

# Silicon Carbide (SiC) MOSFET – 160 mohm, 1200 V, M1, Bare Die

## NTC160N120SC1

### 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

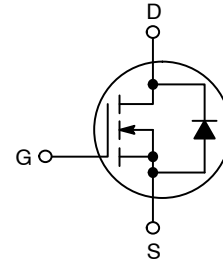
- 1200 V @  $T_J = 175^\circ\text{C}$
- Typ  $R_{DS(on)} = 160\text{ m}\Omega$  at  $V_{GS} = 20\text{ V}$ ,  $I_D = 10\text{ A}$
- High Speed Switching with Low Capacitance
- 100% UIL Tested
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb-Free 2LI (on second level interconnection)

### Applications

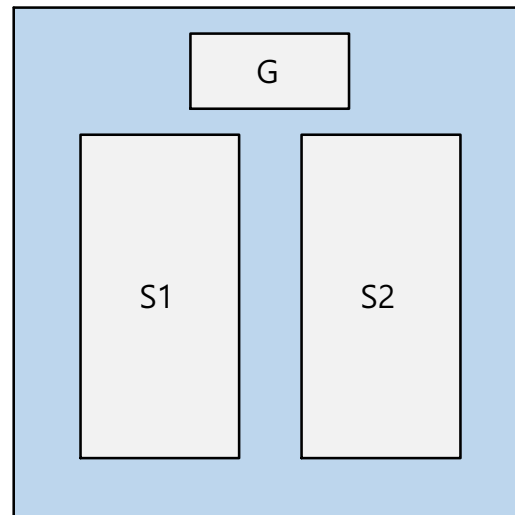
- Industrial Motor Drive
- UPS
- Boost Inverter
- PV Charger

| $V_{(BR)DSS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|---------------|-------------------------|------------------|
| 1200 V        | 224 m $\Omega$ @ 20 V   | 17 A             |

### N-CHANNEL MOSFET



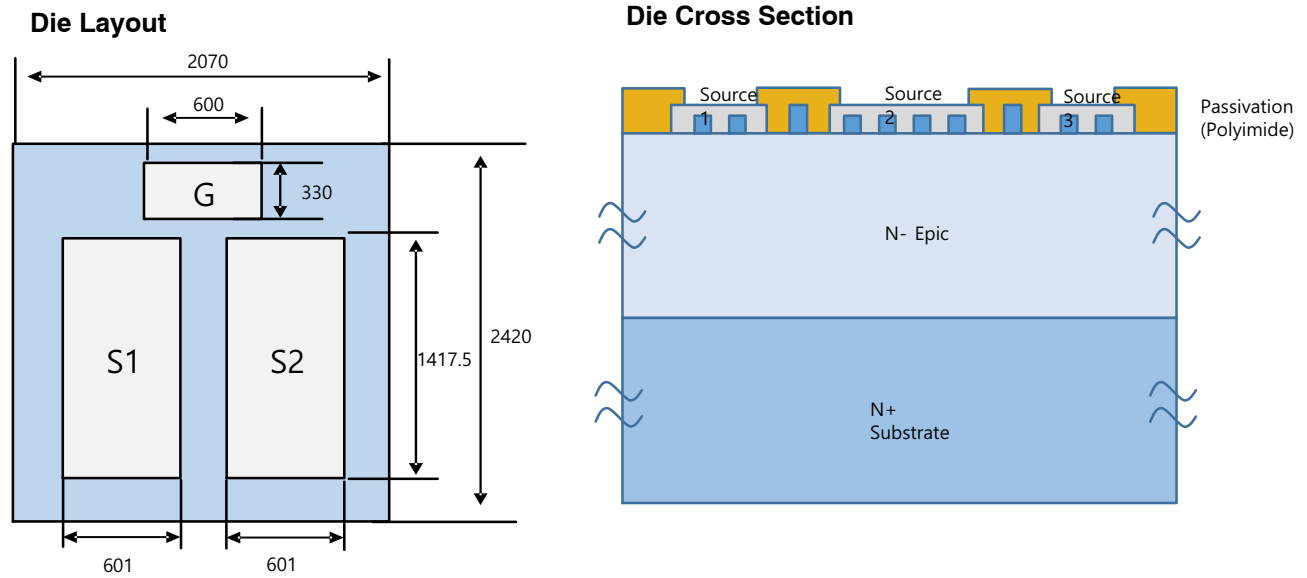
### DIE DIAGRAM



### Die Information

- Wafer Diameter 6 inch
- Die Size 2,070 x 2,420  $\mu\text{m}$
- Metallization
  - Top Ti/TiN/Al 5  $\mu\text{m}$
  - Back Ti/NiV/Ag
- Die Thickness Typ. 200  $\mu\text{m}$
- Gate Pad Size 600 x 330  $\mu\text{m}$

