

# Silicon Carbide (SiC) MOSFET – EliteSiC, 28 mohm, 1700 V, M1, D2PAK-7L NTBG028N170M1

## Features

- Typ.  $R_{DS(on)}$  = 28 m $\Omega$
- Ultra Low Gate Charge (typ.  $Q_{G(tot)}$  = 222 nC)
- Low Effective Output Capacitance (typ.  $C_{oss}$  = 200 pF)
- 100% Avalanche Tested
- RoHS Compliant

## Typical Applications

- UPS
- DC-DC Converter
- Boost Converter

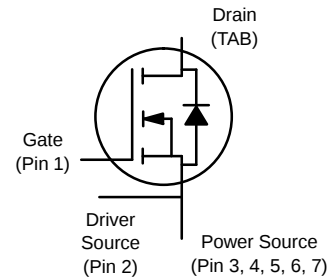
## MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| 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                                                   |                            | $T_C < 175^{\circ}\text{C}$ | $V_{GSop}$     | -5/+20      | V                  |
| Continuous Drain Current (Note 2)                                                                        | Steady State               | $T_C = 25^{\circ}\text{C}$  | $I_D$          | 71          | A                  |
| Power Dissipation (Note 2)                                                                               |                            |                             | $P_D$          | 428         | W                  |
| Continuous Drain Current (Note 2)                                                                        | Steady State               | $T_C = 100^{\circ}\text{C}$ | $I_D$          | 53          | A                  |
| Power Dissipation (Note 2)                                                                               |                            |                             | $P_D$          | 214         | W                  |
| Pulsed Drain Current (Note 3)                                                                            | $T_A = 25^{\circ}\text{C}$ |                             | $I_{DM}$       | 195         | A                  |
| Operating Junction and Storage Temperature Range                                                         |                            |                             | $T_J, T_{stg}$ | -55 to +175 | $^{\circ}\text{C}$ |
| Source Current (Body Diode)                                                                              |                            |                             | $I_S$          | 99          | A                  |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_{L(pk)} = 30\text{ A}$ , $L = 1\text{ mH}$ ) (Note 4) |                            |                             | $E_{AS}$       | 450         | mJ                 |
| Maximum Lead Temperature for Soldering (1/8" from case for 5 s)                                          |                            |                             | $T_L$          | 300         | $^{\circ}\text{C}$ |

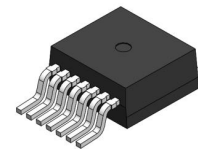
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Surface mounted on a FR-4 board using 1 in<sup>2</sup> 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. EAS of 450 mJ is based on starting  $T_J = 25^\circ\text{C}$ ;  $L = 1\text{ mH}$ ,  $I_{AS} = 30\text{ A}$ ,  $V_{DD} = 120\text{ V}$ ,  $V_{GS} = 18\text{ V}$ .

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| 1700 V        | 40 m $\Omega$ @ 20 V     | 71 A              |



N-CHANNEL MOSFET



D2PAK-7L  
CASE 418BJ

## MARKING DIAGRAM



A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Lot Traceability  
BG028N170M1 = Specific Device Code

## ORDERING INFORMATION

| Device        | Package  | Shipping <sup>†</sup> |
|---------------|----------|-----------------------|
| NTBG028N170M1 | 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.

