

# Silicon Carbide (SiC) MOSFET – EliteSiC, 960 mohm, 1700 V, M1, D2PAK-7L

## NTBG1000N170M1

### Features

- Typ.  $R_{DS(on)}$  = 960 m $\Omega$
- Ultra Low Gate Charge (typ.  $Q_{G(tot)}$  = 14 nC)
- Low Effective Output Capacitance (typ.  $C_{oss}$  = 11 pF)
- 100% Avalanche Tested
- RoHS Compliant

### Typical Applications

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

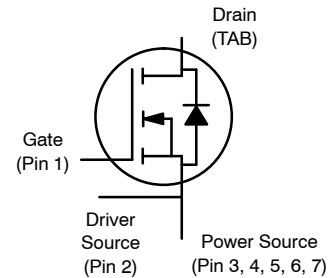
### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter   |                          | Symbol                                  | Value       | Unit             |   |
|---|--------------------------|---|-------------|------------------|---|
| Drain-to-Source Voltage   |                          | $V_{DSS}$                               | 1700        | V                |   |
| Gate-to-Source Voltage  |                          | $V_{GS}$                                | -15/+25     | V                |   |
| Recommended Operation Values of Gate-to-Source Voltage  |                          | $T_C < 175^\circ\text{C}$<br>$V_{GSop}$ | -5/+20      | V                |   |
| Continuous Drain Current (Note 2)   | Steady State             | $T_C = 25^\circ\text{C}$                | $I_D$       | 4.3              | A |
|   |                          |   | $P_D$       | 51               | W |
| Power Dissipation (Note 2)  | Steady State             | $T_C = 100^\circ\text{C}$               | $I_D$       | 3.0              | A |
|   |                          |   | $P_D$       | 25               | W |
| Pulsed Drain Current (Note 3)   | $T_C = 25^\circ\text{C}$ |   | $I_{DM}$    | 14.6             | A |
| Operating Junction and Storage Temperature Range  |                          | $T_J, T_{stg}$                          | -55 to +175 | $^\circ\text{C}$ |   |
| Source Current (Body Diode) (Note 2)  |                          | $I_S$                                   | 10          | A                |   |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 6.9\text{ A}$ , $L = 1\text{ mH}$ ) (Note 4) |                          | $E_{AS}$                                | 24          | mJ               |   |
| Maximum Temperature for Soldering (10 s)  |                          | $T_L$                                   | 270         | $^\circ\text{C}$ |   |

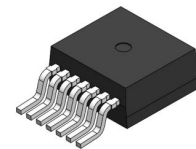
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Surface mounted on a FR-4 board using 1 in2 pad of 2 oz copper.
2. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
3. Repetitive rating, limited by max junction temperature.
4.  $E_{AS}$  of 24 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 6.9\text{ A}$ ,  $V_{DD} = 120\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ TYP      | $I_D$ MAX |
|---------------|-----------------------|-----------|
| 1700 V        | 960 m $\Omega$ @ 20 V | 4.3 A     |



N-CHANNEL MOSFET



D2PAK-7L  
CASE 418BJ

### MARKING DIAGRAM



- A = Assembly Location
- Y = Year
- WW = Work Week
- ZZ = Lot Traceability
- BG1000N170M1 = Specific Device Code

### ORDERING INFORMATION

| Device         | Package  | Shipping <sup>†</sup> |
|----------------|----------|-----------------------|
| NTBG1000N170M1 | D2PAK-7L | 800 ea/<br>Tape&Reel  |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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## THERMAL RESISTANCE MAXIMUM RATINGS

| Parameter                                       | Symbol          | Typ | Max | Unit |
|---|-----------------|-----|-----|------|
| Junction-to-Case – Steady State (Note 2)        | $R_{\theta JC}$ | 2.9 | –   | °C/W |
| Junction-to-Ambient – Steady State (Notes 1, 2) | $R_{\theta JA}$ | –   | 40  |      |

