

# Silicon Carbide (SiC) MOSFET – EliteSiC, 13 mohm, 1200 V, M3S, Die NTCR013N120M3S

### 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

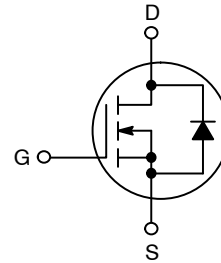
- Typ.  $R_{DS(on)} = 13\text{ m}\Omega @ V_{GS} = 18\text{ V}$
- Low Switching Losses (Typ.  $E_{ON} 563\text{ J at } 75\text{ A, } 800\text{ V}$ )

### Applications

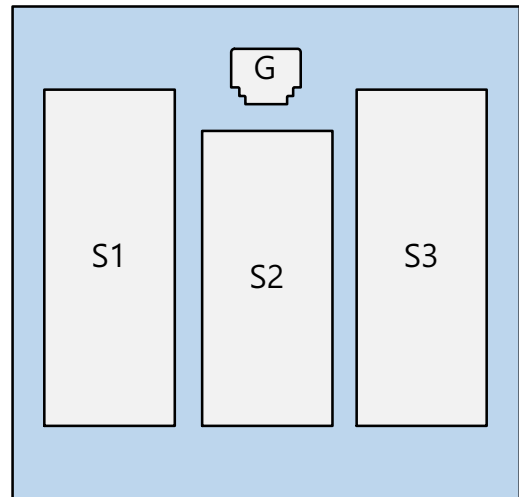
- Solar Inverters
- Electric Vehicle Charging Stations
- Uninterruptible Power Supplies (UPS)
- Energy Storage Systems
- Switch Mode Power Supplies (SMPS)

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

### N-CHANNEL MOSFET



### DIE DIAGRAM

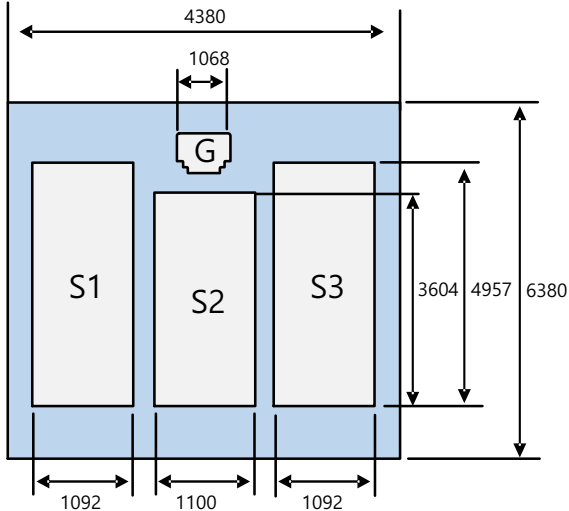


### Die Information

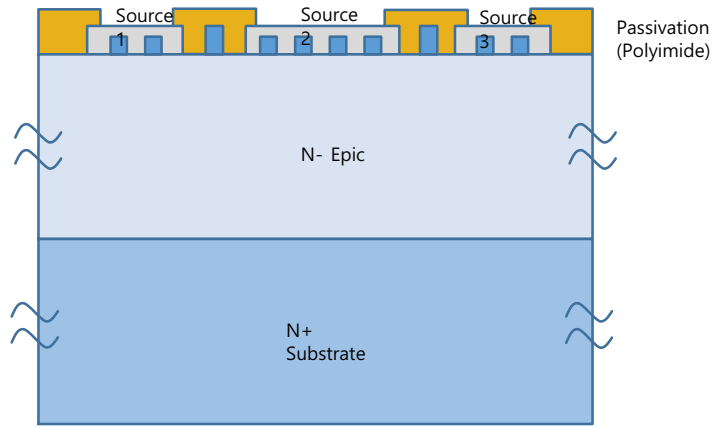
- Wafer Diameter 6 inch
- Die Size 4,380 x 6,380  $\mu\text{m}$
- Metallization
  - Top Al/Si/Cu 5  $\mu\text{m}$
  - Back Ti/NiV/Ag 0.5  $\mu\text{m}$
- Die Thickness Typ. 100  $\mu\text{m}$
- Gate Pad Size 1300 x 1068  $\mu\text{m}$

