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# MOSFET – N-Channel, Silicon Carbide

## 1200 V, 80 mΩ

### NVC080N120SC1

#### 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  $R_{DS(on)} = 80\text{ m}\Omega$  at  $V_{GS} = 20\text{ V}$ ,  $I_D = 20\text{ A}$
- High Speed Switching with Low Capacitance
- 100% UIL Tested
- Qualified According to AEC-Q101
- These Devices are Pb-Free and are RoHS Compliant

#### Applications

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

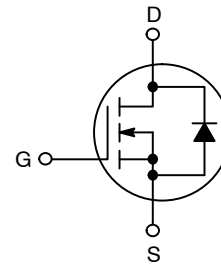


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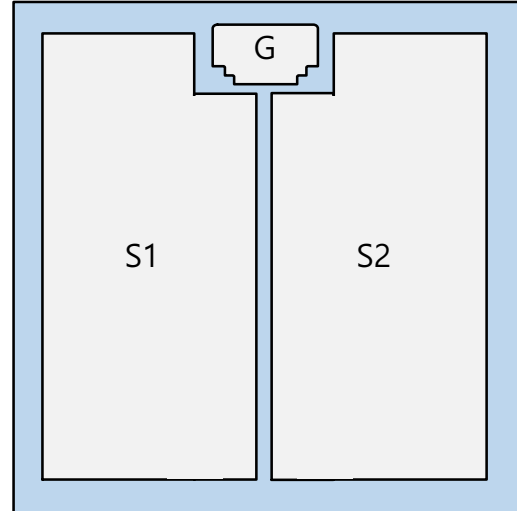
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| $V_{(BR)DSS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|---------------|-------------------------|------------------|
| 1200 V        | 110 mΩ @ 20 V           | 31 A             |

#### N-CHANNEL MOSFET



#### DIE DIAGRAM

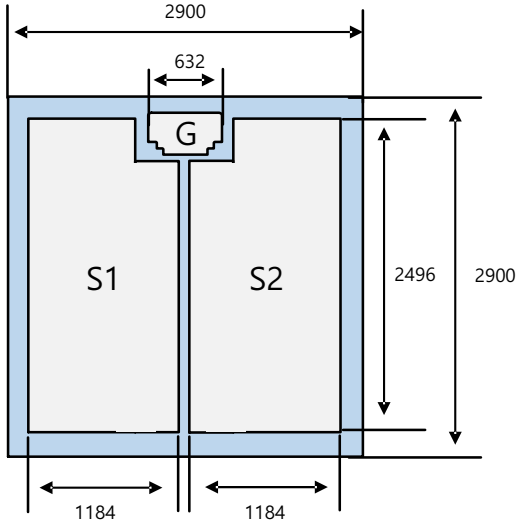


#### Die Information

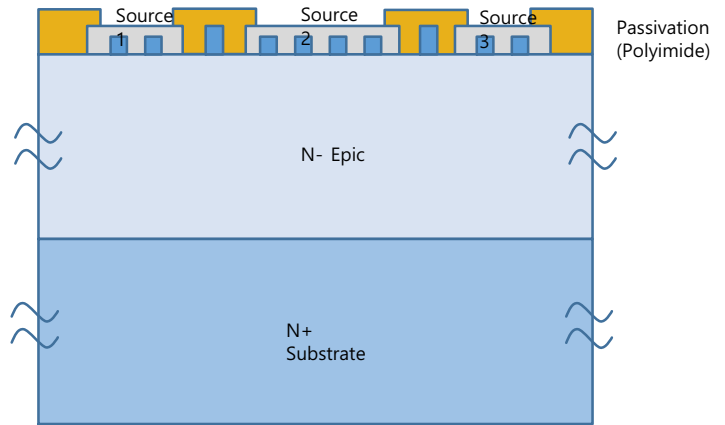
- Wafer Diameter 6 inch
- Die Size 2,900 x 2,900 μm
- Metallization
  - Top Ti/TiN/Al 5 μm
  - Back Ti/V/Ni/Ag
- Die Thickness Typ. 200 μm
- Gate Pad Size 632 x 242.5 μm