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

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

### OFF CHARACTERISTICS

|   |                   |  |                           |     |         |               |               |
|---|-------------------|--|---------------------------|-----|---------|---------------|---------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$               | 1700                      | –   | –       | V             |               |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | $I_D = 1\text{ mA}$ , referenced to $25^\circ\text{C}$ | –                         | 0.5 | –       | V/°C          |               |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = 1700\text{ V}$          | $T_J = 25^\circ\text{C}$  | –   | –       | 100           | $\mu\text{A}$ |
|   |                   |  | $T_J = 175^\circ\text{C}$ | –   | –       | 1             | mA            |
| 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 (Note 3)

|                               |              |   |     |      |      |            |
|-------------------------------|--------------|---|-----|------|------|------------|
| Gate Threshold Voltage        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 640\text{ }\mu\text{A}$                   | 1.8 | 3.2  | 4.3  | V          |
| Recommended Gate Voltage      | $V_{GOP}$    |   | –5  | –    | +20  | V          |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 20\text{ V}, I_D = 2\text{ A}, T_J = 25^\circ\text{C}$  | –   | 960  | 1430 | m $\Omega$ |
|                               |              | $V_{GS} = 20\text{ V}, I_D = 2\text{ A}, T_J = 175^\circ\text{C}$ | –   | 1824 | –    |            |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 10\text{ V}, I_D = 2\text{ A}$ (Note 6)                 | –   | 0.6  | –    | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |   |                    |     |     |    |
|------------------------------|--------------|---|--------------------|-----|-----|----|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 1000\text{ V}$ (Note 6)    | –                  | 150 | –   | pF |
| Output Capacitance           | $C_{OSS}$    |   | –                  | 11  | –   |    |
| Reverse Transfer Capacitance | $C_{RSS}$    |   | –                  | 0.6 | –   |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 2\text{ A}$ (Note 6) | –                  | 14  | –   | nC |
| Threshold Gate Charge        | $Q_{G(TH)}$  |   | –                  | 1.5 | –   |    |
| Gate-to-Source Charge        | $Q_{GS}$     |   | –                  | 2.6 | –   |    |
| Gate-to-Drain Charge         | $Q_{GD}$     |   | –                  | 7.5 | –   |    |
| Gate-Resistance              | $R_G$        |   | $f = 1\text{ MHz}$ | –   | 5.7 |    |

### SWITCHING CHARACTERISTICS

|                         |              |   |   |    |   |               |
|-------------------------|--------------|---|---|----|---|---------------|
| Turn-On Delay Time      | $t_{d(ON)}$  | $V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 2\text{ A}, R_G = 25\text{ }\Omega, L = 300\text{ }\mu\text{H}$<br>Inductive load (Notes 5, 6) | – | 6  | – | ns            |
| Rise Time               | $t_r$        |   | – | 18 | – |               |
| Turn-Off Delay Time     | $t_{d(OFF)}$ |   | – | 11 | – |               |
| Fall Time               | $t_f$        |   | – | 55 | – |               |
| Turn-On Switching Loss  | $E_{ON}$     |   | – | 59 | – | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |   | – | 11 | – |               |
| Total Switching Loss    | $E_{tot}$    |   | – | 70 | – |               |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|  |           |  |   |     |    |    |
|--|-----------|--|---|-----|----|----|
| Continuous Drain-Source Diode Forward Current (Note 2) | $I_{SD}$  | $V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$ (Note 6)                                      | – | –   | 10 | A  |
| Pulsed Drain-Source Diode Forward Current (Note 3)     | $I_{SDM}$ |  | – | –   | 50 |    |
| Forward Diode Voltage                                  | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 2\text{ A}, T_J = 25^\circ\text{C}$                          | – | 4.2 | –  | V  |
| Reverse Recovery Time                                  | $t_{RR}$  | $V_{GS} = -5/20\text{ V}, I_{SD} = 2\text{ A}, dI_S/dt = 1000\text{ A}/\mu\text{s}$ (Note 6) | – | 5.9 | –  | ns |
| Reverse Recovery Charge                                | $Q_{RR}$  |  | – | 11  | –  | nC |

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.

5.  $E_{ON}/E_{OFF}$  result is with body diode.