# NTCR013N120M3S

## Die Layout



## Die Cross Section



## Passivation Information

- Passivation Material: Polyimide (PSP)
- Passivation Type: Local Passivation
- Passivation Thickness 15  $\mu\text{m}$
- : Passivation Area

## Die Layout

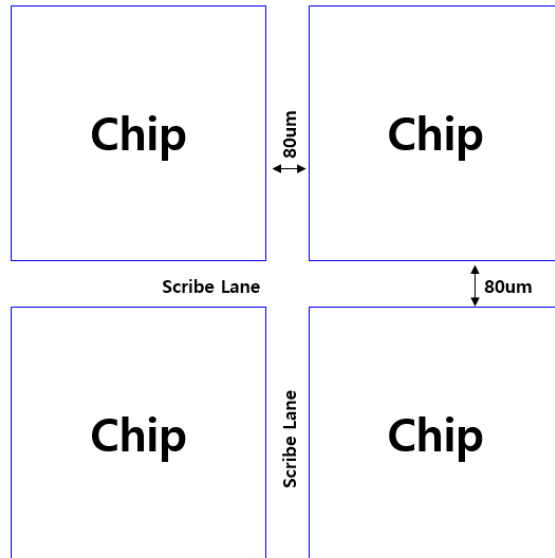


Figure 1. Bare Die Dimensions

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

# NTCR013N120M3S

## 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 ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
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### OFF-STATE CHARACTERISTICS

Drain-to-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	1200	–	–	V
Drain-to-Source Breakdown Voltage Temperature Coefficient	$V_{(BR)DSS}/T_J$	$I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$ (Note 9)	–	0.3	–	V/°C
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 25^\circ\text{C}$	–	–	100	$\mu\text{A}$
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +22/-10\text{ V}, V_{DS} = 0\text{ V}$	–	–	$\pm 1$	$\mu\text{A}$

### ON-STATE CHARACTERISTICS (Note 5)

Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 37\text{ mA}$	2.04	2.8	4.4	V
Recommended Gate Voltage	$V_{GOP}$		–3	–	+18	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 18\text{ V}, I_D = 75\text{ A}, T_J = 25^\circ\text{C}$	–	13	20	m $\Omega$
		$V_{GS} = 18\text{ V}, I_D = 75\text{ A}, T_J = 175^\circ\text{C}$ (Note 9)	–	29	–	
Forward Transconductance	$g_{FS}$	$V_{DS} = 10\text{ V}, I_D = 75\text{ A}$ (Note 9)	–	57	–	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$ (Note 9)	–	5813	–	pF
Output Capacitance	$C_{OSS}$		–	262	–	
Reverse Transfer Capacitance	$C_{RSS}$		–	21	–	
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 75\text{ A}$ (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	$R_G$		$f = 1\text{ MHz}$	–	1.4	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(ON)}$	$V_{GS} = -3/18\text{ V}, V_{DS} = 800\text{ V}, I_D = 75\text{ A}, R_G = 4.7\text{ }\Omega$ 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	–	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		–	390	–	
Total Switching Loss	$E_{tot}$		–	953	–	

### SOURCE-DRAIN DIODE CHARACTERISTICS

Continuous Source-Drain Diode Forward Current	$I_{SD}$	$V_{GS} = -3\text{ V}, T_C = 25^\circ\text{C}$ (Note 9)	–	–	151	A
Pulsed Source-Drain Diode Forward Current (Note 5)	$I_{SDM}$		–	–	505	
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -3\text{ V}, I_{SD} = 75\text{ A}, T_J = 25^\circ\text{C}$	–	4.7	–	V

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## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise specified) (continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
<b>SOURCE-DRAIN DIODE CHARACTERISTICS</b>						
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -3/18\text{ V}$ , $I_{SD} = 75\text{ A}$ , $di_S/dt = 1000\text{ A}/\mu\text{s}$ , $V_{DS} = 800\text{ V}$ (Note 9)	-	29	-	ns
Reverse Recovery Charge	$Q_{RR}$		-	252	-	nC
Reverse Recovery Energy	$E_{REC}$		-	26	-	$\mu\text{J}$
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  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 40\text{ A}$ ,  $V_{DD} = 100\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .
8.  $E_{ON}/E_{OFF}$  result is with body diode.
9. Defined by design, not subject to production test.

