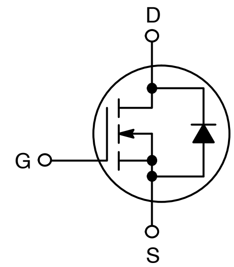
Silicon Carbide (SiC) MOSFET – EliteSiC, 13 mohm, 1200 V, M3S, Die

NTCR013N120M3S

$V_{(BR)DSS}$	$R_{DS(on)}$ TYP	I_D MAX
1200 V	13 mΩ @ 18 V	151 A

N−CHANNEL MOSFET



Description

Silicon Carbide (SiC) MOSFET uses a completely new technology that provides superior switching performance and higher reliability compared to Silicon. In addition, the low ON resistance and compact chip size ensure low capacitance and gate charge. Consequently, system benefits include highest efficiency, faster operation frequency, increased power density, reduced EMI, and reduced system size.

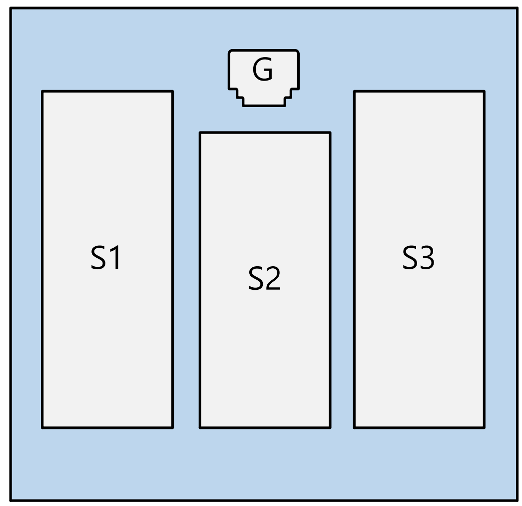
Features

- Typ. $R_{DS(on)}$ = 13 mΩ @ V_{GS} = 18 V
- Low Switching Losses (Typ. E_{ON} 563 J at 75 A, 800 V)

Applications

- Solar Inverters
- Electric Vehicle Charging Stations
- Uninterruptible Power Supplies (UPS)
- Energy Storage Systems
- Switch Mode Power Supplies (SMPS)