# NTBG028N170M1

## THERMAL RESISTANCE MAXIMUM RATINGS

| Parameter                                       | Symbol          | Typ  | Max | Unit |
|-------------------------------------------------|-----------------|------|-----|------|
| Junction-to-Case – Steady State (Note 2)        | $R_{\theta JC}$ | 0.35 |     | °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 $25^\circ\text{C}$ |                           | 0.44 |         | 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        | $V_{GS(TH)}$ | $V_{GS} = V_{DS}, I_D = 20\text{ mA}$                              | 1.8 | 3.0 | 4.3 | V                |
| Recommended Gate Voltage      | $V_{GOP}$    |                                                                    | -5  |     | +20 | V                |
| Drain-to-Source On Resistance | $R_{DS(on)}$ | $V_{GS} = 20\text{ V}, I_D = 60\text{ A}, T_J = 25^\circ\text{C}$  |     | 28  | 40  | $\text{m}\Omega$ |
|                               |              | $V_{GS} = 20\text{ V}, I_D = 60\text{ A}, T_J = 175^\circ\text{C}$ |     | 57  |     |                  |
| Forward Transconductance      | $g_{FS}$     | $V_{DS} = 20\text{ V}, I_D = 60\text{ A}$                          |     | 27  |     | S                |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                              |              |                                                                     |  |      |  |             |
|------------------------------|--------------|---------------------------------------------------------------------|--|------|--|-------------|
| Input Capacitance            | $C_{ISS}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = 800\text{ V}$      |  | 4160 |  | $\text{pF}$ |
| Output Capacitance           | $C_{OSS}$    |                                                                     |  | 200  |  |             |
| Reverse Transfer Capacitance | $C_{RSS}$    |                                                                     |  | 15   |  |             |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = -5/20\text{ V}, V_{DS} = 800\text{ V}, I_D = 60\text{ A}$ |  | 222  |  | $\text{nC}$ |
| Threshold Gate Charge        | $Q_{G(TH)}$  |                                                                     |  | 40   |  |             |
| Gate-to-Source Charge        | $Q_{GS}$     |                                                                     |  | 72   |  |             |
| Gate-to-Drain Charge         | $Q_{GD}$     |                                                                     |  | 53   |  |             |
| Gate-Resistance              | $R_G$        | $f = 1\text{ MHz}$                                                  |  | 6.1  |  | $\Omega$    |

### SWITCHING CHARACTERISTICS

|                         |              |                                                                                                               |  |      |  |               |
|-------------------------|--------------|---------------------------------------------------------------------------------------------------------------|--|------|--|---------------|
| Turn-On Delay Time      | $t_{d(ON)}$  | $V_{GS} = -5/20\text{ V}, V_{DS} = 1200\text{ V}, I_D = 60\text{ A}, R_G = 2\text{ }\Omega$<br>inductive load |  | 47   |  | ns            |
| Rise Time               | $t_r$        |                                                                                                               |  | 18   |  |               |
| Turn-Off Delay Time     | $t_{d(OFF)}$ |                                                                                                               |  | 121  |  |               |
| Fall Time               | $t_f$        |                                                                                                               |  | 13   |  |               |
| Turn-On Switching Loss  | $E_{ON}$     |                                                                                                               |  | 1311 |  | $\mu\text{J}$ |
| Turn-Off Switching Loss | $E_{OFF}$    |                                                                                                               |  | 683  |  |               |
| Total Switching Loss    | $E_{tot}$    |                                                                                                               |  | 1994 |  |               |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                                                    |           |                                                                                      |  |     |     |    |
|----------------------------------------------------|-----------|--------------------------------------------------------------------------------------|--|-----|-----|----|
| Continuous Drain-Source Diode Forward Current      | $I_{SD}$  | $V_{GS} = -5\text{ V}, T_J = 25^\circ\text{C}$                                       |  |     | 99  | A  |
| Pulsed Drain-Source Diode Forward Current (Note 3) | $I_{SDM}$ |                                                                                      |  |     | 195 |    |
| Forward Diode Voltage                              | $V_{SD}$  | $V_{GS} = -5\text{ V}, I_{SD} = 60\text{ A}, T_J = 25^\circ\text{C}$                 |  | 4.3 |     | V  |
| Reverse Recovery Time                              | $t_{RR}$  | $V_{GS} = -5/20\text{ V}, I_{SD} = 60\text{ A}, dI_S/dt = 1000\text{ A}/\mu\text{s}$ |  | 33  |     | ns |
| Reverse Recovery Charge                            | $Q_{RR}$  |                                                                                      |  | 247 |     | 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.