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## TYPICAL CHARACTERISTICS

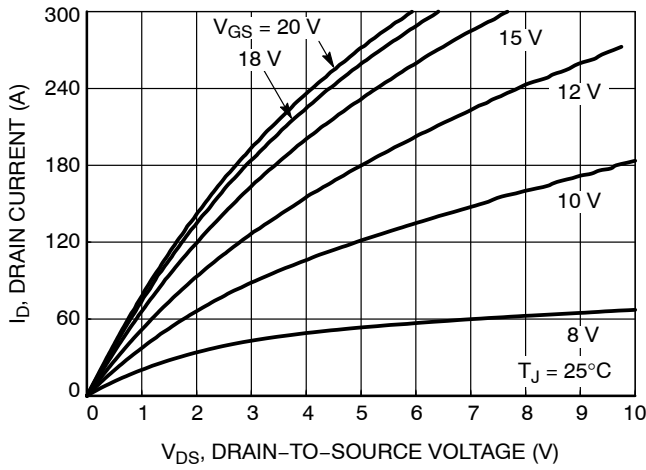


Figure 2. On-Region Characteristics

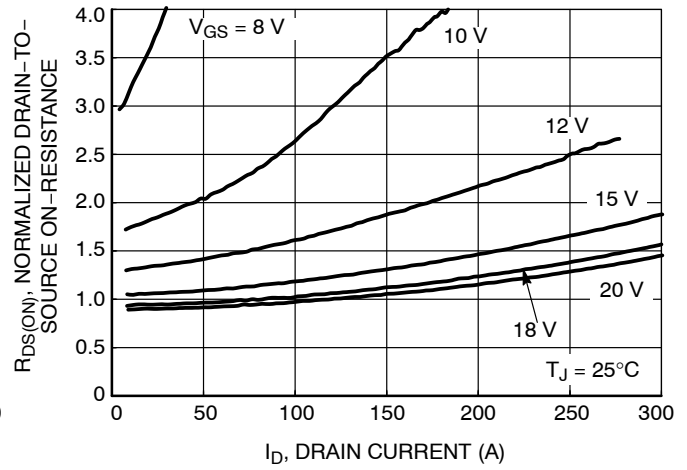


Figure 3. Normalized On-Resistance vs. Drain Current and Gate Voltage

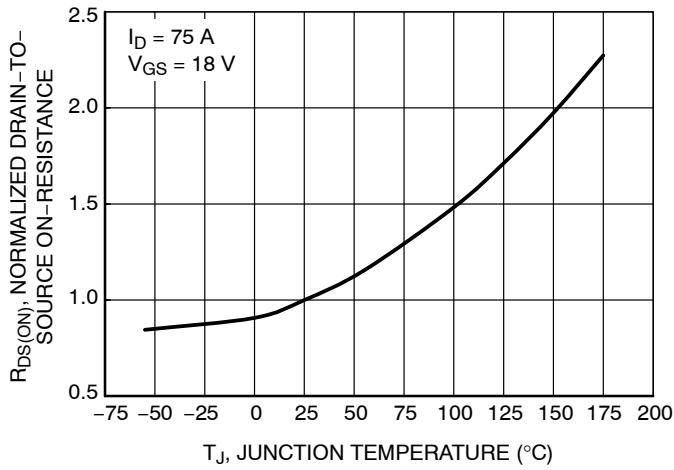