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## Passivation Information

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

## Die Layout

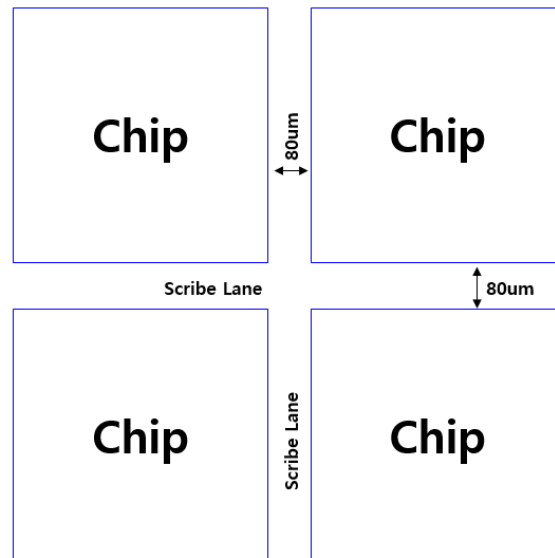


Figure 1. Bare Die Dimensions

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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>                    | 17          | A    |
| Power Dissipation R <sub>θJC</sub>                                                           |                                                                       |                        | P <sub>D</sub>                    | 119         | W    |
| Continuous Drain Current R <sub>θJC</sub>                                                    | Steady State                                                          | T <sub>C</sub> = 100°C | I <sub>D</sub>                    | 12          | A    |
| Power Dissipation R <sub>θJC</sub>                                                           |                                                                       |                        | P <sub>D</sub>                    | 59          | W    |
| Pulsed Drain Current (Note 2)                                                                | T <sub>C</sub> = 25°C                                                 |                        | I <sub>DM</sub>                   | 69          | 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>                  | 140         | 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>                    | 11          | A    |
| Single Pulse Drain-to-Source Avalanche Energy (I <sub>L(pk)</sub> = 23 A, L = 1 mH) (Note 3) |                                                                       |                        | E <sub>AS</sub>                   | 128         | 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> | 1.3   | °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 128 mJ is based on starting T<sub>J</sub> = 25°C; L = 1 mH, I<sub>AS</sub> = 16 A, V<sub>DD</sub> = 120 V, V<sub>GS</sub> = 18 V.

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

| 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 $25^\circ\text{C}$                 | –    | 600 | –       | 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        | $V_{GS(th)}$ | $V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$                             | 1.8 | 3.1 | 4.3 | V          |
| Recommended Gate Voltage      | $V_{GOP}$    |                                                                    | –5  | –   | +20 | V          |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 20\text{ V}, I_D = 12\text{ A}, T_J = 25^\circ\text{C}$  | –   | 162 | 224 | m $\Omega$ |
|                               |              | $V_{GS} = 20\text{ V}, I_D = 12\text{ A}, T_J = 150^\circ\text{C}$ | –   | 247 | –   |            |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 12\text{ A}$                          | –   | 3   | –   | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |                                                                     |   |      |   |          |
|------------------------------|--------------|---------------------------------------------------------------------|---|------|---|----------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$      | – | 665  | – | pF       |
| Output Capacitance           | $C_{OSS}$    |                                                                     | – | 50   | – |          |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                     | – | 5    | – |          |
| Total Gate Charge            | $Q_{G(tot)}$ | $V_{GS} = -5/20\text{ V}, V_{DS} = 600\text{ V}, I_D = 16\text{ A}$ | – | 34   | – | nC       |
| Threshold Gate Charge        | $Q_{G(th)}$  |                                                                     | – | 6    | – |          |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                     | – | 12.5 | – |          |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                     | – | 9.6  | – |          |
| Gate Resistance              | $R_G$        | $f = 1\text{ MHz}$                                                  | – | 1.4  | – | $\Omega$ |