6. Defined by design, not subject to production test.

# NTBG1000N170M1

## TYPICAL CHARACTERISTICS

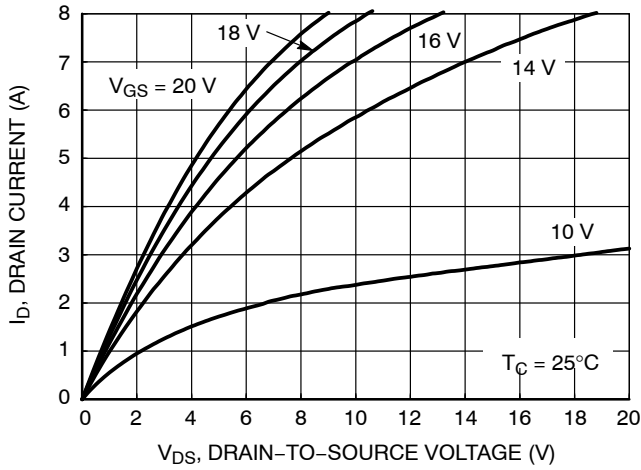


Figure 1. On-Region Characteristics

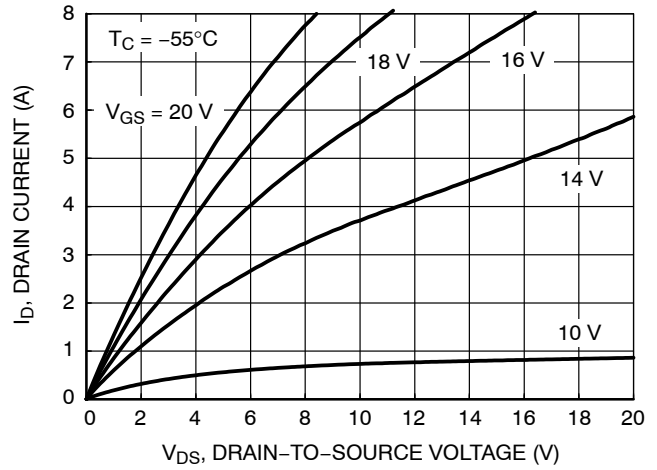


Figure 2. On-Region Characteristics

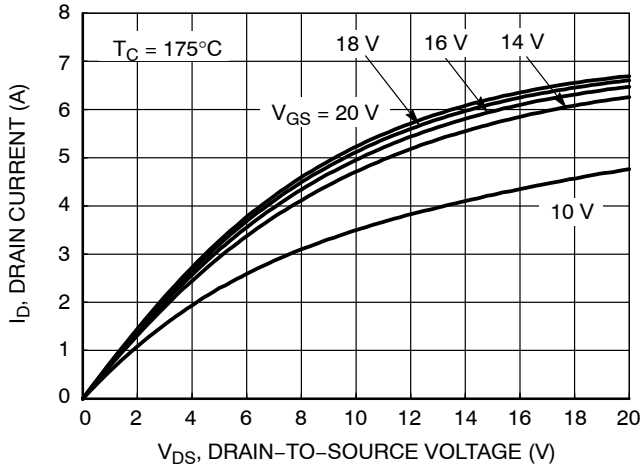


Figure 3. On-Region Characteristics

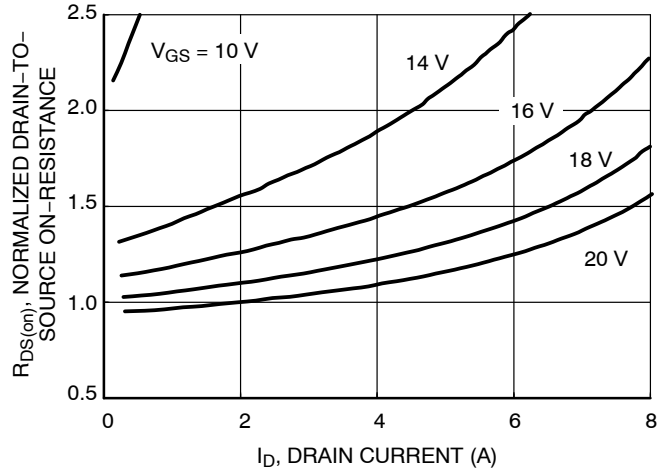


