G-G" AND "H-H"
SCALE: NONE

SYMBOL	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
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
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
øP	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.	

6、Test conditions

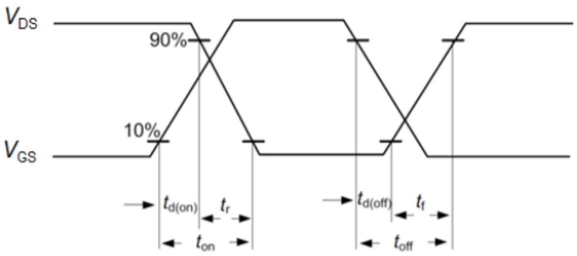


Figure A. Definition of switching times

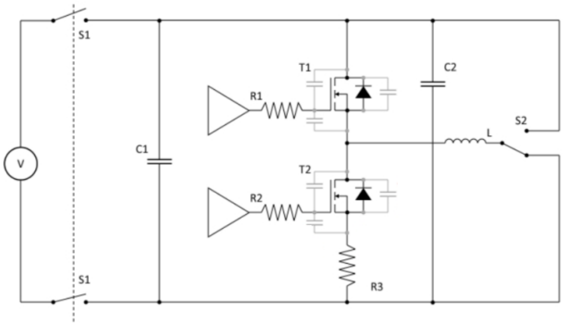


Figure B. Dynamic test circuit

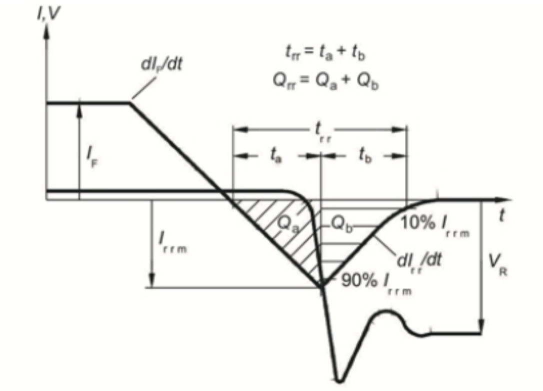


Figure C. **Definition of diode switching characteristics**

Figure C. Definition of body diode switching characteristics