TYPICAL CHARACTERISTICS

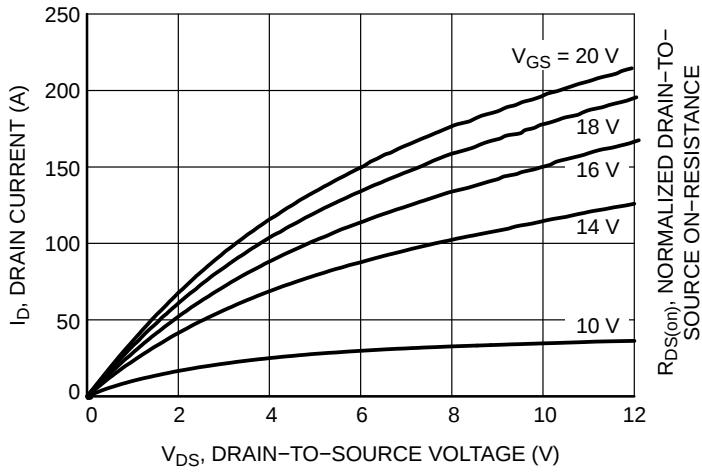


Figure 1. On-Region Characteristics

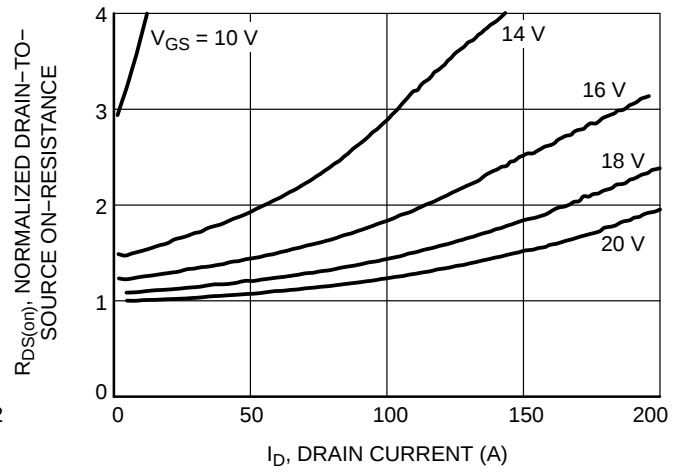


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

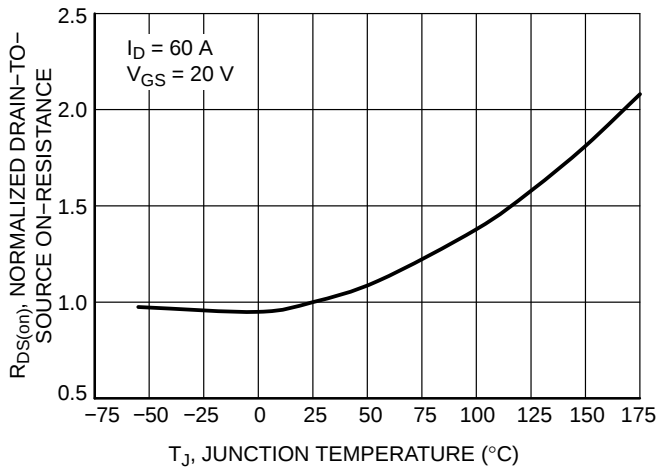


Figure 3. Normalized On-Resistance Variation with Temperature

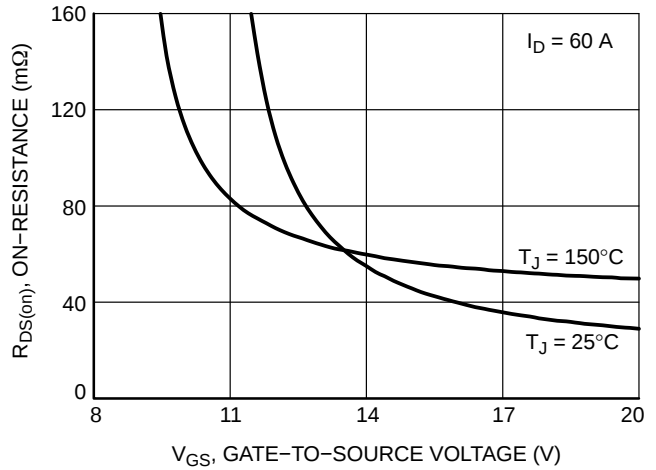


Figure 4. On-Resistance vs. Gate-to-Source Voltage

