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MOSFET – N-Channel, Silicon Carbide

1200 V, 40 mΩ

NVC040N120SC1

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
- Qualified According to AEC-Q101 Conditions
- These Devices are Pb-Free and are RoHS Compliant

Applications

- Automotive Traction Inverter
- Automotive DC/DC Converter for EV/HEV

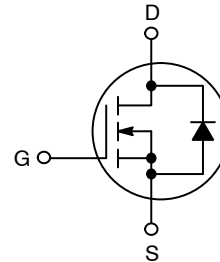


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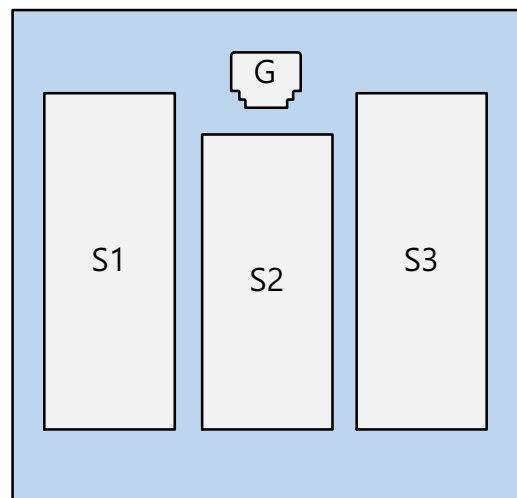
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$V_{(BR)DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
1200 V	56 mΩ @ 20 V	60 A

N-CHANNEL MOSFET



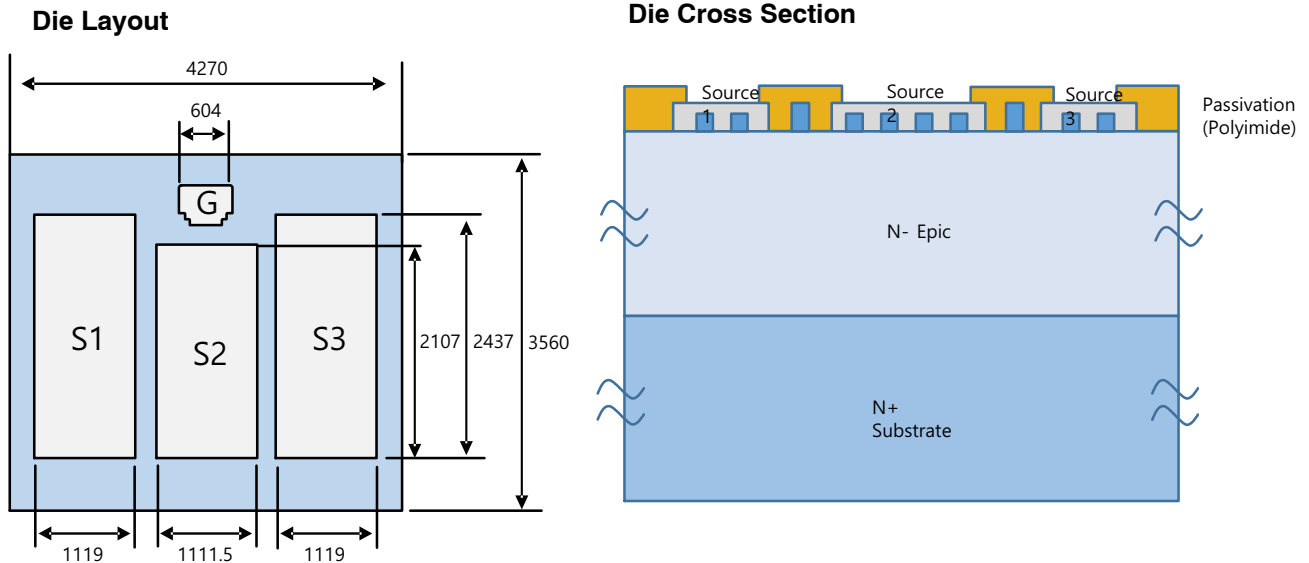
DIE DIAGRAM



Die Information

- Wafer Diameter 6 inch
- Die Size 4,270 x 3,560 μm
- Metallization
 - Top Ti/TiN/Al 5 μm
 - Back Ti/NiV/Ag
- Die Thickness Typ. 200 μm
- Gate Pad Size 604 x 415 μm