Figure 4. Normalized On-Resistance vs. Drain Current and Gate Voltage

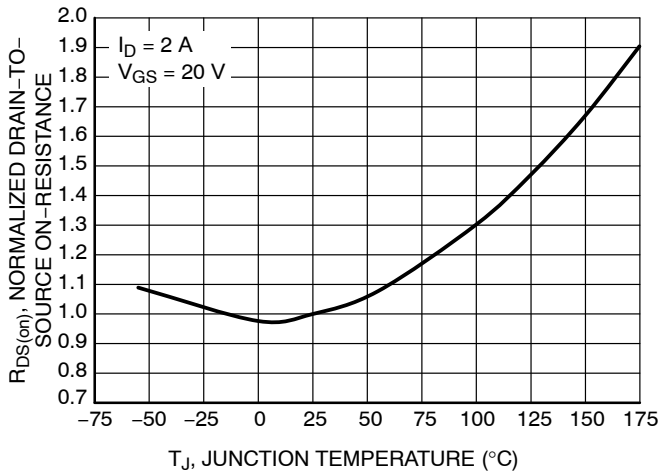


Figure 5. Normalized On-Resistance Variation with Temperature

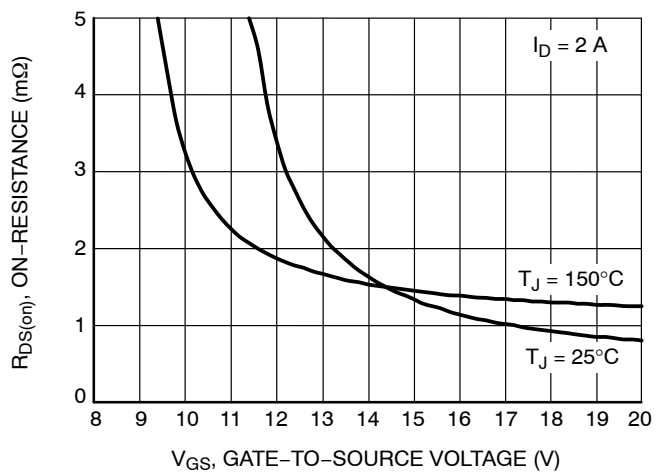


Figure 6. On-Resistance vs. Gate-to-Source Voltage

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## TYPICAL CHARACTERISTICS

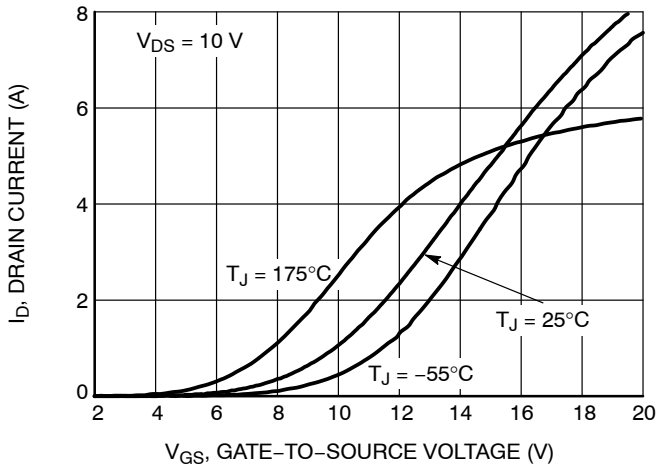