DIE DIAGRAM

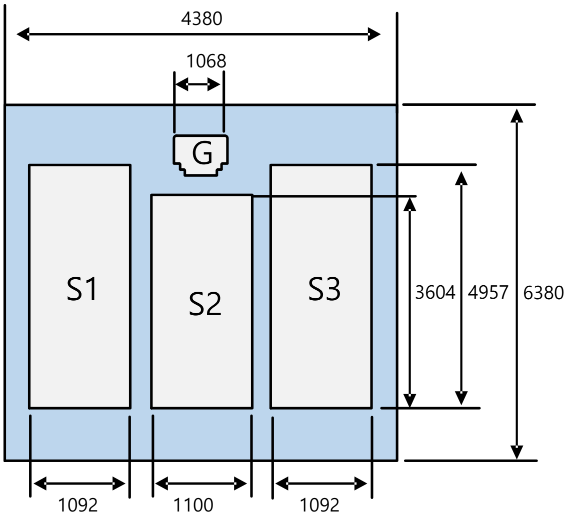


Die Information

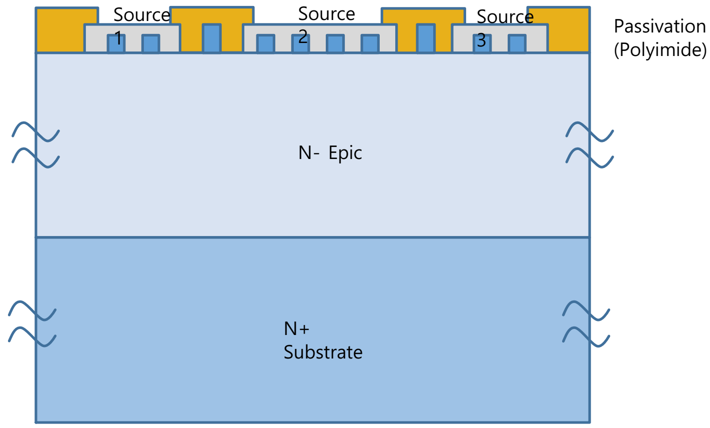
- Wafer Diameter: 6 inch
- Die Size: 4,380 x 6,380 µm
- Metallization
  - Top: Al/Si/Cu 5 µm
  - Back: Ti/NiV/Ag 0.5 µm
- Die Thickness: Typ. 100 µm
- Gate Pad Size: 1300 x 1068 µm

October, 2023 − Rev. 1
Publication Order Number:
NTCR013N120M3S−DIE/D

Die Layout



Die Cross Section



Passivation Information

- Passivation Material: Polymide (PSPI)
- Passivation Type: Local Passivation
- Passivation Thickness 15 μm
- : Passivation Area

Die Layout

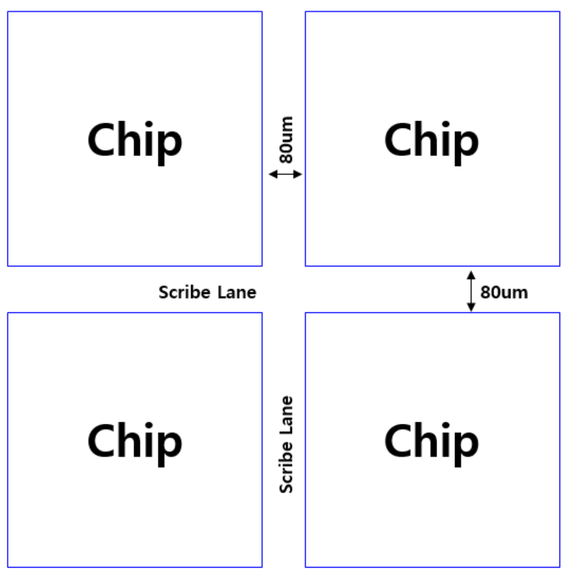


Figure 1. Bare Die Dimensions

1. Based on TO−247 package of **onsemi**
2. Tested 100% on wafer
3. Sawn−on−film frame packing based on wafer tested

For Additional Product Information and Electrical Characteristics on Package Refer to the NTH4L013N120M3S product datasheet.

ORDERING INFORMATION AND PACKAGE MARKING

Part Number	Package	Packing Method
NTCR013N120M3S	Die	Wafer sawn−on−film

THERMAL CHARACTERISTICS

Parameter	Symbol	Typ	Max	Unit
Junction–to–Case – Steady State (Note 4)	$R_{\theta JC}$	0.17	0.22	°C/W
Junction–to–Ambient – Steady State (Note 4)	$R_{\theta JA}$	–	40	

