

# 11N60C3-VB TO263 Datasheet

## N-Channel 650 V (D-S) MOSFET

### PRODUCT SUMMARY

|                                    |                 |      |
|------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.         | 650             |      |
| $R_{DS(on)}$ ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.36 |
| $Q_g$ max. (nC)                    | 106             |      |
| $Q_{gs}$ (nC)                      | 14              |      |
| $Q_{gd}$ (nC)                      | 33              |      |
| Configuration                      | Single          |      |

### FEATURES

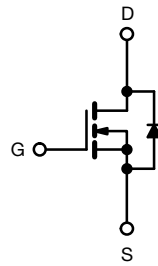
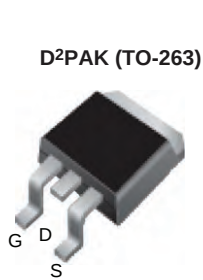
- Reduced  $t_{rr}$ ,  $Q_{rr}$ , and  $I_{RRM}$
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Low switching losses due to reduced  $Q_{rr}$
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)

### APPLICATIONS

- Telecommunications
  - Server and telecom power supplies
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Consumer and computing
  - ATX power supplies
- Industrial
  - Welding
  - Battery chargers
- Renewable energy
  - Solar (PV inverters)
- Switch mode power supplies (SMPS)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**



N-Channel MOSFET

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)

| PARAMETER                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| Drain-Source Voltage                                      |                         |                         | V <sub>DS</sub>                   | 650         | V    |
| Gate-Source Voltage                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)        | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 18          | A    |
|                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 16          |      |
| Pulsed Drain Current <sup>a</sup>                         |                         |                         | I <sub>DM</sub>                   | 53          |      |
| Linear Derating Factor                                    |                         |                         |                                   | 1.7         | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                |                         |                         | E <sub>AS</sub>                   | 367         | mJ   |
| Maximum Power Dissipation                                 |                         |                         | P <sub>D</sub>                    | 208         | W    |
| Operating Junction and Storage Temperature Range          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-Source Voltage Slope                                | T <sub>J</sub> = 125 °C |                         | dV/dt                             | 37          | V/ns |
| Reverse Diode dV/dt <sup>d</sup>                          |                         | 31                      |                                   |             |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup> | for 10 s                |                         |                                   | 300         | °C   |

#### Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature.  
 b.  $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 5.1$  A.  
 c. 1.6 mm from case.  
 d.  $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.5  |      |

**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                | MIN. | TYP. | MAX.  | UNIT |
|-----------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------|------|-------|------|
| Static                                                    |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Drain-Source Breakdown Voltage                            | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                                | 650  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                   | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                                                |                                                | -    | 0.67 | -     | V/°C |
| Gate-Source Threshold Voltage (N)                         | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                                | 2    | -    | 4     | V    |
| Gate-Source Leakage                                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                                                 |                                                | -    | -    | ± 100 | nA   |
|                                                           |                                  | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                                | -    | -    | ± 1   | μA   |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                | -    | -    | 1     | μA   |
|                                                           |                                  | V <sub>DS</sub> = 520 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                | -    | -    | 500   |      |
| Drain-Source On-State Resistance                          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 11 A                          | -    | 0.36 | -     | Ω    |
| Forward Transconductance                                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 11 A                                                                                                            |                                                | -    | 7.0  | -     | S    |
| Dynamic                                                   |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Input Capacitance                                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                                | -    | 2322 | -     | pF   |
| Output Capacitance                                        | C <sub>oss</sub>                 |                                                                                                                                                          |                                                | -    | 105  | -     |      |
| Reverse Transfer Capacitance                              | C <sub>rss</sub>                 |                                                                                                                                                          |                                                | -    | 4    | -     |      |
| Effective Output Capacitance, Energy Related <sup>a</sup> | C <sub>o(er)</sub>               | V <sub>DS</sub> = 0 V to 520 V, V <sub>GS</sub> = 0 V                                                                                                    |                                                | -    | 84   | -     |      |
| Effective Output Capacitance, Time Related <sup>b</sup>   | C <sub>o(tr)</sub>               |                                                                                                                                                          |                                                | -    | 293  | -     |      |
| Total Gate Charge                                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 11 A, V <sub>DS</sub> = 520 V | -    | 71   | 106   | nC   |
| Gate-Source Charge                                        | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                | -    | 14   | -     |      |
| Gate-Drain Charge                                         | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                | -    | 33   | -     |      |
| Turn-On Delay Time                                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 520 V, I <sub>D</sub> = 11 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω                                                        |                                                | -    | 22   | 44    | ns   |
| Rise Time                                                 | t <sub>r</sub>                   |                                                                                                                                                          |                                                | -    | 34   | 68    |      |
| Turn-Off Delay Time                                       | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                | -    | 68   | 102   |      |
| Fall Time                                                 | t <sub>f</sub>                   |                                                                                                                                                          |                                                | -    | 42   | 84    |      |
| Gate Input Resistance                                     | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                | -    | 0.78 | -     | Ω    |
| Drain-Source Body Diode Characteristics                   |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Continuous Source-Drain Diode Current                     | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                | -    | -    | 21    | A    |
| Pulsed Diode Forward Current                              | I <sub>SM</sub>                  |                                                                                                                                                          |                                                | -    | -    | 53    |      |
| Diode Forward Voltage                                     | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 11 A, V <sub>GS</sub> = 0 V                                                                                     |                                                | -    | 0.9  | 1.2   | V    |
| Reverse Recovery Time                                     | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 11 A,<br>dI/dt = 100 A/μs, V <sub>R</sub> = 25 V                                               |                                                | -    | 160  | -     | ns   |
| Reverse Recovery Charge                                   | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                | -    | 1.2  | -     | μC   |
| Reverse Recovery Current                                  | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                | -    | 14   | -     | A    |