# NVC080N120SC1

## 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

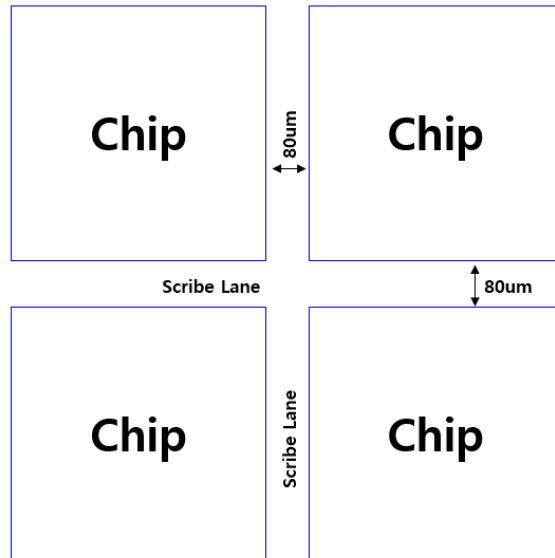


Figure 1. Bare Die Dimensions

# NVC080N120SC1

## 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<br>T <sub>C</sub> = 25°C                                 | I <sub>D</sub>                    | 31          | A    |
| Power Dissipation R <sub>θJC</sub>   |   | P <sub>D</sub>                    | 178         | W    |
| Continuous Drain Current R <sub>θJC</sub>  | Steady State<br>T <sub>C</sub> = 100°C                                | I <sub>D</sub>                    | 22          | A    |
| Power Dissipation R <sub>θJC</sub>   |   | P <sub>D</sub>                    | 89          | W    |
| Pulsed Drain Current (Note 2)  | T <sub>C</sub> = 25°C   | I <sub>DM</sub>                   | 132         | 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>                  | 132         | 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>                    | 18          | A    |
| Single Pulse Drain-to-Source Avalanche Energy (I <sub>L(pk)</sub> = 18.5 A, L = 1 mH) (Note 3) |   | E <sub>AS</sub>                   | 171         | 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> | 0.84  | °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 171 mJ is based on starting T<sub>J</sub> = 25°C; L = 1 mH, I<sub>AS</sub> = 18.5 A, V<sub>DD</sub> = 120 V, V<sub>GS</sub> = 18 V.

# NVC080N120SC1

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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

### 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 $25^\circ\text{C}$                 | -    | 700 | -       | 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     | $\mu\text{A}$        |
| 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        | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = 5\text{ mA}$                               | 1.8 | 2.7 | 4.3 | V          |
| Recommended Gate Voltage      | $V_{GOP}$    |  | -5  | -   | +20 | V          |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 20\text{ V}, I_D = 20\text{ A}, T_J = 25^\circ\text{C}$  | -   | 80  | 110 | m $\Omega$ |
|                               |              | $V_{GS} = 20\text{ V}, I_D = 20\text{ A}, T_J = 150^\circ\text{C}$ | -   | 114 | -   |            |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 20\text{ V}, I_D = 20\text{ A}$                          | -   | 13  | -   | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |   |   |      |   |          |
|------------------------------|--------------|---|---|------|---|----------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$      | - | 1112 | - | pF       |
| Output Capacitance           | $C_{OSS}$    |   | - | 80   | - |          |
| Reverse Transfer Capacitance | $C_{RSS}$    |   | - | 6.5  | - |          |
| Total Gate Charge            | $Q_{G(tot)}$ | $V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 20\text{ A}$ | - | 56   | - | nC       |
| Gate-to-Source Charge        | $Q_{GS}$     |   | - | 11   | - |          |
| Gate-to-Drain Charge         | $Q_{GD}$     |   | - | 12   | - |          |
| Gate Resistance              | $R_G$        | $f = 1\text{ MHz}$  | - | 1.7  | - | $\Omega$ |

