

# Silicon Carbide (SiC) MOSFET – EliteSiC, 40 mohm, 1200 V, M1, Die NTC040N120SC1

### Description

Silicon Carbide (SiC) MOSFET uses a completely new technology that provide 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

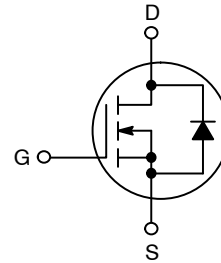
- 1200 V @  $T_J = 175^\circ\text{C}$
- Typ  $R_{DS(on)} = 40\text{ m}\Omega$  at  $V_{GS} = 20\text{ V}$ ,  $I_D = 40\text{ A}$
- High Speed Switching with Low Capacitance
- 100% UIL Tested
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb-Free 2LI (on second level interconnection)

### Applications

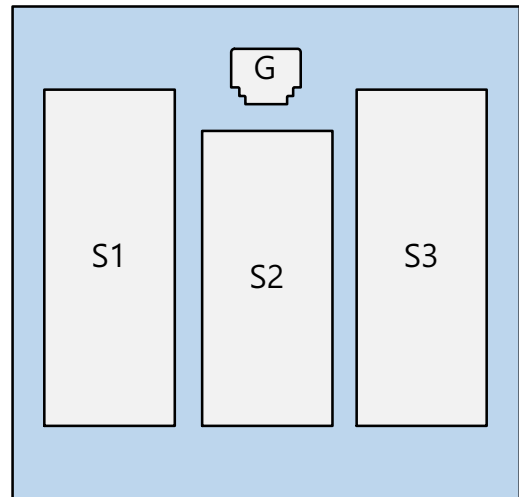
- Industrial Motor Drive
- UPS
- Boost Inverter
- PV Charger

$V_{(BR)DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
1200 V	56 m $\Omega$ @ 20 V	60 A

### N-CHANNEL MOSFET



### DIE DIAGRAM

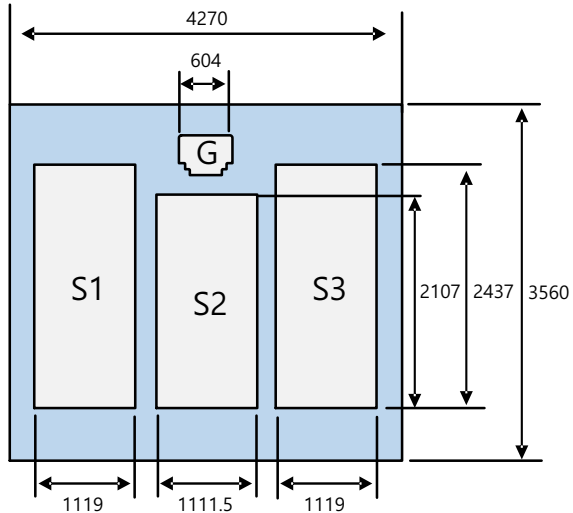


### Die Information

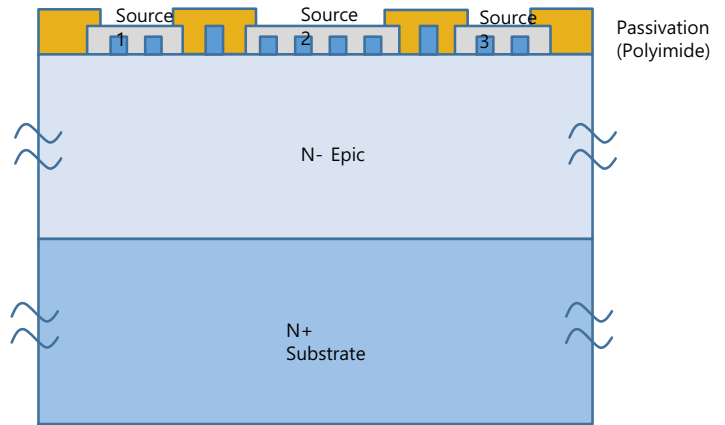
- Wafer Diameter 6 inch
- Die Size 4,270 x 3,560  $\mu\text{m}$
- Metallization
  - Top Ti/TiN/Al 5  $\mu\text{m}$
  - Back Ti/NiV/Ag
- Die Thickness Typ. 200  $\mu\text{m}$
- Gate Pad Size 604 x 415  $\mu\text{m}$