Figure 7. Transfer Characteristics

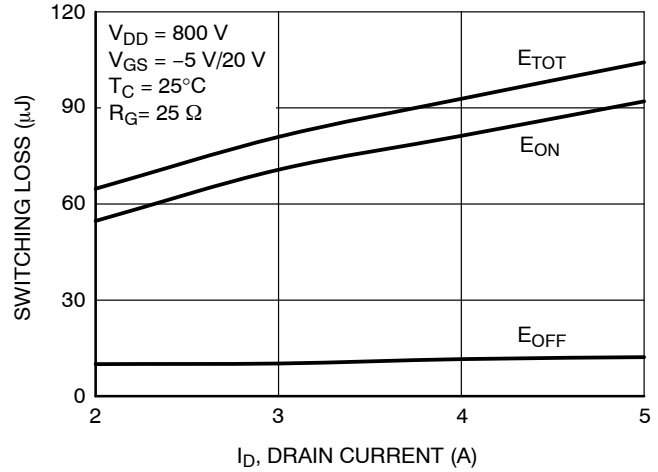


Figure 8. Switching Loss vs. Drain Current

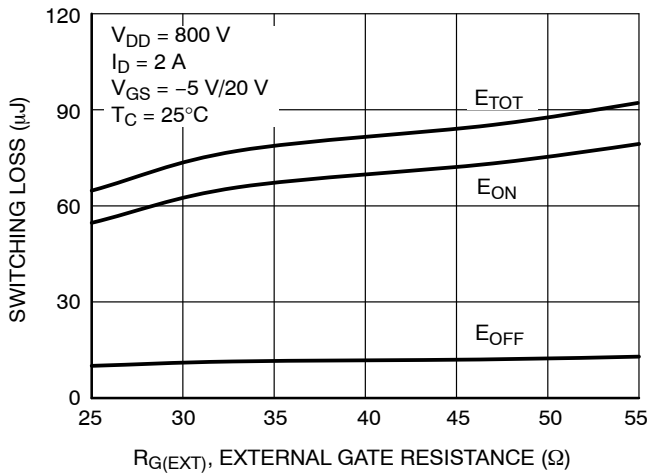


Figure 9. Switching Loss vs. Gate Resistance

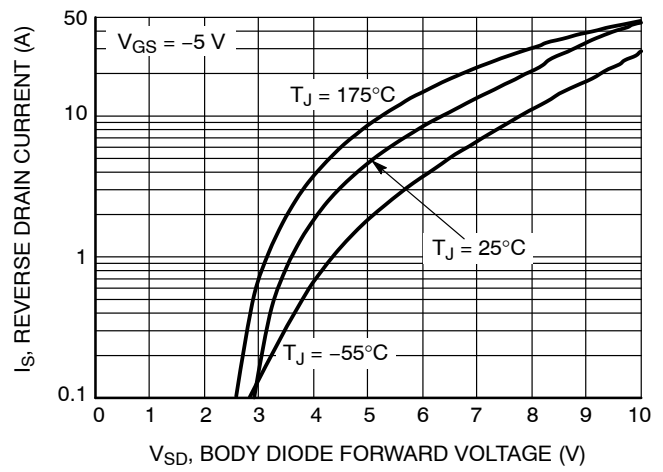


Figure 10. Diode Forward Voltage vs. Current

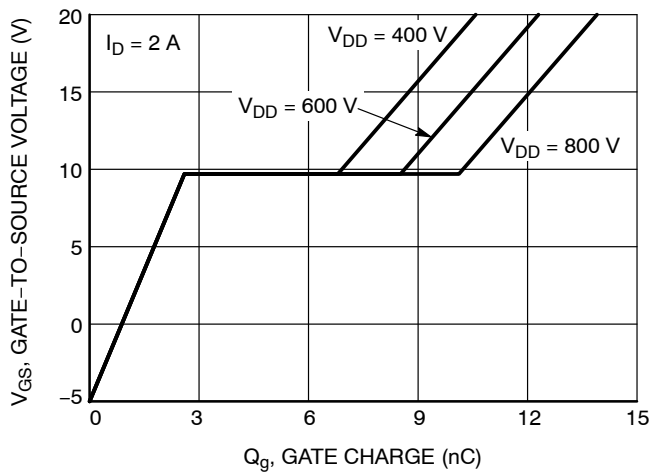


Figure 11. Gate-to-Source Voltage vs. Total Charge