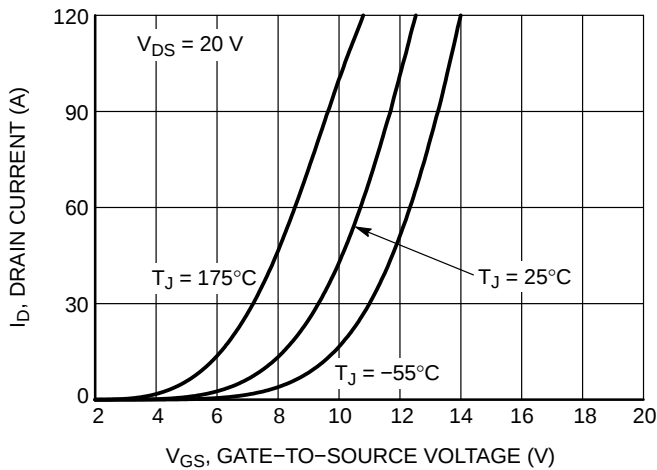


Figure 5. Transfer Characteristics

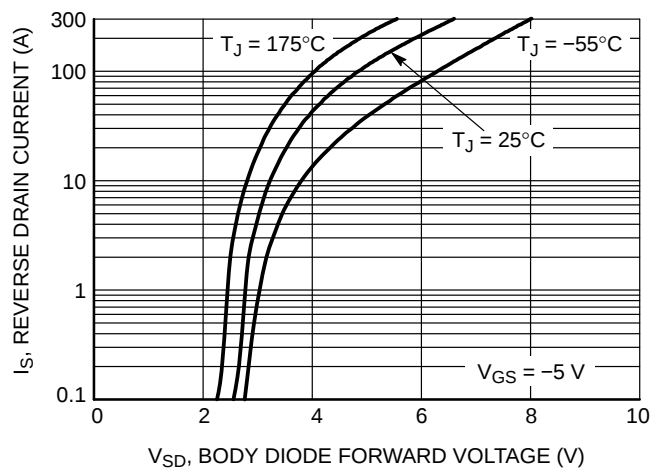


Figure 6. Diode Forward Voltage vs. Current

TYPICAL CHARACTERISTICS

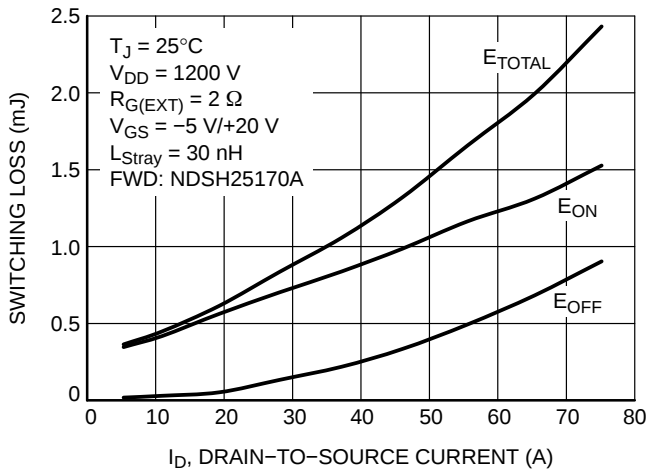


Figure 7. SW Loss vs. ID 25°C

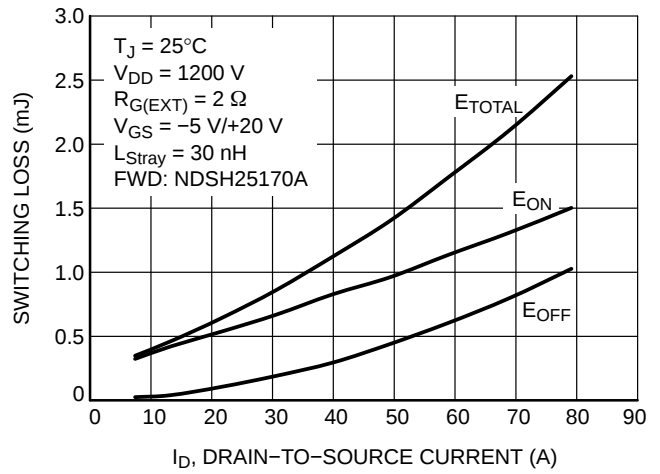


Figure 8. SW Loss vs. ID 125°C

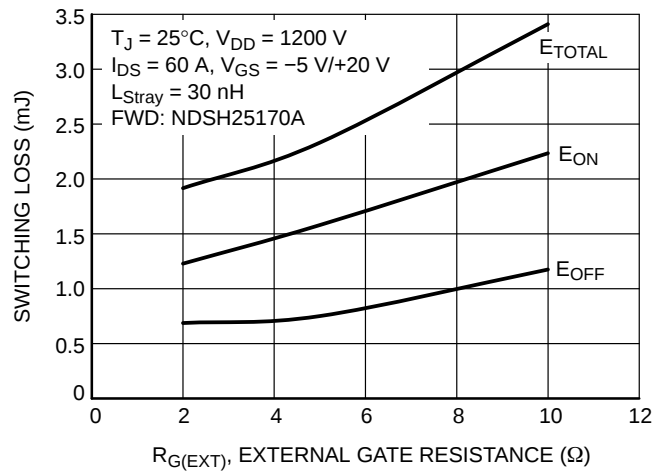


Figure 9. SW Loss vs. Rg