### SWITCHING CHARACTERISTICS

|                         |              |   |   |     |   |               |
|-------------------------|--------------|---|---|-----|---|---------------|
| Turn-On Delay Time      | $t_{d(on)}$  | $V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 20\text{ A}, R_G = 4.7\text{ }\Omega$ , Inductive Load | - | 13  | - | ns            |
| Rise Time               | $t_r$        |   | - | 20  | - |               |
| Turn-Off Delay Time     | $t_{d(off)}$ |   | - | 22  | - |               |
| Fall Time               | $t_f$        |   | - | 10  | - |               |
| Turn-On Switching Loss  | $E_{ON}$     |   | - | 258 | - | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |   | - | 52  | - |               |
| Total Switching Loss    | $E_{TOT}$    |   | - | 311 | - |               |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|   |           |  |   |    |     |               |
|---|-----------|--|---|----|-----|---------------|
| Continuous Drain-to-Source Diode Forward Current      | $I_{SD}$  | $V_{GS} = -5\text{ V}$   | - | -  | 18  | A             |
| Pulsed Drain-to-Source Diode Forward Current (Note 2) | $I_{SDM}$ | $V_{GS} = -5\text{ V}$   | - | -  | 132 | A             |
| Forward Diode Voltage                                 | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 10\text{ A}$   | - | 4  | -   | V             |
| Reverse Recovery Time                                 | $t_{RR}$  | $V_{GS} = -5/20\text{ V}, I_{SD} = 20\text{ A}, dI_S/dt = 1000\text{ A}/\mu\text{s}$ | - | 16 | -   | ns            |
| Reverse Recovery Charge                               | $Q_{RR}$  |  | - | 62 | -   | nC            |
| Reverse Recovery Energy                               | $E_{REC}$ |  | - | 5  | -   | $\mu\text{J}$ |
| Peak Reverse Recovery Current                         | $I_{RRM}$ |  | - | 8  | -   | A             |

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.