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## Die Layout



## Die Cross Section



## Passivation Information

- Passivation Material: Polyimide (PSP)
- Passivation Type: Local Passivation
- Passivation Thickness 10  $\mu\text{m}$
- : Passivation Area

## Die Layout

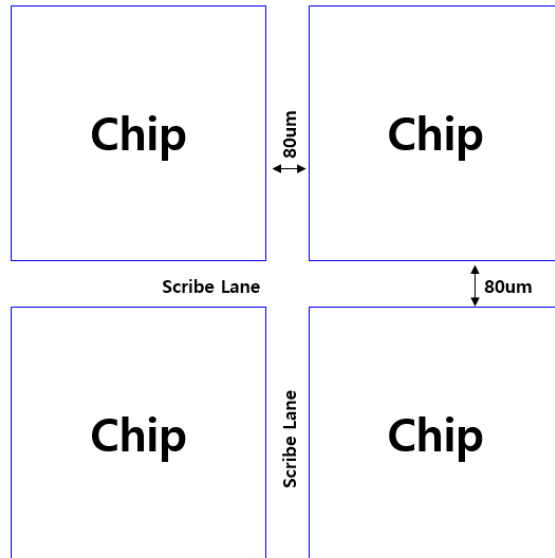


Figure 1. Bare Die Dimensions

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## MAXIMUM RATINGS (T<sub>C</sub> = 25°C unless otherwise noted)

Parameter		Symbol	Value	Unit
Drain-to-Source Voltage		V <sub>DSS</sub>	1200	V
Gate-to-Source Voltage		V <sub>GS</sub>	-15/+25	V
Recommended Operation Values of Gate-to-Source Voltage	T <sub>C</sub> < 175°C	V <sub>GSop</sub>	-5/+20	V
Continuous Drain Current R <sub>θJC</sub>	Steady State T <sub>C</sub> = 25°C	I <sub>D</sub>	60	A
Power Dissipation R <sub>θJC</sub>		P <sub>D</sub>	348	W
Continuous Drain Current R <sub>θJC</sub>	Steady State T <sub>C</sub> = 100°C	I <sub>D</sub>	42	A
Power Dissipation R <sub>θJC</sub>		P <sub>D</sub>	174	W
Pulsed Drain Current (Note 2)	T <sub>C</sub> = 25°C	I <sub>DM</sub>	240	A
Single Pulse Surge Drain Current Capability	T <sub>C</sub> = 25°C, t <sub>p</sub> = 10 μs, R <sub>G</sub> = 4.7 Ω	I <sub>DSC</sub>	416	A
Operating Junction and Storage Temperature Range		T <sub>J</sub> , T <sub>stg</sub>	-55 to +175	°C
Source Current (Body Diode)		I <sub>S</sub>	34	A
Single Pulse Drain-to-Source Avalanche Energy (I <sub>L(pk)</sub> = 35 A, L = 1 mH) (Note 3)		E <sub>AS</sub>	613	mJ

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## THERMAL RESISTANCE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Junction-to-Case (Note 1)	R <sub>θJC</sub>	0.43	°C/W

1. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Repetitive rating, limited by max junction temperature.
3. E<sub>AS</sub> of 613 mJ is based on starting T<sub>J</sub> = 25°C; L = 1 mH, I<sub>AS</sub> = 35 A, V<sub>DD</sub> = 120 V, V<sub>GS</sub> = 20 V.

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
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### OFF 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 $25^\circ\text{C}$	-	450	-	$\text{mV}/^\circ\text{C}$
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 25^\circ\text{C}$	-	-	100	$\mu\text{A}$
		$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 175^\circ\text{C}$	-	-	250	
Gate-to-Source Leakage Current	$I_{GSS}$	$V_{GS} = +25/-15\text{ V}, V_{DS} = 0\text{ V}$	-	-	$\pm 1$	$\mu\text{A}$

### ON CHARACTERISTICS

Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}, I_D = 10\text{ mA}$	1.8	2.97	4.3	V
Recommended Gate Voltage	$V_{GOP}$		-5	-	+20	V
Drain-to-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 25^\circ\text{C}$	-	39	56	$\text{m}\Omega$
		$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 150^\circ\text{C}$	-	60	-	
Forward Transconductance	$g_{FS}$	$V_{DS} = 20\text{ V}, I_D = 35\text{ A}$	-	20	-	S