### SWITCHING CHARACTERISTICS

|                         |              |                                                                                                             |   |     |   |               |
|-------------------------|--------------|-------------------------------------------------------------------------------------------------------------|---|-----|---|---------------|
| Turn-On Delay Time      | $t_{d(on)}$  | $V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 16\text{ A}, R_G = 6\text{ }\Omega$ , Inductive Load | – | 11  | – | ns            |
| Rise Time               | $t_r$        |                                                                                                             | – | 19  | – |               |
| Turn-Off Delay Time     | $t_{d(off)}$ |                                                                                                             | – | 15  | – |               |
| Fall Time               | $t_f$        |                                                                                                             | – | 8   | – |               |
| Turn-On Switching Loss  | $E_{ON}$     |                                                                                                             | – | 200 | – | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |                                                                                                             | – | 34  | – |               |
| Total Switching Loss    | $E_{TOT}$    |                                                                                                             | – | 234 | – |               |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                                                       |           |                                                                                      |   |     |    |               |
|-------------------------------------------------------|-----------|--------------------------------------------------------------------------------------|---|-----|----|---------------|
| Continuous Drain-to-Source Diode Forward Current      | $I_{SD}$  | $V_{GS} = -5\text{ V}$                                                               | – | –   | 11 | A             |
| Pulsed Drain-to-Source Diode Forward Current (Note 2) | $I_{SDM}$ | $V_{GS} = -5\text{ V}$                                                               | – | –   | 69 | A             |
| Forward Diode Voltage                                 | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 6\text{ A}$                                          | – | 4   | 10 | V             |
| Reverse Recovery Time                                 | $t_{RR}$  | $V_{GS} = -5/20\text{ V}, I_{SD} = 16\text{ A}, dI_S/dt = 1000\text{ A}/\mu\text{s}$ | – | 15  | –  | ns            |
| Reverse Recovery Charge                               | $Q_{RR}$  |                                                                                      | – | 45  | –  | nC            |
| Reverse Recovery Energy                               | $E_{REC}$ |                                                                                      | – | 3.9 | –  | $\mu\text{J}$ |
| Peak Reverse Recovery Current                         | $I_{RRM}$ |                                                                                      | – | 6.2 | –  | A             |
| Charge Time                                           | $T_a$     |                                                                                      | – | 7.4 | –  | ns            |
| Discharge Time                                        | $T_b$     |                                                                                      | – | 7   | –  | 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)