TYPICAL CHARACTERISTICS

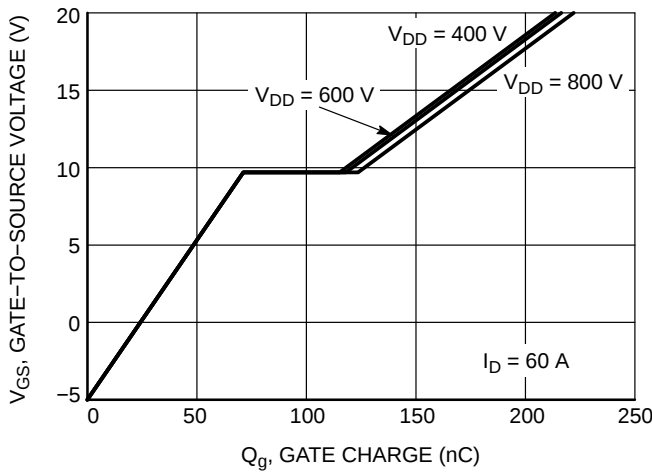


Figure 10. Gate-to-Source Voltage vs. Total Charge

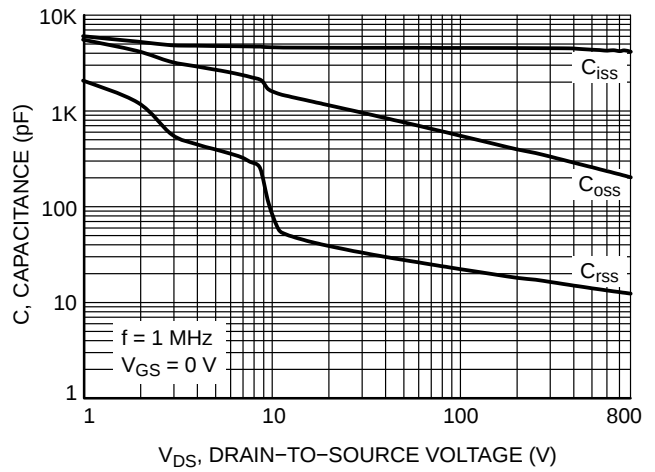


Figure 11. Capacitance vs. Drain-to-Source Voltage

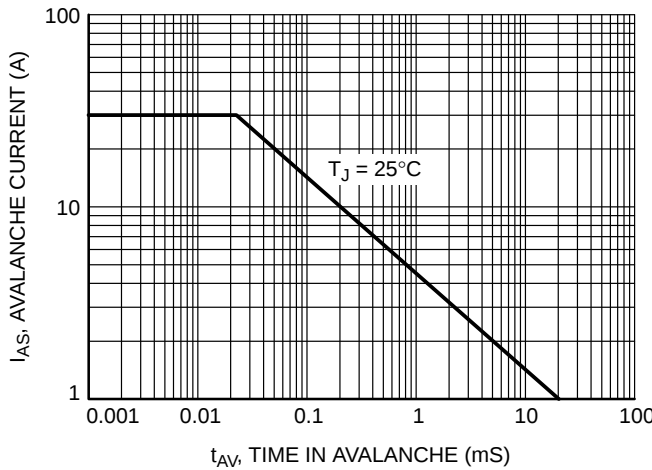


Figure 12. Unclamped Inductive Switching Capability

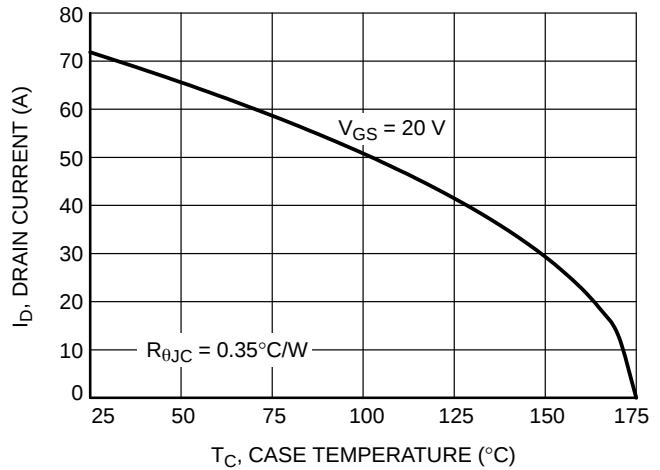


Figure 13. Maximum Continuous Drain Current vs. Case Temperature