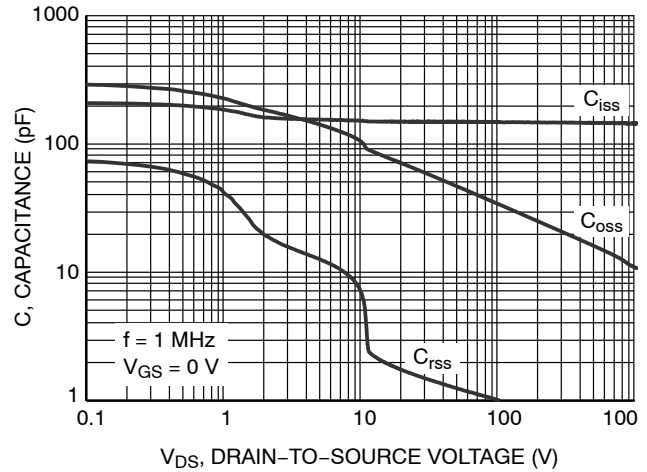
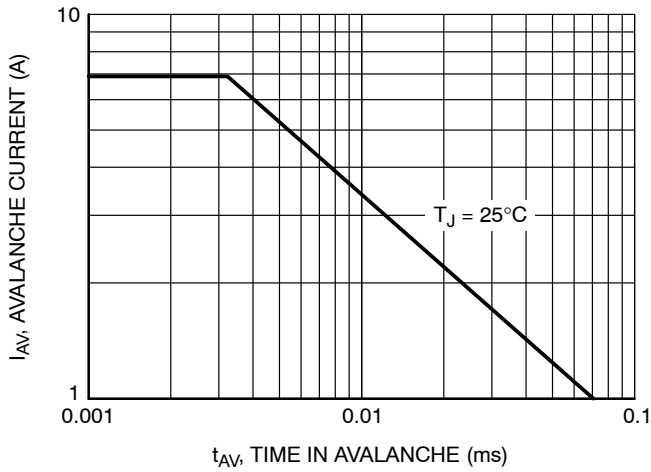


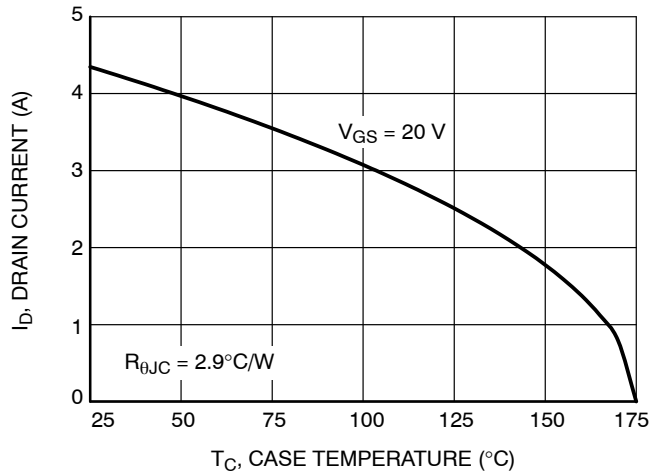
Figure 12. Capacitance vs. Drain-to-Source Voltage

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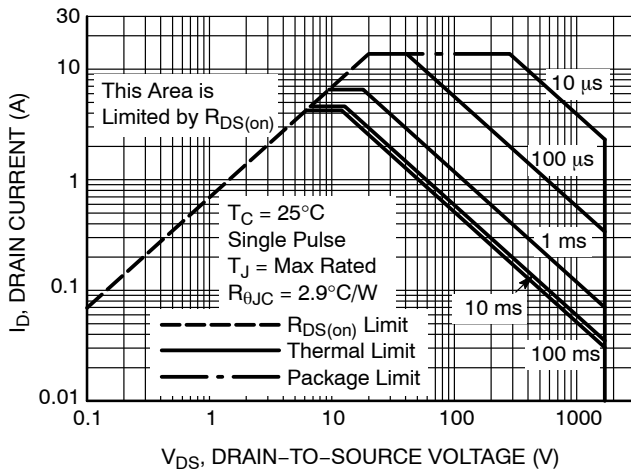
## TYPICAL CHARACTERISTICS



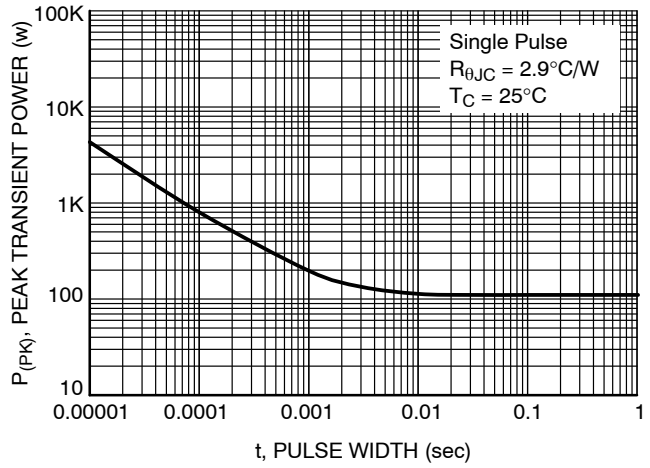
**Figure 13. Unclamped Inductive Switching Capability**