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
OFF–STATE CHARACTERISTICS						
Drain–to–Source Breakdown Voltage	$V_{(BR)DSS}$	V_{GS} = 0 V, I_D = 1 mA	1200	–	–	V
Drain–to–Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	I_D = 1 mA, referenced to 25°C (Note 9)	–	0.3	–	V/°C
Zero Gate Voltage Drain Current	I_{DSS}	V_{GS} = 0 V, V_{DS} = 1200 V, T_J = 25°C	–	–	100	μA
Gate–to–Source Leakage Current	I_{GSS}	V_{GS} = +22/−10 V, V_{DS} = 0 V	–	–	±1	μA
ON–STATE CHARACTERISTICS (Note 5)						
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GS} = V_{DS}, I_D = 37 mA	2.04	2.8	4.4	V
Recommended Gate Voltage	V_{GOP}		−3	–	+18	V
Drain–to–Source On Resistance	$R_{DS(on)}$	V_{GS} = 18 V, I_D = 75 A, T_J = 25°C	–	13	20	mΩ
		V_{GS} = 18 V, I_D = 75 A, T_J = 175°C (Note 9)	–	29	–	
Forward Transconductance	g_{FS}	V_{DS} = 10 V, I_D = 75 A (Note 9)	–	57	–	S
CHARGES, CAPACITANCES & GATE RESISTANCE						
Input Capacitance	C_{ISS}	V_{GS} = 0 V, f = 1 MHz, V_{DS} = 800 V (Note 9)	–	5813	–	pF
Output Capacitance	C_{OSS}		–	262	–	
Reverse Transfer Capacitance	C_{RSS}		–	21	–	
Total Gate Charge	$Q_{G(TOT)}$	V_{GS} = −3/18 V, V_{DS} = 800 V, I_D = 75 A (Note 9)	–	254	–	nC
Threshold Gate Charge	$Q_{G(TH)}$		–	37	–	
Gate–to–Source Charge	Q_{GS}		–	46	–	
Gate–to–Drain Charge	Q_{GD}		–	61	–	
Gate–Resistance	R_G	f = 1 MHz	–	1.4	–	Ω
SWITCHING CHARACTERISTICS						
Turn–On Delay Time	$t_{d(ON)}$	V_{GS} = −3/18 V, V_{DS} = 800 V, I_D = 75 A, R_G = 4.7 Ω Inductive load (Notes 8, 9)	–	22	–	ns
Rise Time	t_r		–	23	–	
Turn–Off Delay Time	$t_{d(OFF)}$		–	56	–	
Fall Time	t_f		–	10	–	
Turn–On Switching Loss	E_{ON}		–	563	–	μJ
Turn–Off Switching Loss	E_{OFF}		–	390	–	
Total Switching Loss	E_{tot}		–	953	–	
SOURCE–DRAIN DIODE CHARACTERISTICS						
Continuous Source–Drain Diode Forward Current	I_{SD}	V_{GS} = −3 V, T_C = 25°C (Note 9)	–	–	151	A
Pulsed Source–Drain Diode Forward Current (Note 5)	I_{SDM}		–	–	505	
Forward Diode Voltage	V_{SD}	V_{GS} = −3 V, I_{SD} = 75 A, T_J = 25°C	–	4.7	–	V

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise specified) (continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
SOURCE−DRAIN DIODE CHARACTERISTICS						
Reverse Recovery Time	t_{RR}	V_{GS} = −3/18 V, I_{SD} = 75 A, dI_S/dt = 1000 A/µs, V_{DS} = 800 V (Note 9)	–	29	–	ns
Reverse Recovery Charge	Q_{RR}		–	252	–	nC
Reverse Recovery Energy	E_{REC}		–	26	–	µJ
Peak Reverse Recovery Current	I_{RRM}		–	18	–	A
Charge Time	T_A		–	17	–	ns
Discharge Time	T_B		–	12	–	ns

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
5. Repetitive rating, limited by max junction temperature.
6. The maximum current rating is based on typical $R_{DS(on)}$ performance.
7. E_{AS} of 800 mJ is based on starting T_J = 25°C; L = 1 mH, I_{AS} = 40 A, V_{DD} = 100 V, V_{GS} = 18 V.
8. E_{ON}/E_{OFF} result is with body diode.
9. Defined by design, not subject to production test.