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Passivation Information

- Passivation Material: Polyimide (PSP)
- Passivation Type: Local Passivation
- Passivation Thickness 10 μm
- : Passivation Area

Die Layout

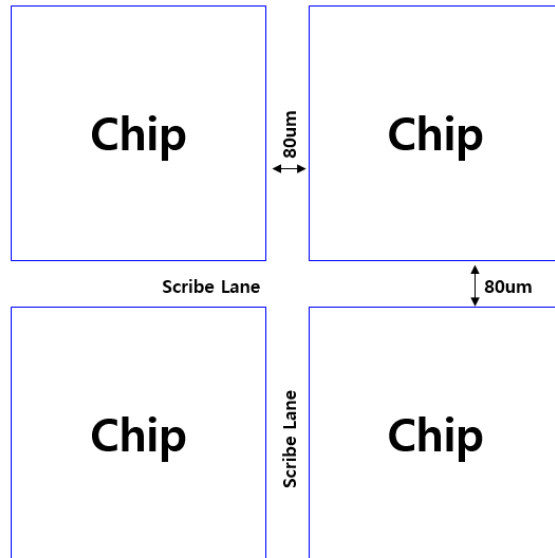


Figure 1. Bare Die Dimensions

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MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Parameter		Symbol	Value	Unit
Drain-to-Source Voltage		V _{DSS}	1200	V
Gate-to-Source Voltage		V _{GS}	-15/+25	V
Recommended Operation Values of Gate-to-Source Voltage	T _C < 175°C	V _{GSop}	-5/+20	V
Continuous Drain Current R _{θJC}	Steady State T _C = 25°C	I _D	60	A
Power Dissipation R _{θJC}		P _D	348	W
Continuous Drain Current R _{θJC}	Steady State T _C = 100°C	I _D	42	A
Power Dissipation R _{θJC}		P _D	174	W
Pulsed Drain Current (Note 2)	T _C = 25°C	I _{DM}	240	A
Single Pulse Surge Drain Current Capability	T _C = 25°C, t _p = 10 μs, R _G = 4.7 Ω	I _{DSC}	416	A
Operating Junction and Storage Temperature Range		T _J , T _{stg}	-55 to +175	°C
Source Current (Body Diode)		I _S	34	A
Single Pulse Drain-to-Source Avalanche Energy (I _{L(pk)} = 35 A, L = 1 mH) (Note 3)		E _{AS}	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 _{θJC}	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_{AS} of 613 mJ is based on starting T_J = 25°C; L = 1 mH, I_{AS} = 35 A, V_{DD} = 120 V, V_{GS} = 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°C	-	450	-	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	μA
		$V_{GS} = 0\text{ V}, V_{DS} = 1200\text{ V}, T_J = 175^\circ\text{C}$	-	-	250	
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = +25/-15\text{ V}, V_{DS} = 0\text{ V}$	-	-	± 1	μA

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	m Ω
		$V_{GS} = 20\text{ V}, I_D = 35\text{ A}, T_J = 150^\circ\text{C}$	-	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	-	μF
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	-	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	$t_{d(on)}$	$V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 47\text{ A}, R_G = 4.7\text{ }\Omega$, Inductive Load	-	18	-	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	-	μJ
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	-	ns
Reverse Recovery Charge	Q_{RR}		-	125	-	nC
Reverse Recovery Energy	E_{REC}		-	8.5	-	μJ
Peak Reverse Recovery Current	I_{RRM}		-	10.4	-	A
Charge Time	t_a		-	12.4	-	ns
Discharge Time	t_b		-	11.6	-	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)