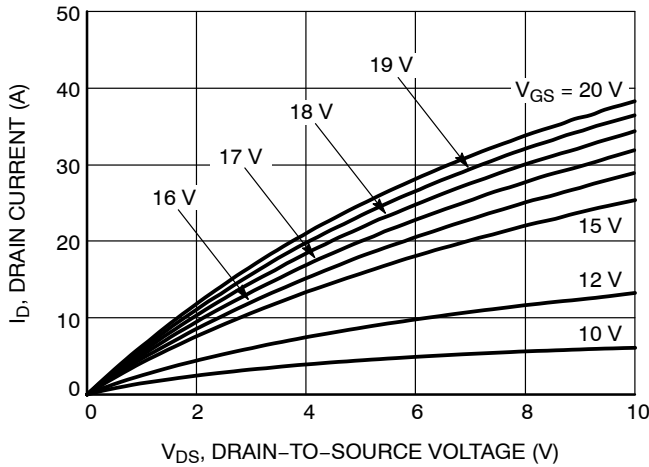


Figure 2. On-Region Characteristics

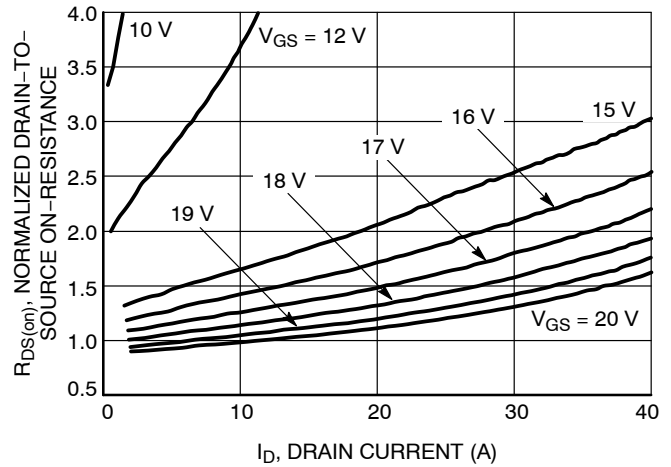


Figure 3. Normalized On-Resistance vs. Drain Current and Gate Voltage

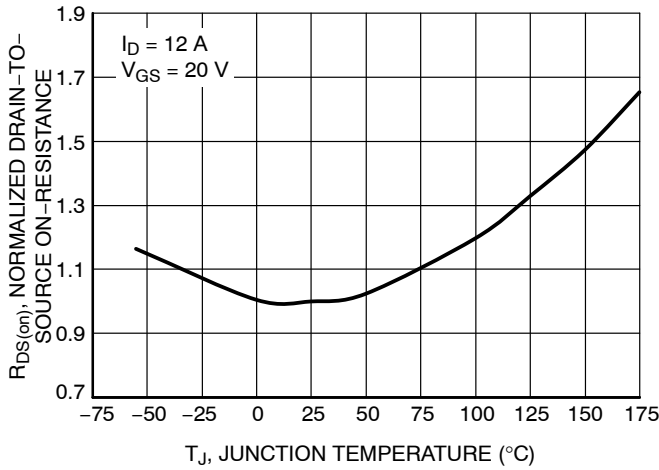


Figure 4. On-Resistance Variation with Temperature

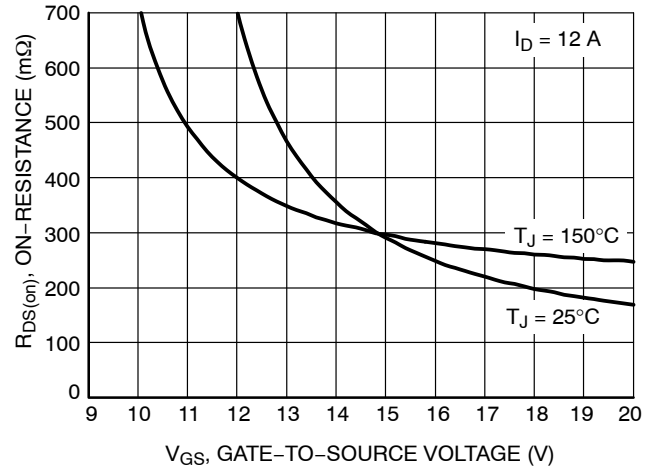


Figure 5. On-Resistance vs. Gate-to-Source Voltage

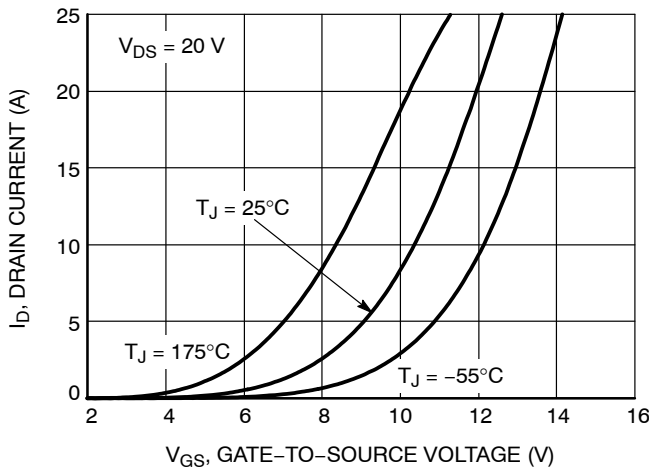


Figure 6. Transfer Characteristics

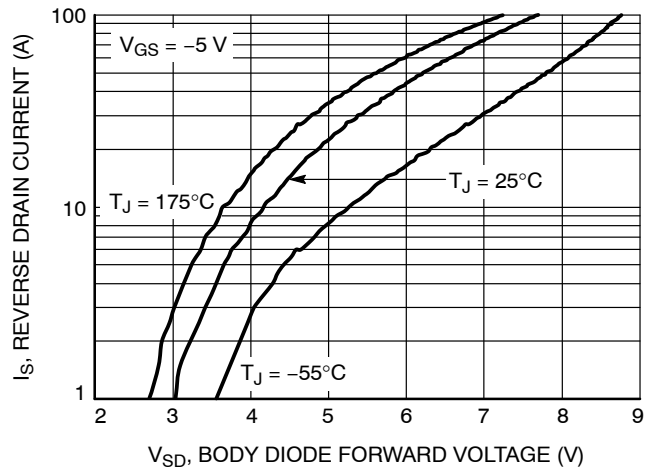


Figure 7. Diode Forward Voltage vs. Current