Figure 4. On-Resistance Variation with Temperature

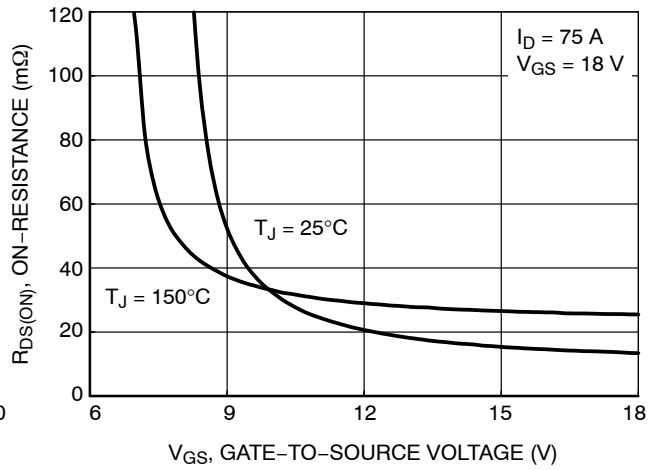


Figure 5. On-Resistance vs. Gate-to-Source Voltage

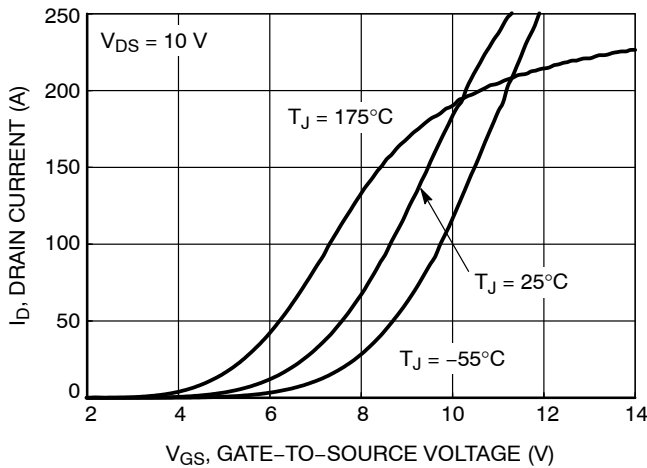


Figure 6. Transfer Characteristics

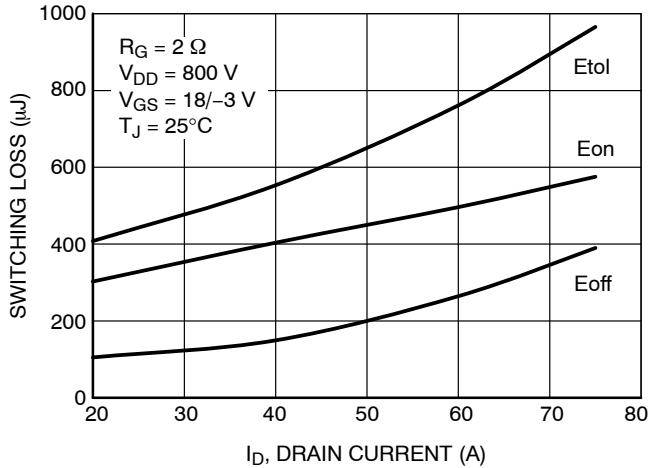
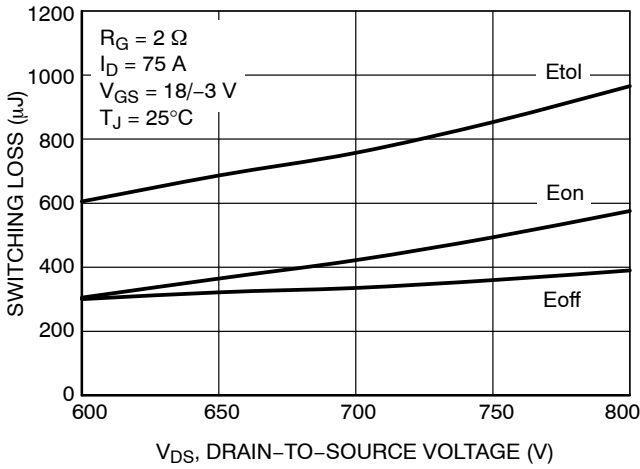