### CHARGES, CAPACITANCES & GATE RESISTANCE

Input Capacitance	$C_{ISS}$	$V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$	-	1781	-	$\text{pF}$
Output Capacitance	$C_{OSS}$		-	140	-	
Reverse Transfer Capacitance	$C_{RSS}$		-	12	-	
Total Gate Charge	$Q_{G(tot)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 47\text{ A}$	-	106	-	$\text{nC}$
Threshold Gate Charge	$Q_{G(th)}$		-	16	-	
Gate-to-Source Charge	$Q_{GS}$		-	34	-	
Gate-to-Drain Charge	$Q_{GD}$		-	26	-	
Gate Resistance	$R_G$		$f = 1\text{ MHz}$	-	2.2	

### SWITCHING CHARACTERISTICS

Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 47\text{ A}, R_G = 4.7\ \Omega$ , Inductive Load	-	18	-	$\text{ns}$
Rise Time	$t_r$		-	41	-	
Turn-Off Delay Time	$t_{d(off)}$		-	33	-	
Fall Time	$t_f$		-	10.4	-	
Turn-On Switching Loss	$E_{ON}$		-	1003	-	$\mu\text{J}$
Turn-Off Switching Loss	$E_{OFF}$		-	247	-	
Total Switching Loss	$E_{TOT}$		-	1248	-	

### DRAIN-SOURCE DIODE CHARACTERISTICS

Continuous Drain-to-Source Diode Forward Current	$I_{SD}$	$V_{GS} = -5\text{ V}$	-	-	34	A
Pulsed Drain-to-Source Diode Forward Current (Note 2)	$I_{SDM}$	$V_{GS} = -5\text{ V}$	-	-	240	A
Forward Diode Voltage	$V_{SD}$	$V_{GS} = -5\text{ V}, I_{SD} = 17.5\text{ A}$	-	3.8	-	V
Reverse Recovery Time	$t_{RR}$	$V_{GS} = -5/20\text{ V}, I_{SD} = 47\text{ A}, di_S/dt = 1000\text{ A}/\mu\text{s}$	-	24	-	$\text{ns}$
Reverse Recovery Charge	$Q_{RR}$		-	125	-	$\text{nC}$
Reverse Recovery Energy	$E_{REC}$		-	8.5	-	$\mu\text{J}$
Peak Reverse Recovery Current	$I_{RRM}$		-	10.4	-	A
Charge Time	$t_a$		-	12.4	-	$\text{ns}$
Discharge Time	$t_b$		-	11.6	-	$\text{ns}$

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.