TYPICAL CHARACTERISTICS

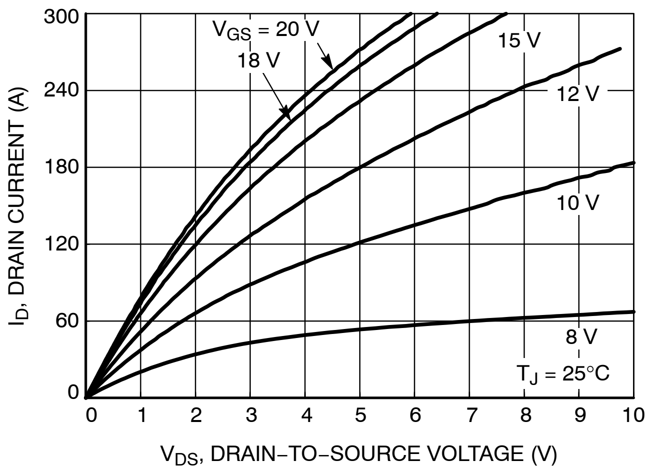


Figure 2. On−Region Characteristics

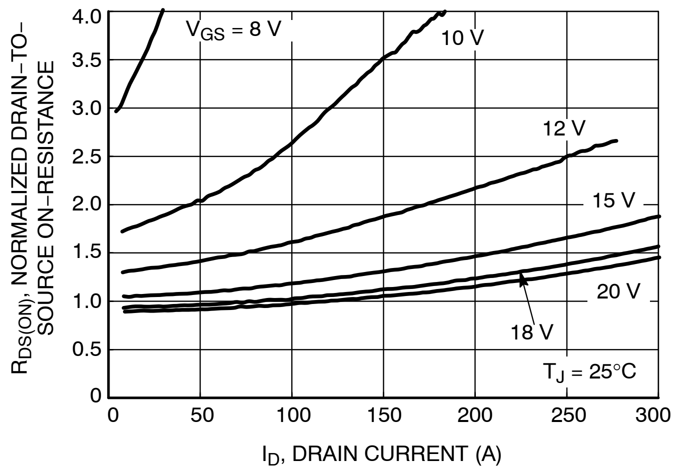


Figure 3. Normalized On−Resistance vs. Drain Current and Gate Voltage

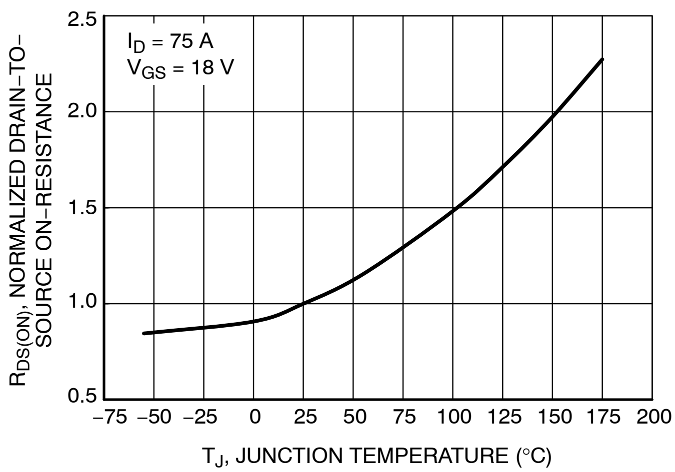


Figure 4. On−Resistance Variation with Temperature

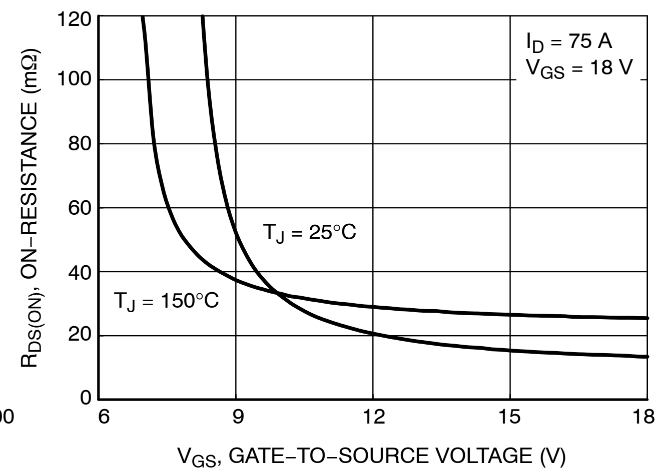