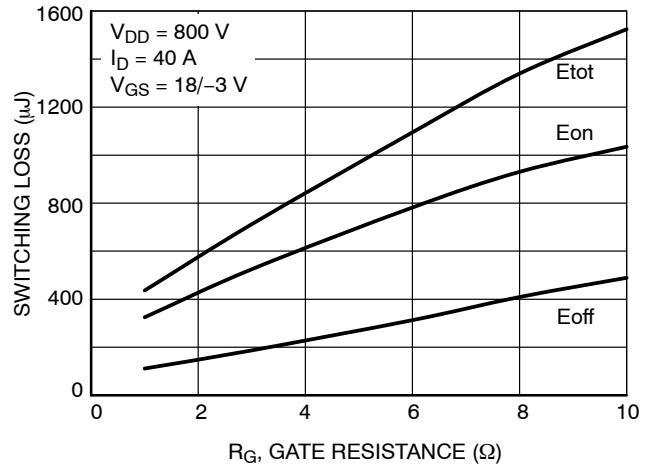
Figure 7. Switching Loss vs. Drain Current

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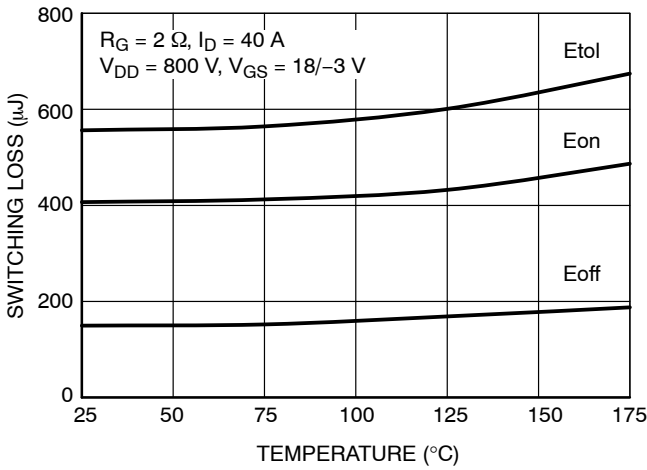
## TYPICAL CHARACTERISTICS



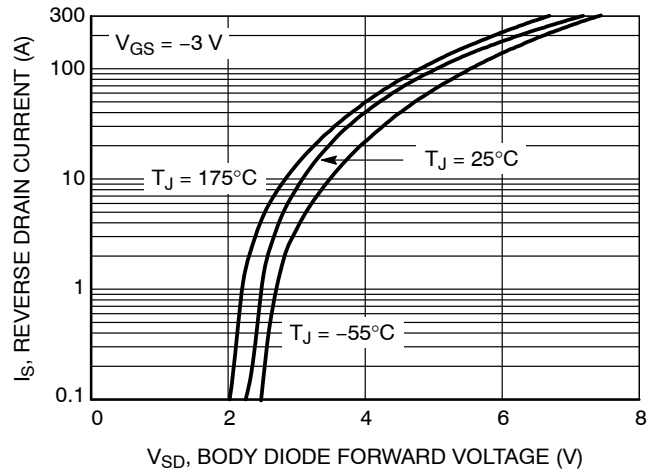
**Figure 8. Switching Loss vs. Drain-to-Source Voltage**



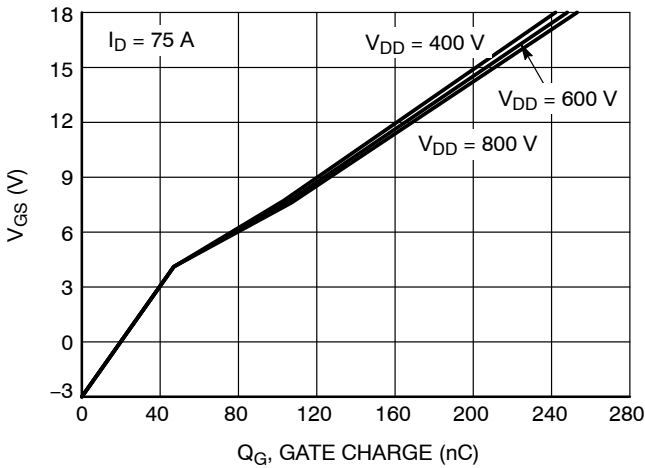
**Figure 9. Switching Loss vs. Gate Resistance**