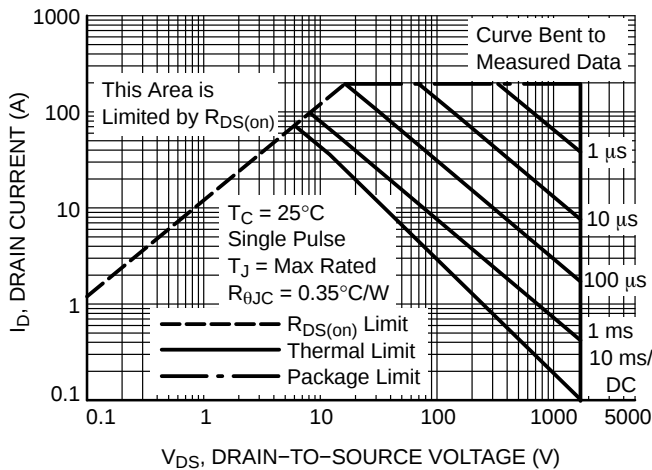


Figure 14. Maximum Rated Forward Biased Safe Operating Area

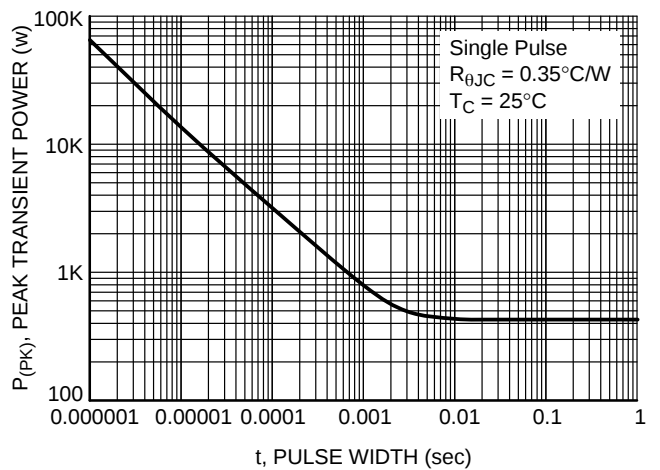


Figure 15. Single Pulse Maximum Power Dissipation

TYPICAL CHARACTERISTICS

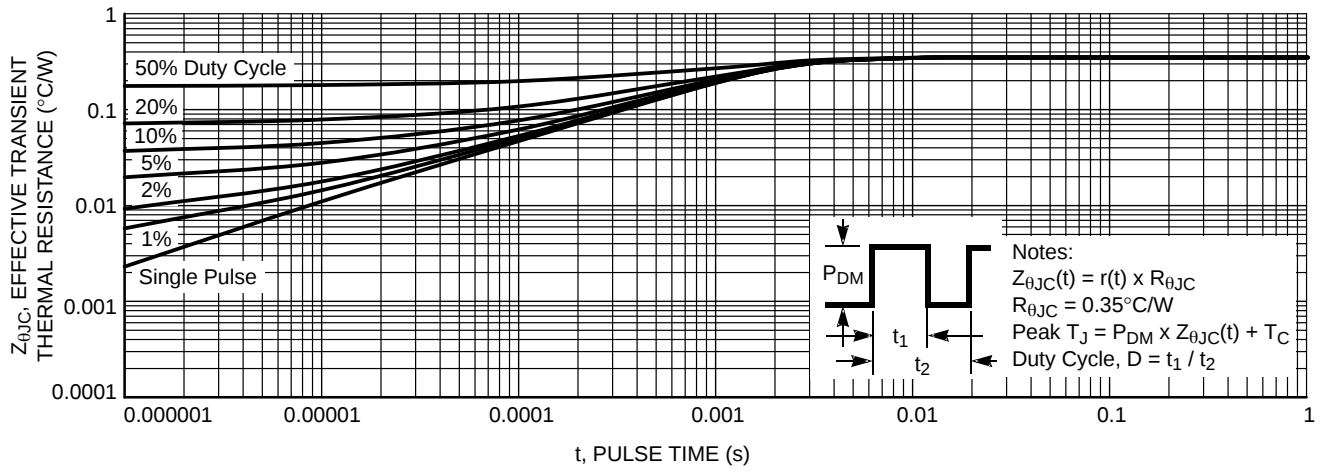
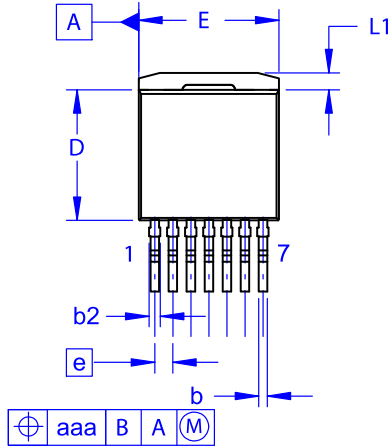


Figure 16. Transient Thermal Impedance



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