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

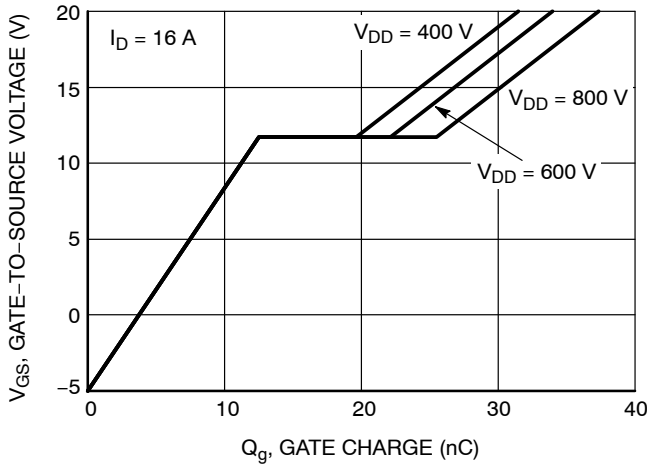


Figure 8. Gate-to-Source Voltage vs. Total Charge

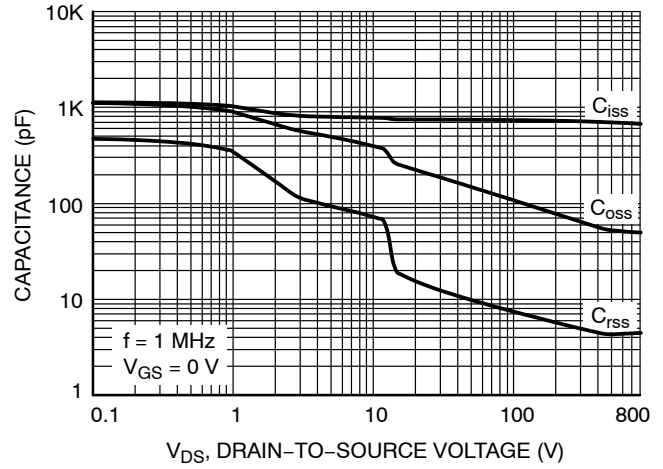


Figure 9. Capacitance vs. Drain-to-Source Voltage

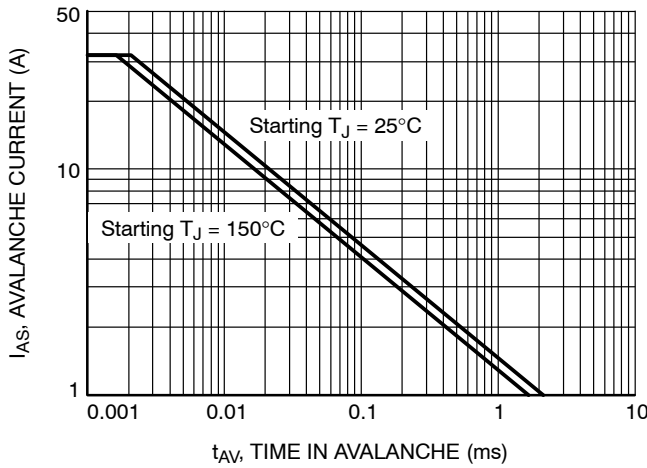


Figure 10. Unclamped Inductive Switching Capability

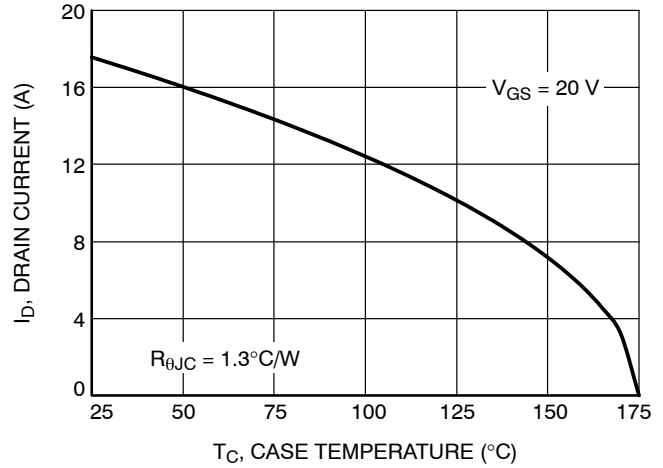


Figure 11. Maximum Continuous Drain Current vs. Case Temperature

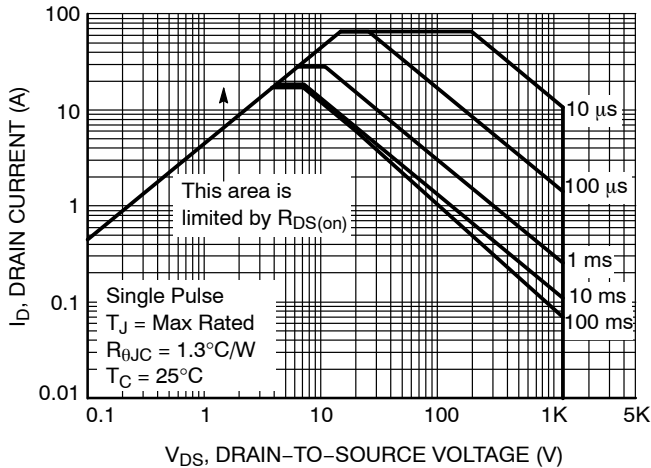


Figure 12. Safe Operating Area

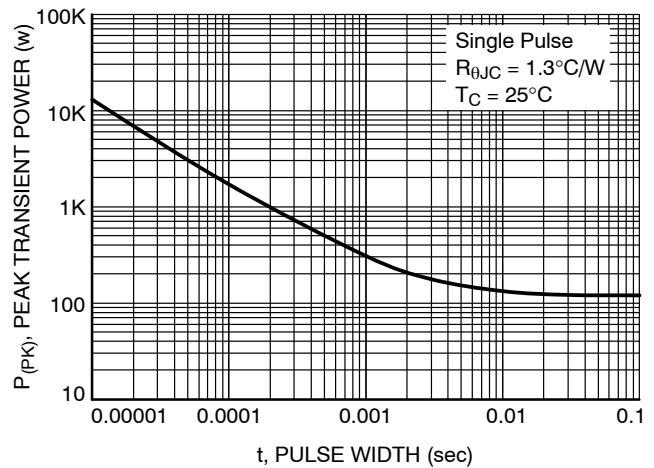


Figure 13. Single Pulse Maximum Power Dissipation