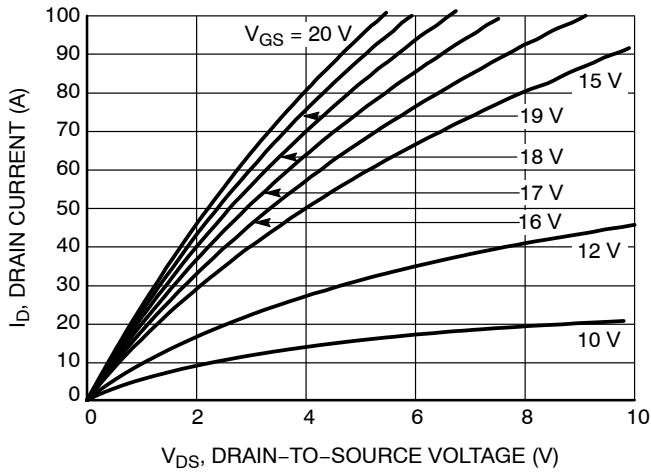


Figure 2. On-Region Characteristics

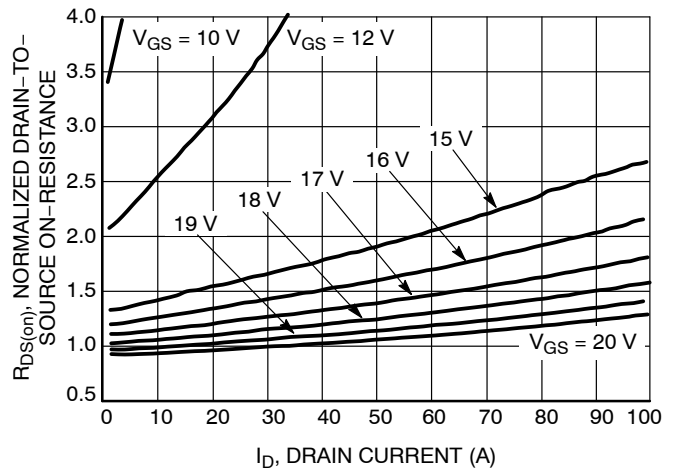


Figure 3. Normalized On-Resistance vs. Drain Current and Gate Voltage

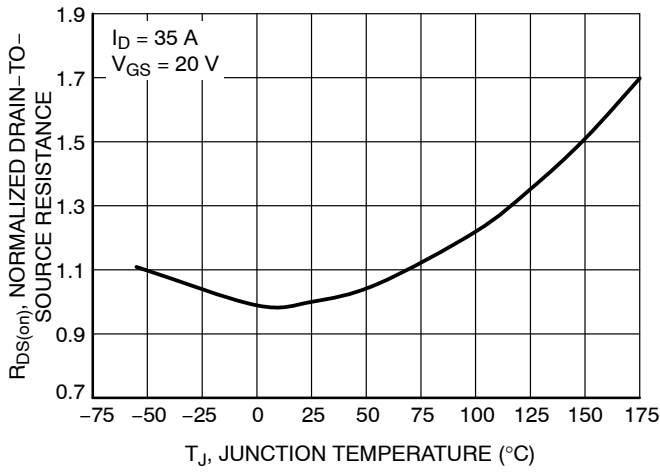


Figure 4. On-Resistance Variation with Temperature

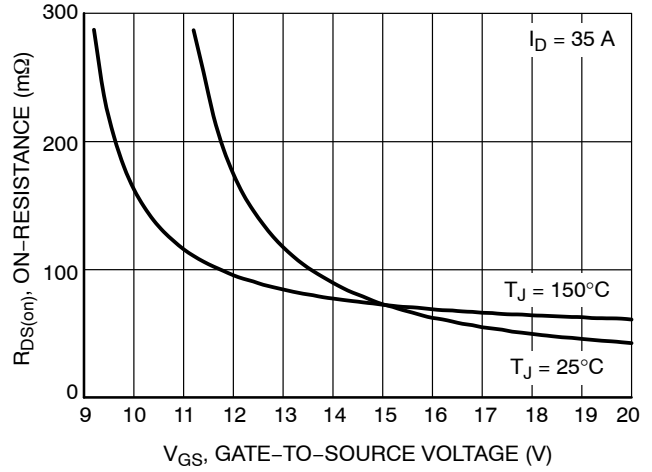


Figure 5. On-Resistance vs. Gate-to-Source Voltage