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

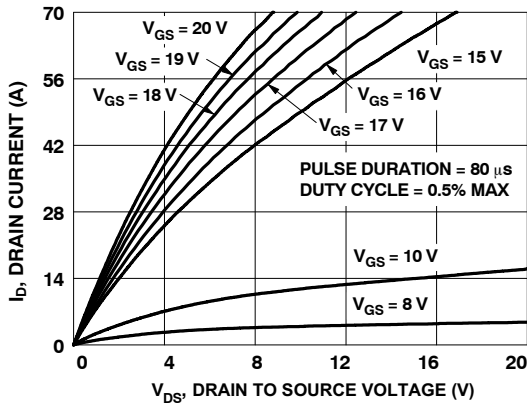


Figure 2. On Region Characteristics

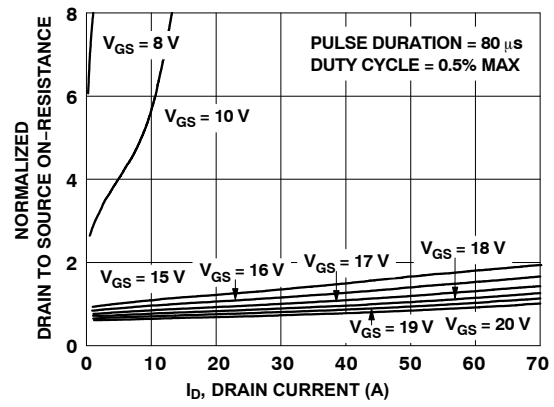


Figure 3. Normalized On-Resistance vs. Drain Current and Gate Voltage

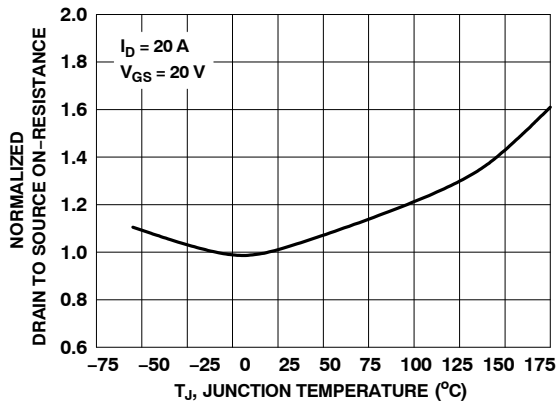


Figure 4. Normalized On Resistance vs. Junction Temperature

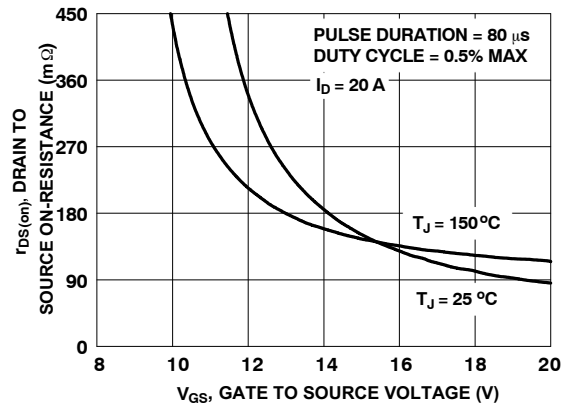


Figure 5. On-Resistance vs. Gate-to-Source Voltage

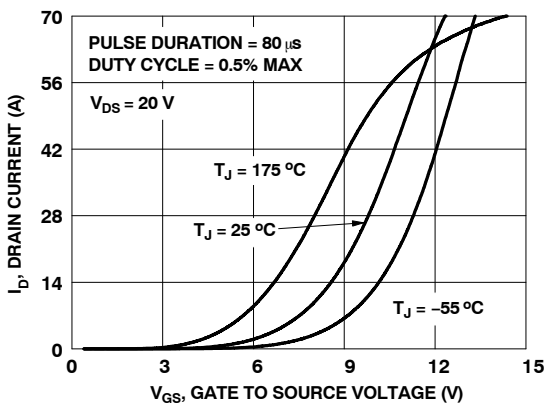


Figure 6. Transfer Characteristics

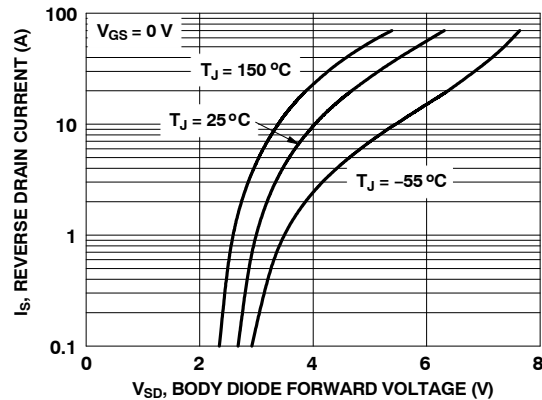


Figure 7. Source-to-Drain Diode Forward Voltage vs. Source Current

# NVC080N120SC1

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

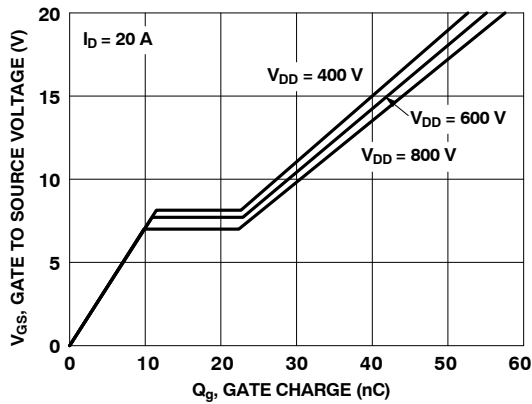


Figure 8. Gate Charge Characteristics

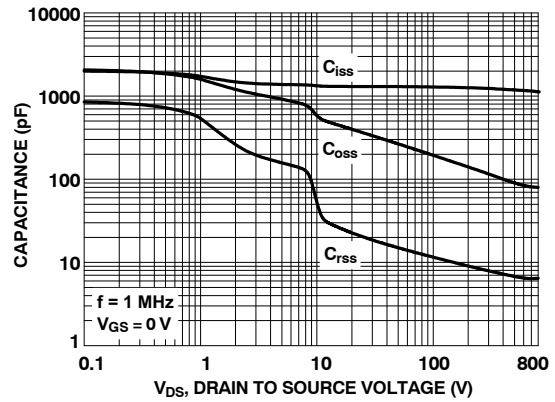


Figure 9. Capacitance vs. Drain-to-Source Voltage

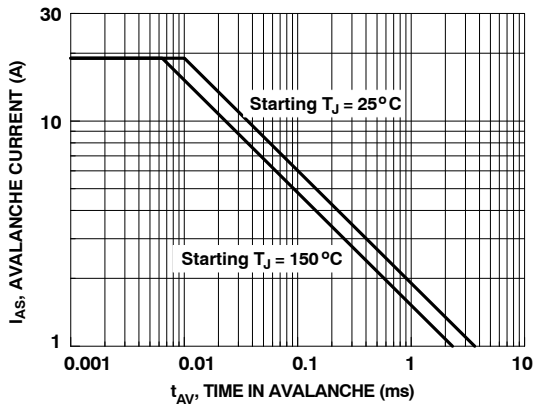