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

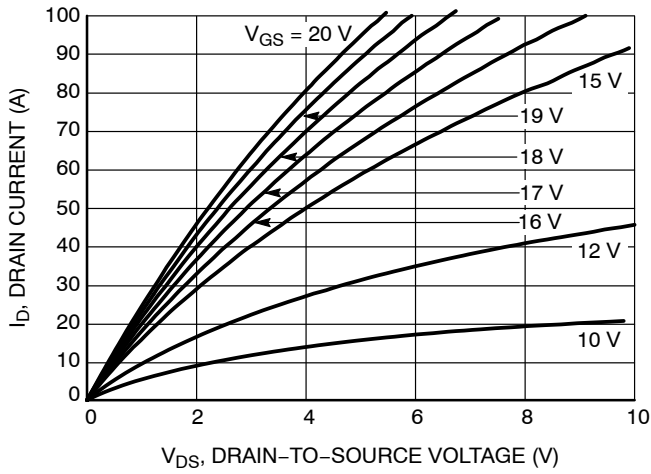


Figure 2. On-Region Characteristics

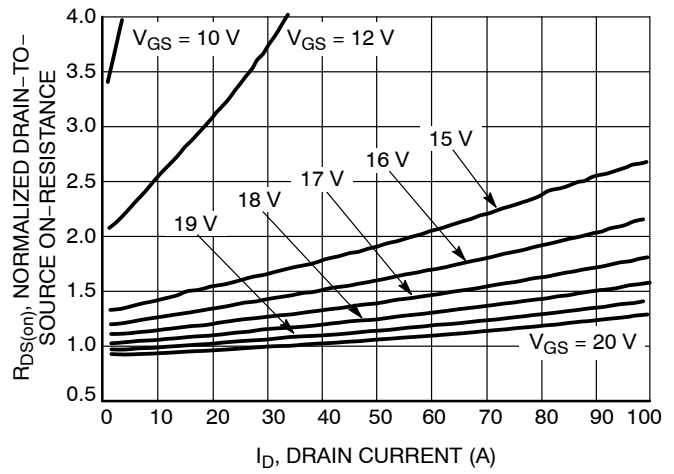


Figure 3. Normalized On-Resistance vs. Drain Current and Gate Voltage

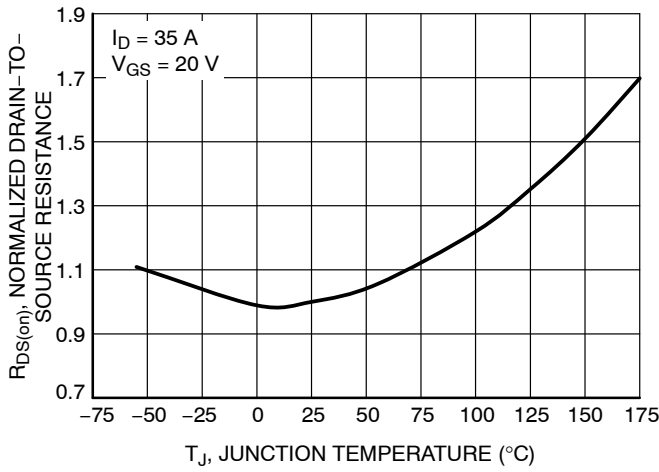


Figure 4. On-Resistance Variation with Temperature

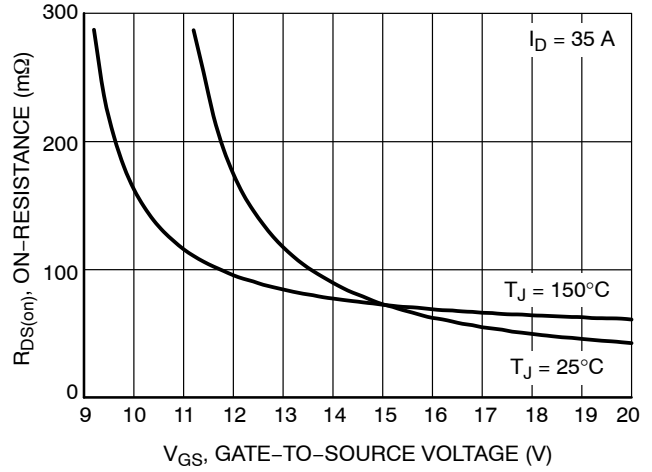


Figure 5. On-Resistance vs. Gate-to-Source Voltage

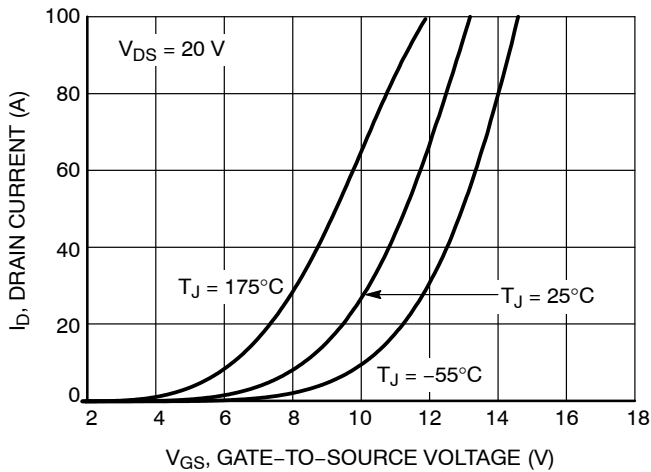


Figure 6. Transfer Characteristics

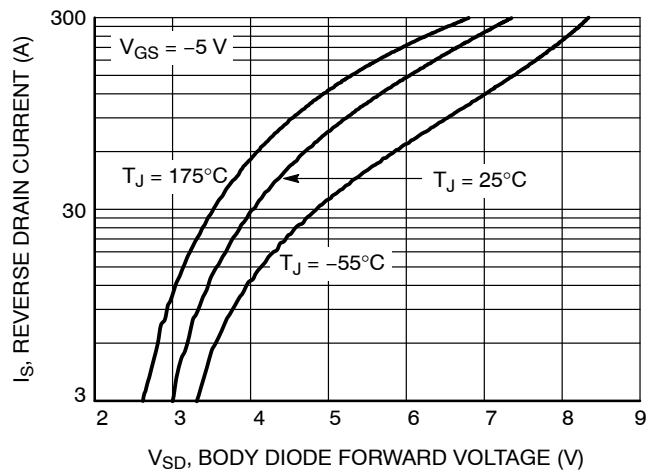
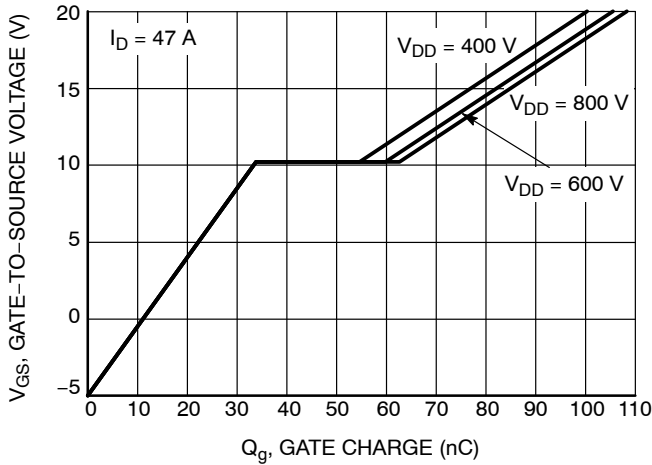