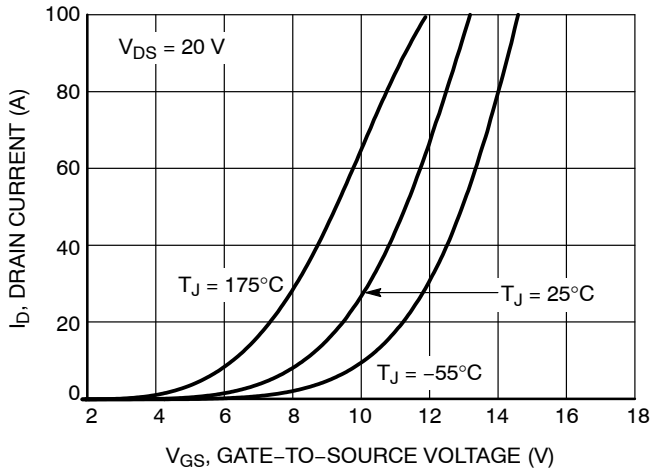


Figure 6. Transfer Characteristics

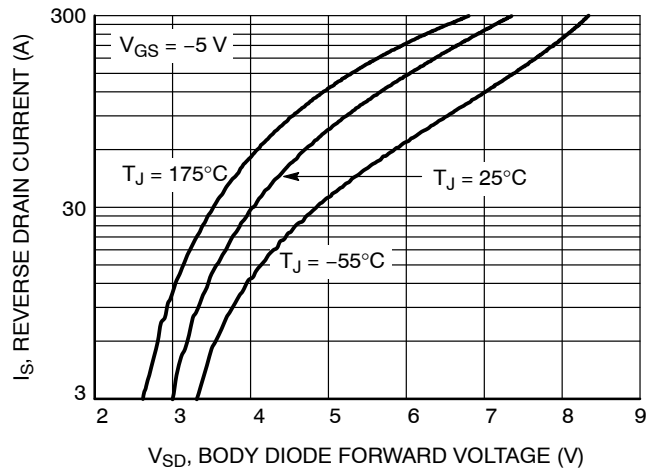


Figure 7. Diode Forward Voltage vs. Current

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

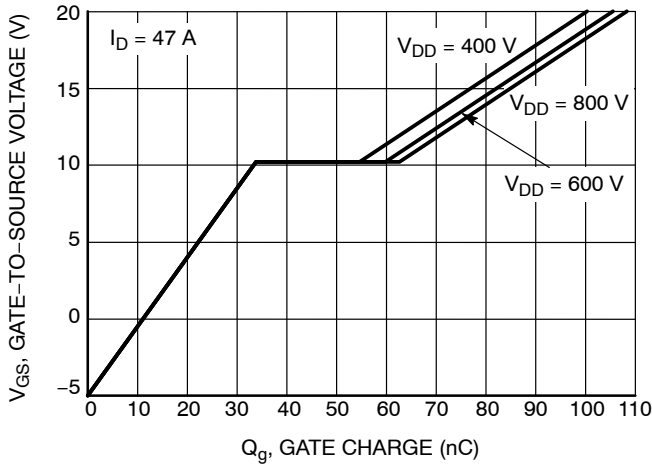


Figure 8. Gate-to-Source Voltage vs. Total Charge

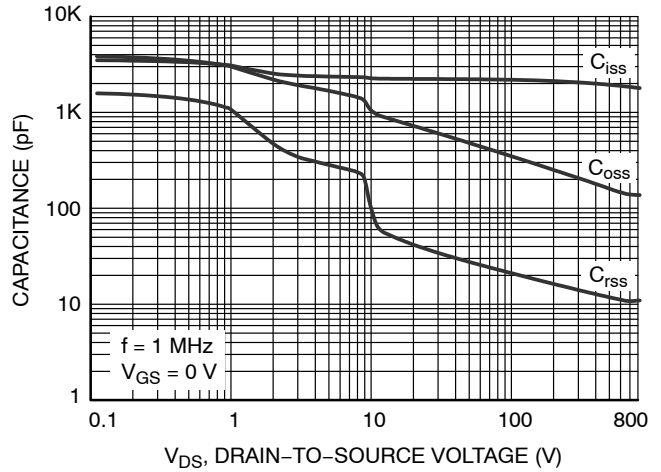


Figure 9. Capacitance vs. Drain-to-Source Voltage