Figure 5. On−Resistance vs. Gate−to−Source Voltage

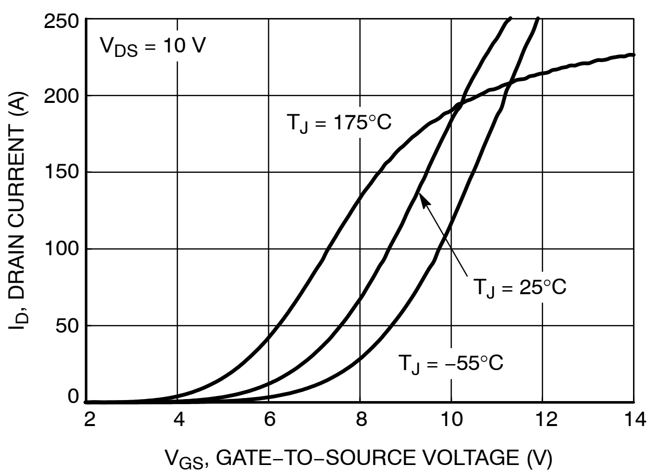


Figure 6. Transfer Characteristics

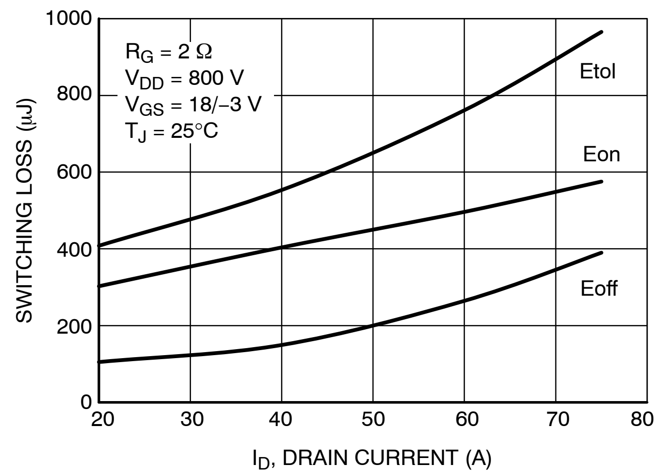


Figure 7. Switching Loss vs. Drain Current

TYPICAL CHARACTERISTICS

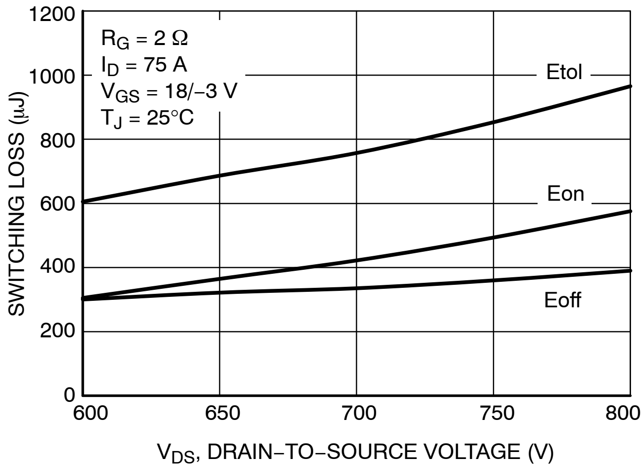


Figure 8. Switching Loss vs. Drain−to−Source Voltage