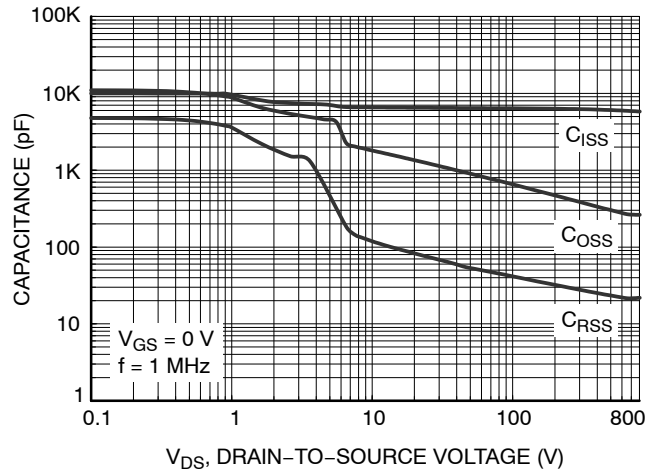
**Figure 10. Switching Loss vs. Temperature**



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



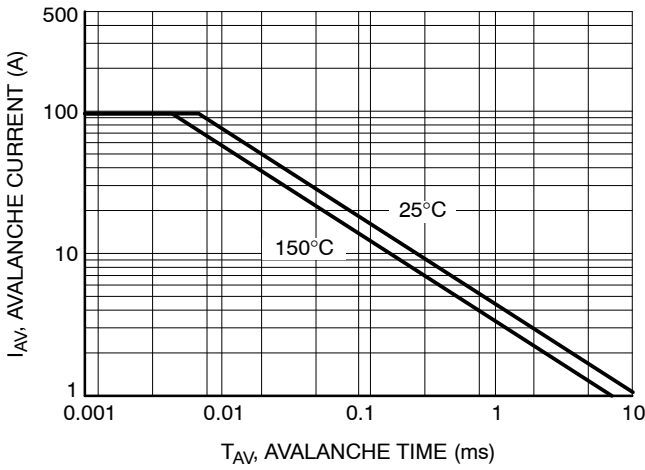
**Figure 12. Gate-to-Source Voltage vs. Total Charge**



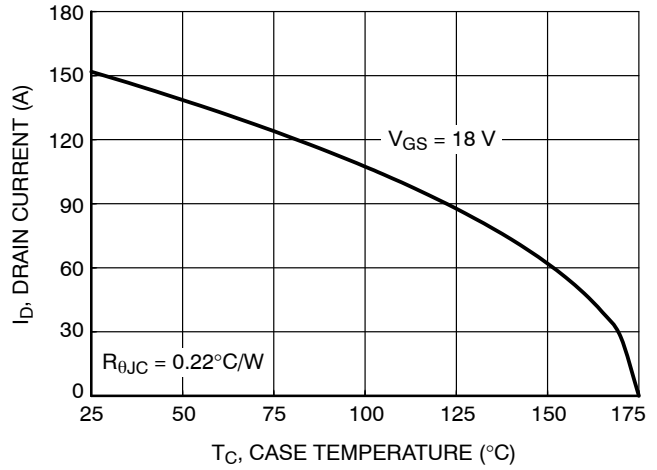
**Figure 13. Capacitance vs. Drain-to-Source Voltage**