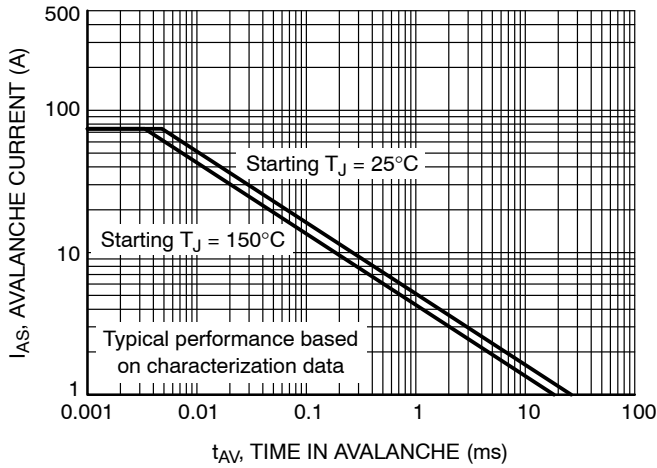


Figure 10. Unclamped Inductive Switching Capability

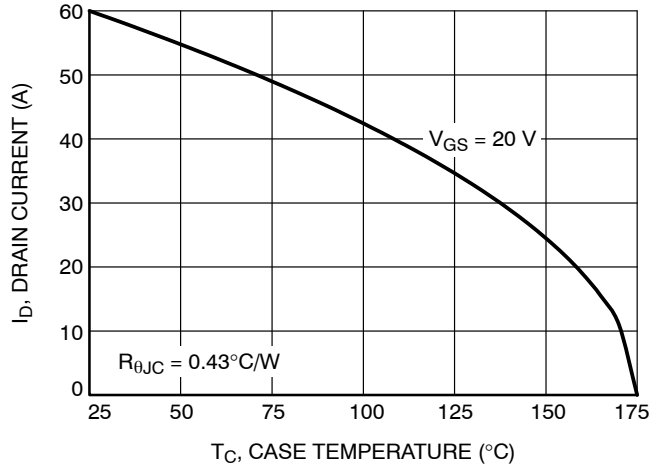


Figure 11. Maximum Continuous Drain Current vs. Case Temperature

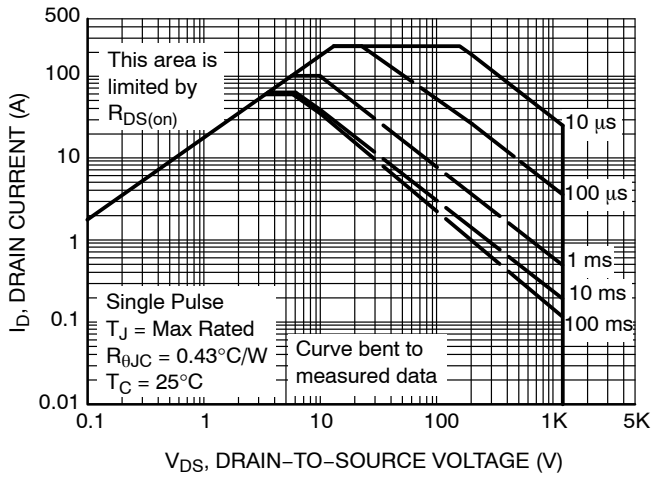


Figure 12. Safe Operating Area

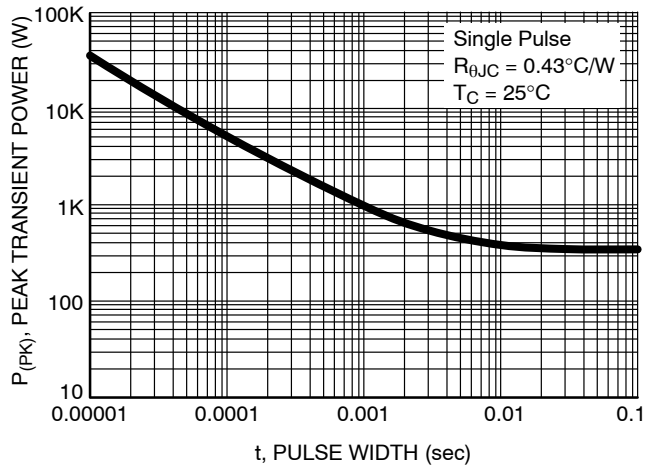


Figure 13. Single Pulse Maximum Power Dissipation