Figure 10. Unclamped Inductive Switching Capability

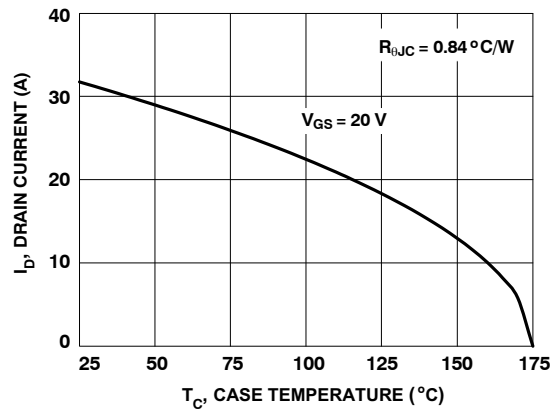


Figure 11. Maximum Continuous Drain Current vs. Case Temperature

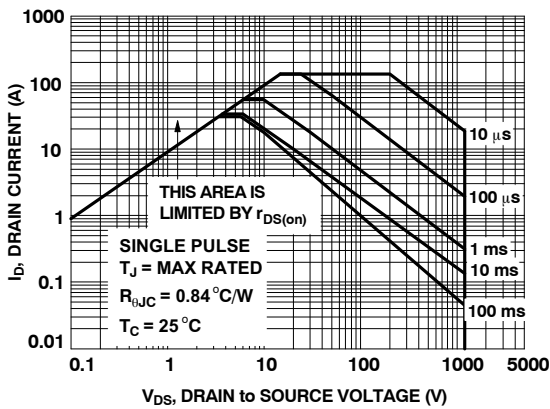


Figure 12. Forward Bias Safe Operating Area

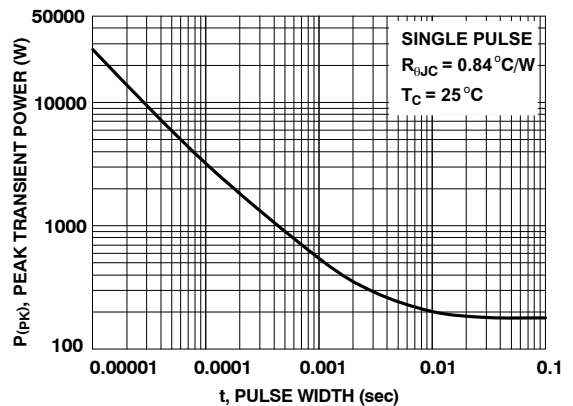


Figure 13. Single Pulse Maximum Power Dissipation

# NVC080N120SC1

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

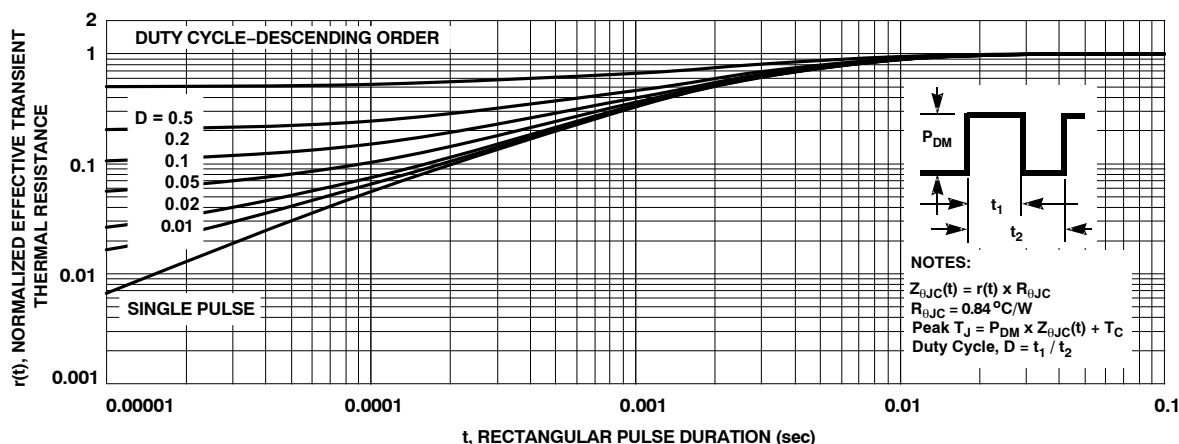


Figure 14. Junction-to-Case Transient Thermal Response Curve

### ORDERING INFORMATION AND PACKAGE MARKING

| Orderable Part Number | Top Marking | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-----------------------|-------------|---------|----------------|-----------|------------|----------|
| NVC080N120SC1         | N/A         | Die     | Wafer          | N/A       | N/A        | N/A      |

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