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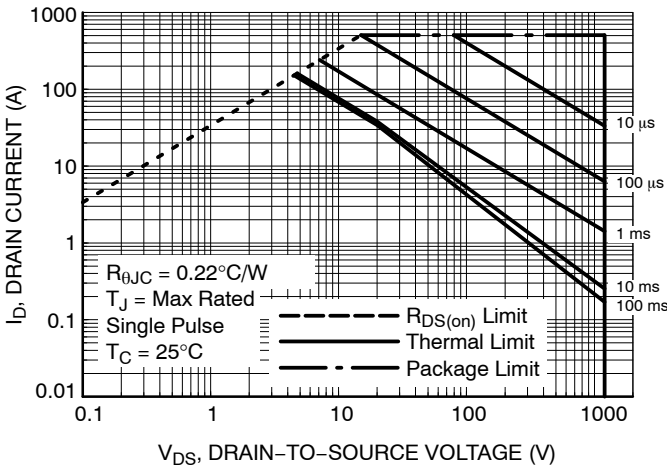
## TYPICAL CHARACTERISTICS



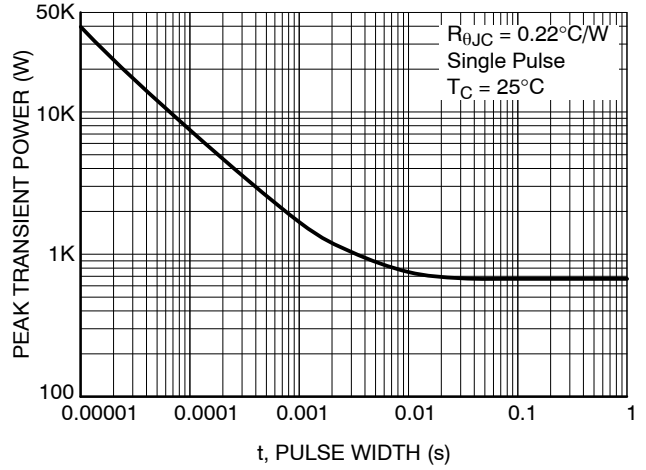
**Figure 14. Unclamped Inductive Switching Capability**



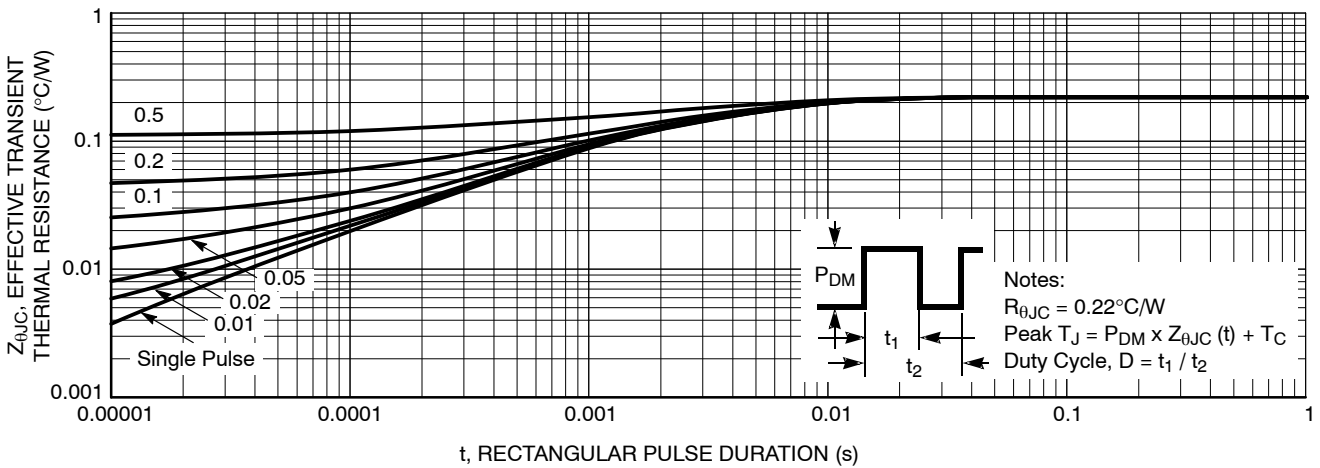
**Figure 15. Maximum Continuous Drain Current vs. Case Temperature**



**Figure 16. Safe Operating Area**



**Figure 17. Single Pulse Maximum Power Dissipation**



**Figure 18. Junction-to-Case Transient Thermal Response**

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