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

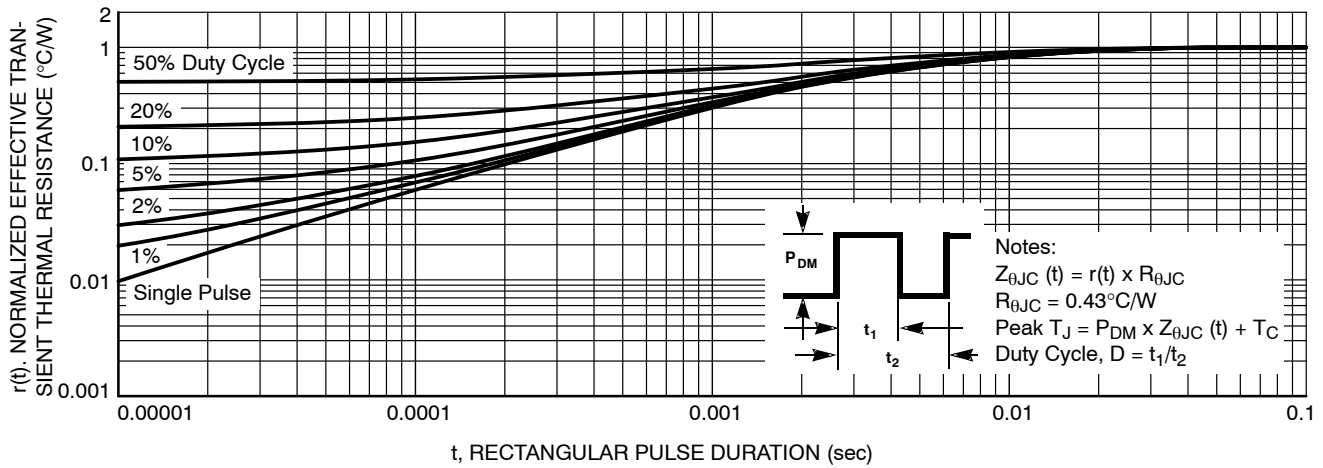


Figure 14. Junction-to-Ambient Thermal Response

ORDERING INFORMATION AND PACKAGE MARKING

Orderable Part Number	Top Marking	Package	Packing Method	Reel Size	Tape Width	Quantity
NVC040N120SC1	No Marking	Die	Wafer	N/A	N/A	N/A

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