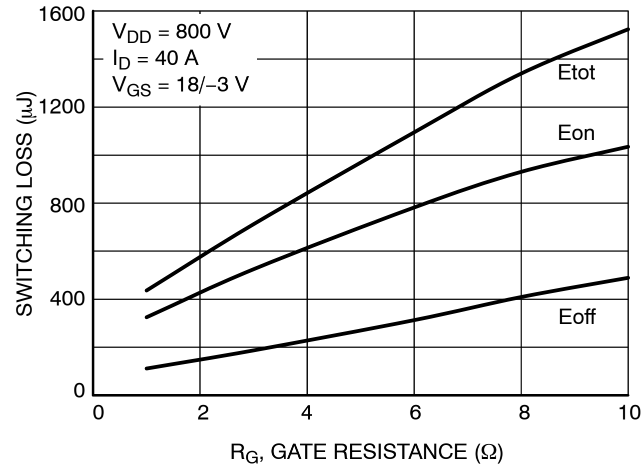


Figure 9. Switching Loss vs. Gate Resistance

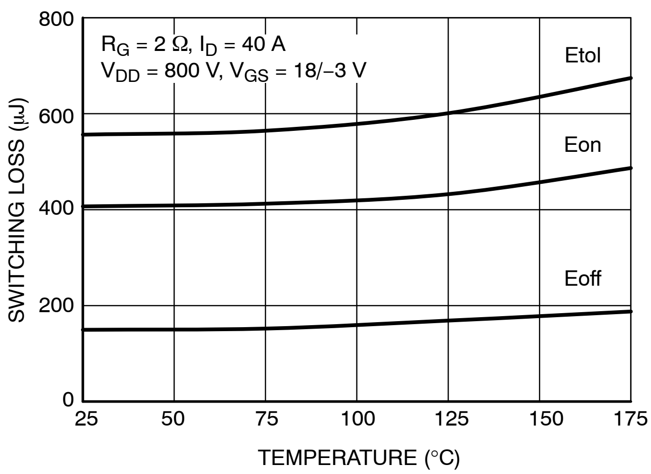


Figure 10. Switching Loss vs. Temperature

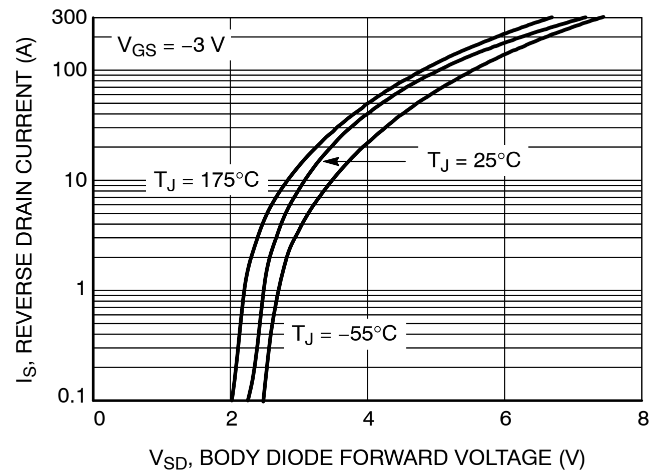


Figure 11. Reverse Drain Current vs. Body Diode Forward Voltage

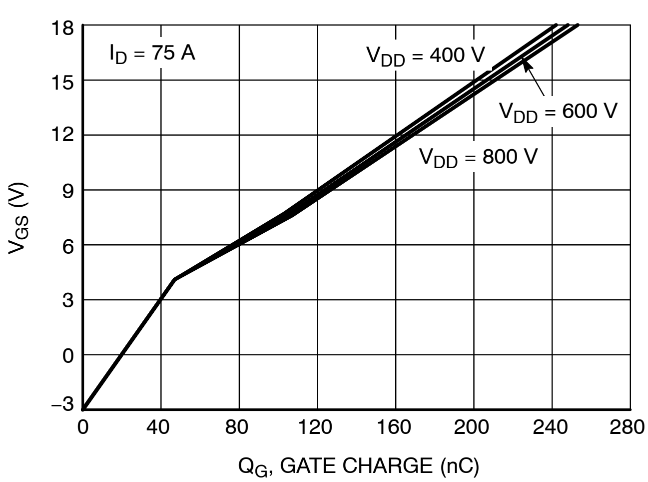