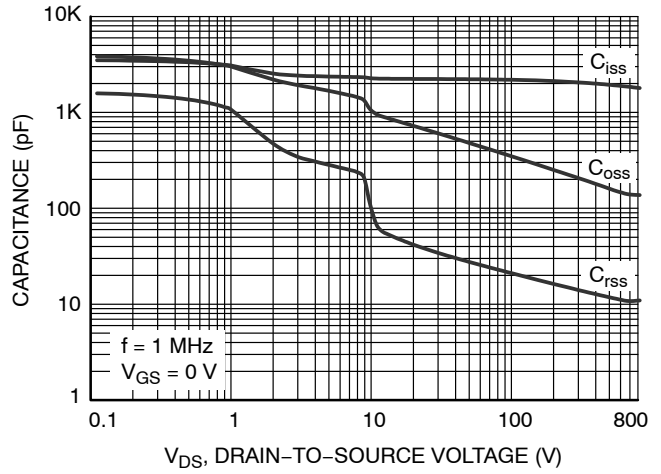
Figure 7. Diode Forward Voltage vs. Current

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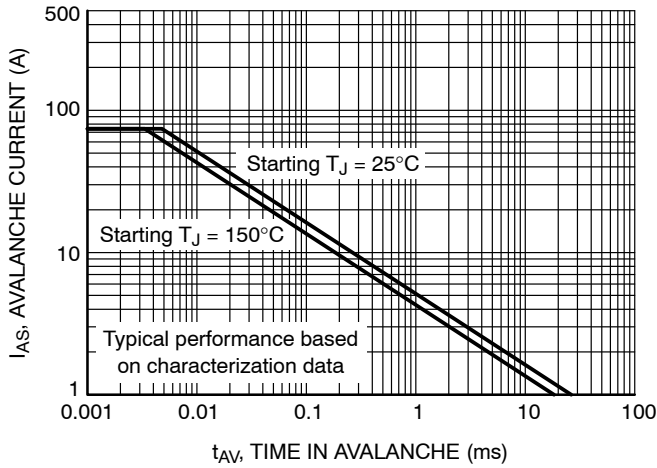
## TYPICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)



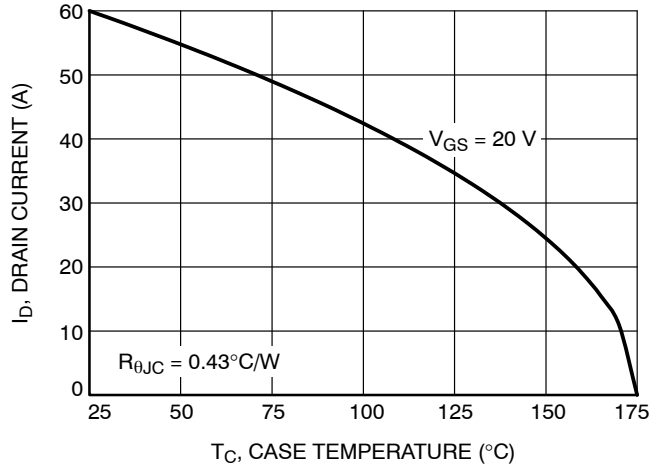
**Figure 8. Gate-to-Source Voltage vs. Total Charge**