# NTC160N120SC1

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

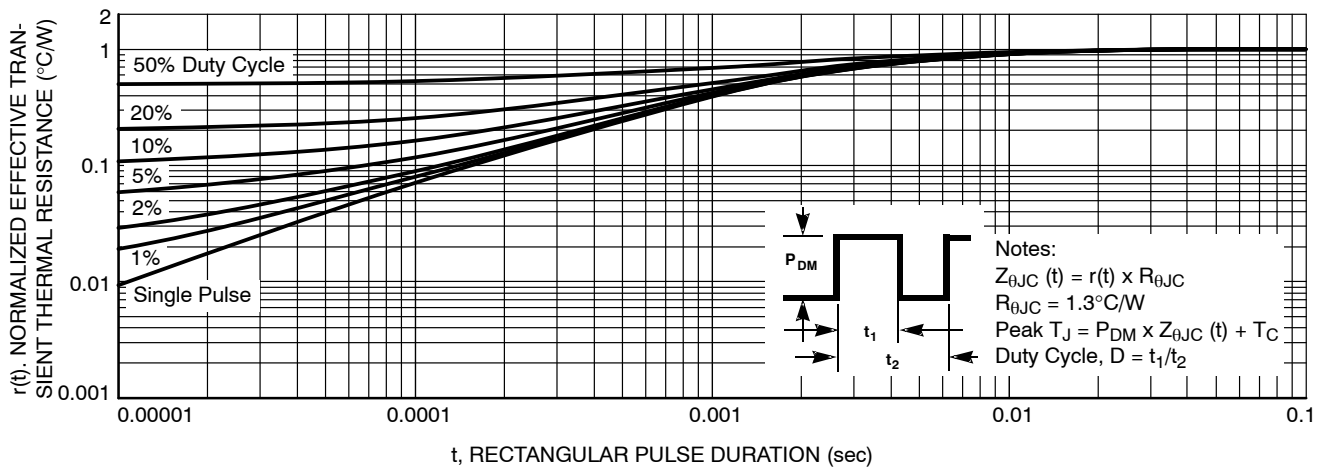


Figure 14. Junction-to-Ambient Thermal Response

### ORDERING INFORMATION AND PACKAGE MARKING

| Orderable Part Number | Top Marking | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-----------------------|-------------|---------|----------------|-----------|------------|----------|
| NTC160N120SC1         | N/A         | Die     | Wafer          | N/A       | N/A        | N/A      |

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