Figure 12. Gate−to−Source Voltage vs. Total Charge

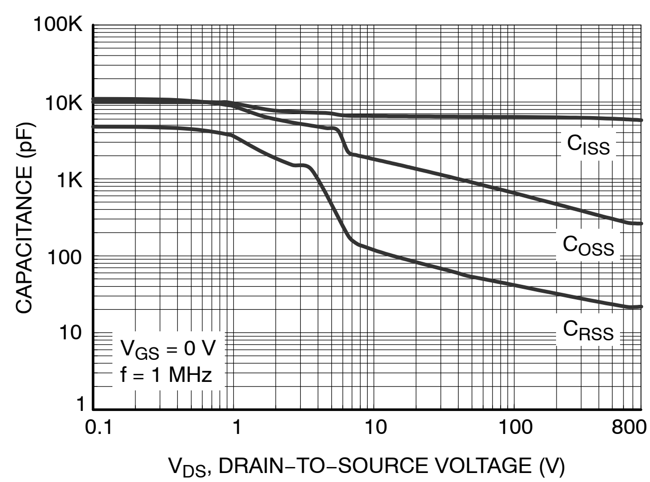


Figure 13. Capacitance vs. Drain−to−Source Voltage

TYPICAL CHARACTERISTICS

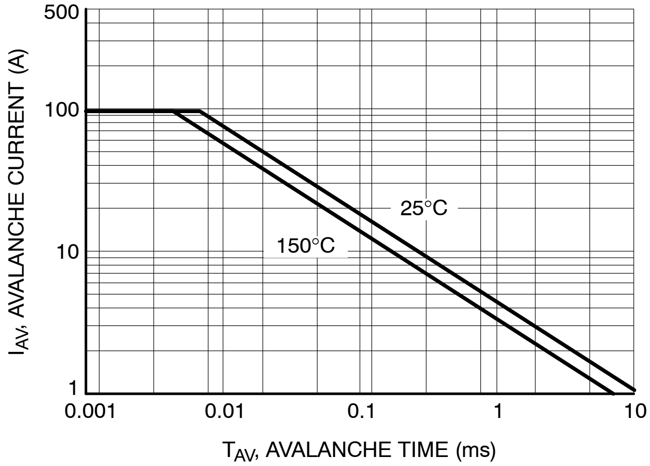


Figure 14. Unclamped Inductive Switching Capability

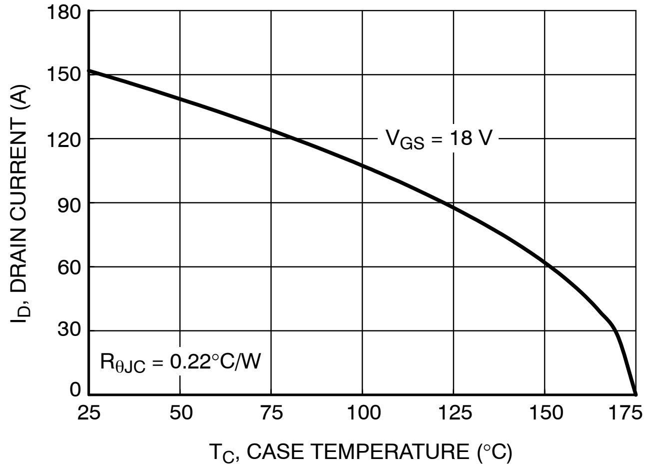


Figure 15. Maximum Continuous Drain Current vs. Case Temperature