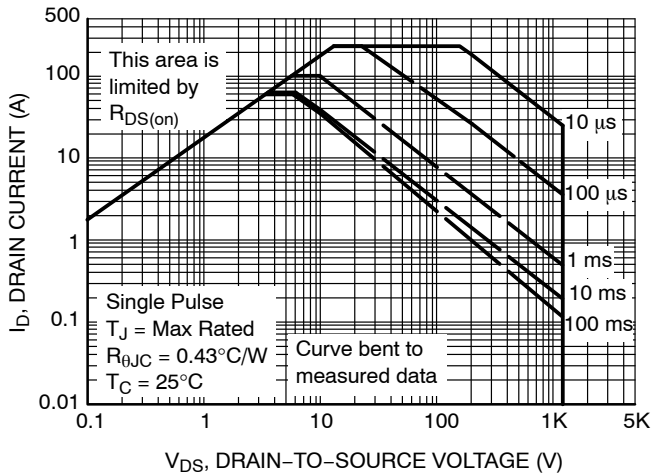
**Figure 9. Capacitance vs. Drain-to-Source Voltage**



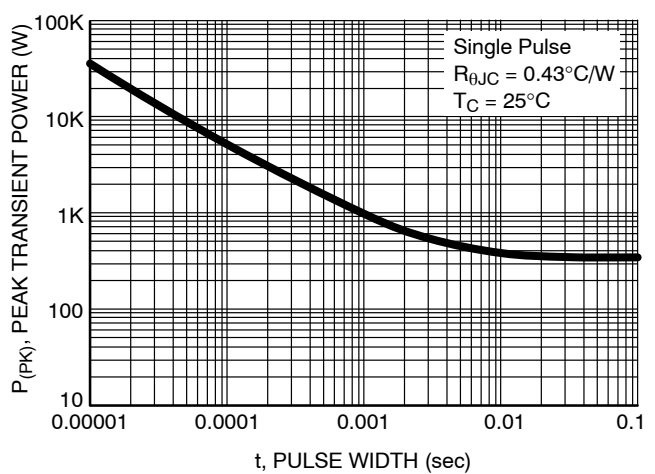
**Figure 10. Unclamped Inductive Switching Capability**



**Figure 11. Maximum Continuous Drain Current vs. Case Temperature**



**Figure 12. Safe Operating Area**



**Figure 13. Single Pulse Maximum Power Dissipation**

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

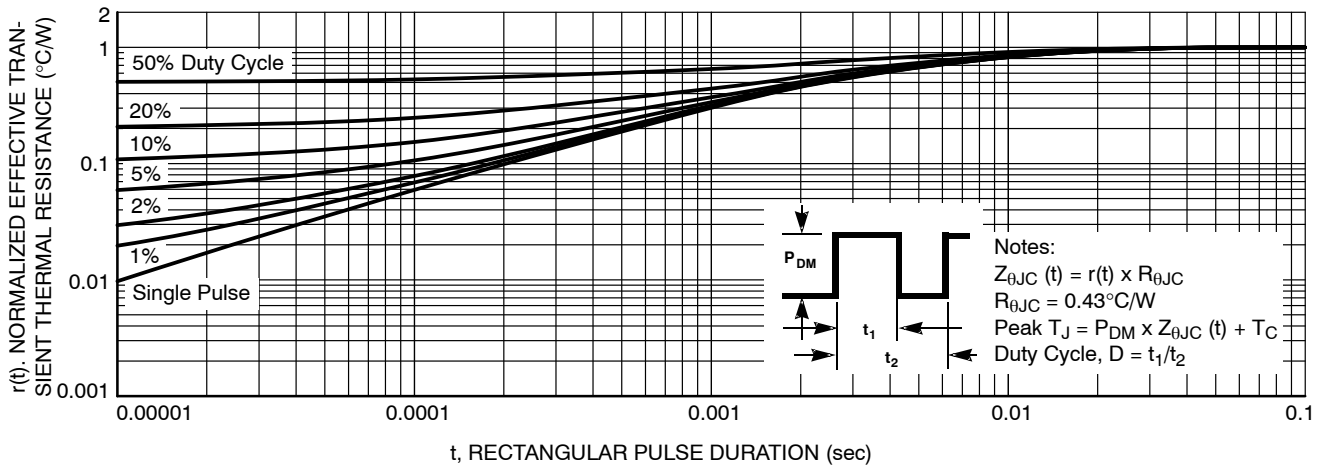


Figure 14. Junction-to-Ambient Thermal Response

### ORDERING INFORMATION AND PACKAGE MARKING

Orderable Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NTC040N120SC1	No Marking	Die	Wafer	N/A	N/A	N/A

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