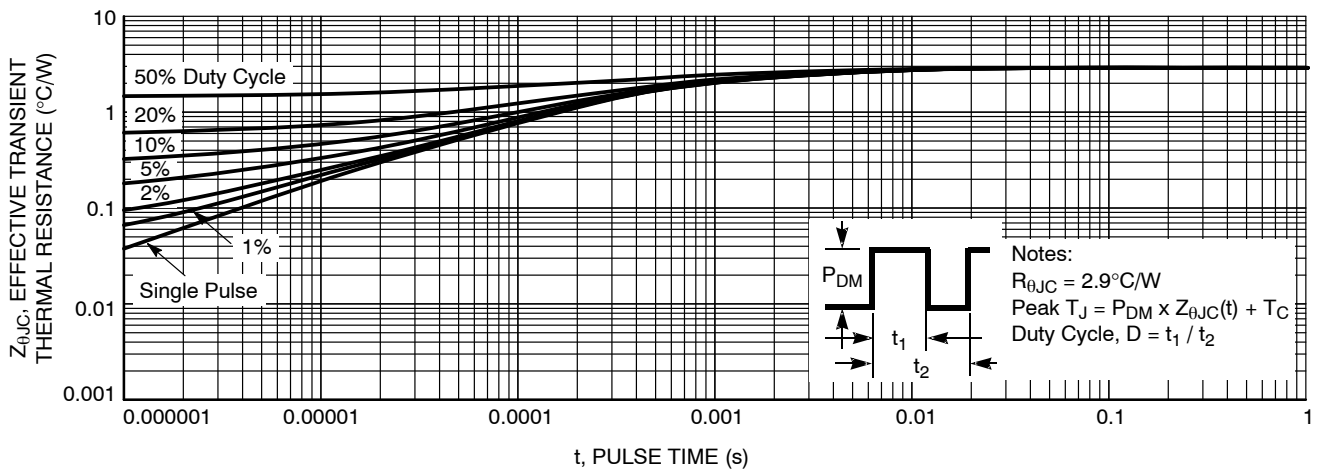
**Figure 14. Maximum Continuous Drain Current vs. Case Temperature**



**Figure 15. Maximum Rated Forward Biased Safe Operating Area**



**Figure 16. Single Pulse Maximum Power Dissipation**



**Figure 17. Transient Thermal Impedance**

# NTBG1000N170M1

## ESD RATINGS

| ESD Test | Classification       | Standard               |
|----------|----------------------|------------------------|
| ESD-HBM  | 0B (125 V to <250 V) | ANSI/ESDA/JEDEC JS-001 |
| ESD-CDM  | C3 (>1000 V)         | ANSI/ESDA/JEDEC JS-002 |

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



## D<sup>2</sup>PAK7 (TO-263-7L HV) CASE 418BJ ISSUE B

DATE 16 AUG 2019



NOTES:

- A. PACKAGE CONFORMS TO JEDEC TO-263 VARIATION CB EXCEPT WHERE NOTED.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. OUT OF JEDEC STANDARD VALUE.
- D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.
- E. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.30        | 4.50  | 4.70  |
| A1  | 0.00        | 0.10  | 0.20  |
| b2  | 0.60        | 0.70  | 0.80  |
| b   | 0.51        | 0.60  | 0.70  |
| c   | 0.40        | 0.50  | 0.60  |
| c2  | 1.20        | 1.30  | 1.40  |
| D   | 9.00        | 9.20  | 9.40  |
| D1  | 6.15        | 6.80  | 7.15  |
| E   | 9.70        | 9.90  | 10.20 |
| E1  | 7.15        | 7.65  | 8.15  |
| e   | ~           | 1.27  | ~     |
| H   | 15.10       | 15.40 | 15.70 |
| L   | 2.44        | 2.64  | 2.84  |
| L1  | 1.00        | 1.20  | 1.40  |
| L3  | ~           | 0.25  | ~     |
| aaa | ~           | ~     | 0.25  |



### GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.



|                         |   |  |
|-------------------------|---|--|
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| <b>DESCRIPTION:</b>     | <b>D<sup>2</sup>PAK7 (TO-263-7L HV)</b> | <b>PAGE 1 OF 1</b>   |

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