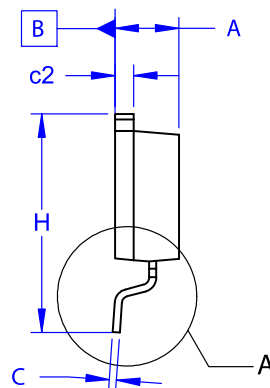
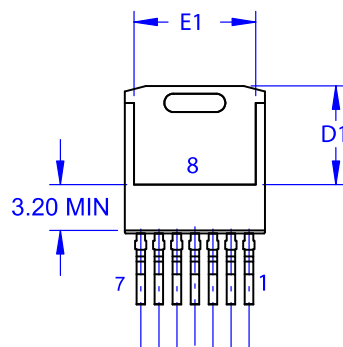
DATE 16 AUG 2019



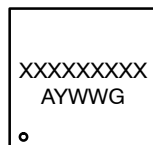
**NOTES:**

- 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  |

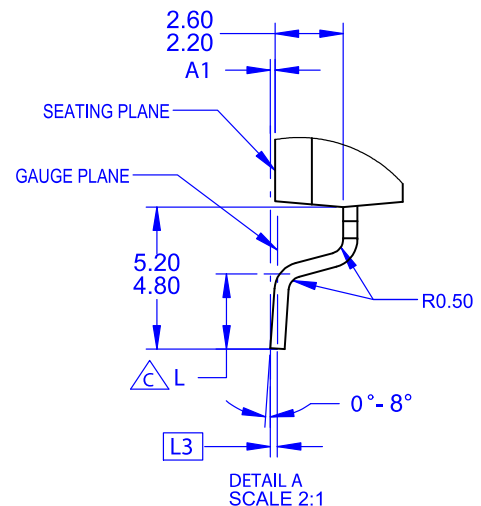


**GENERIC MARKING DIAGRAM\***



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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