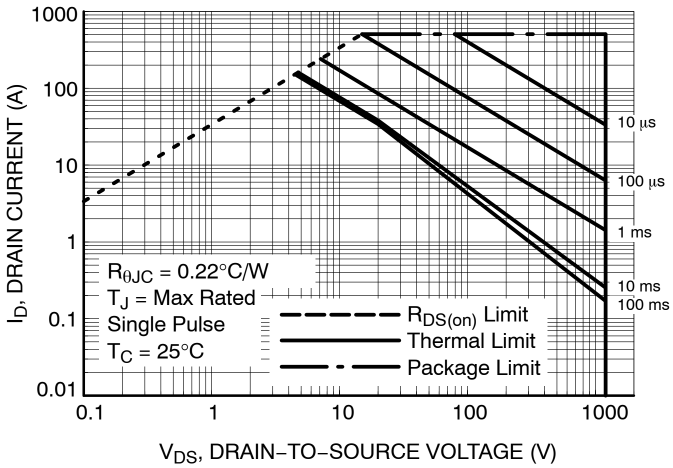


Figure 16. Safe Operating Area

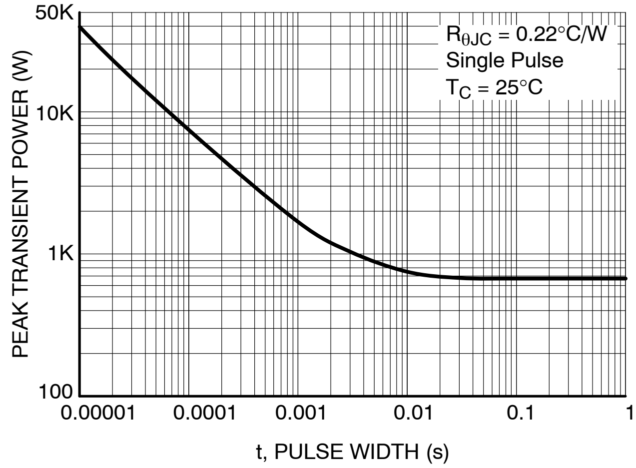


Figure 17. Single Pulse Maximum Power Dissipation

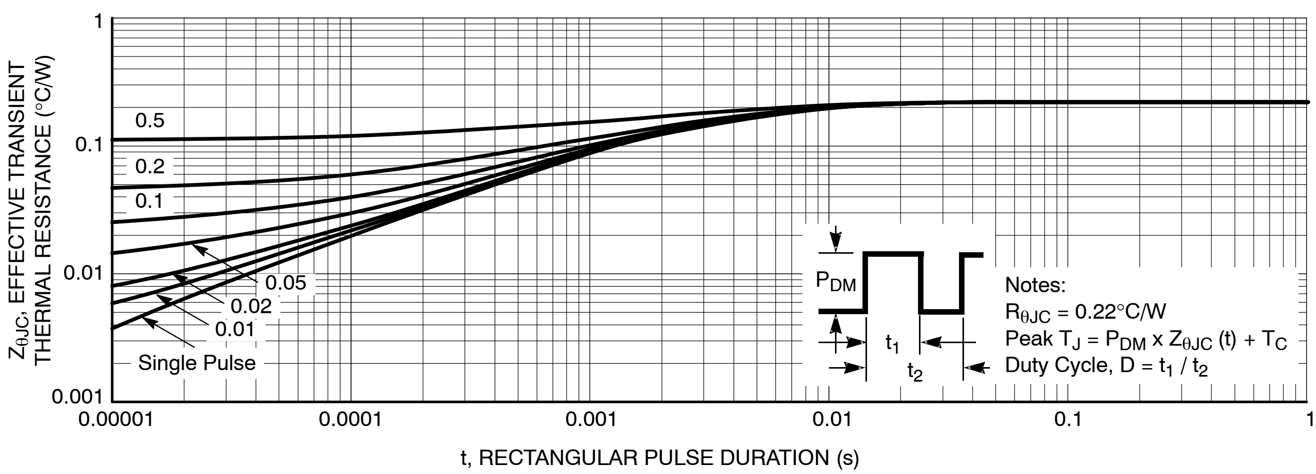


Figure 18. Junction−to−Case Transient Thermal Response

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