**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .  
 b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

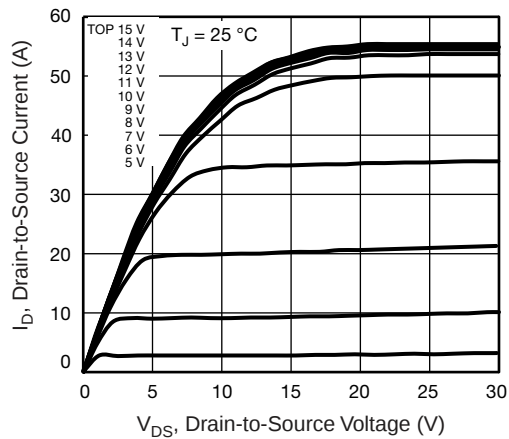


Fig. 1 - Typical Output Characteristics

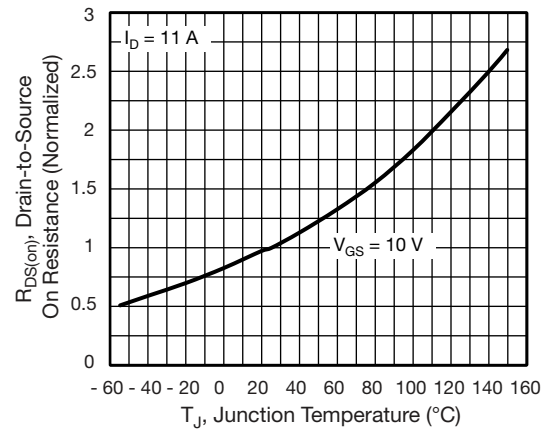


Fig. 4 - Normalized On-Resistance vs. Temperature



Fig. 2 - Typical Output Characteristics

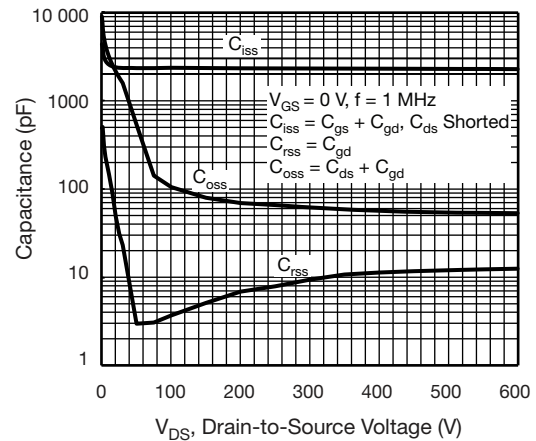


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

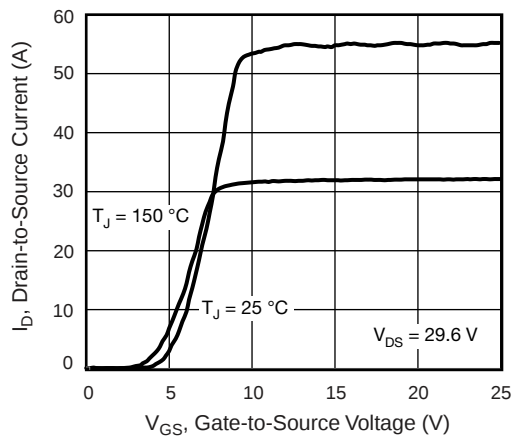


Fig. 3 - Typical Transfer Characteristics

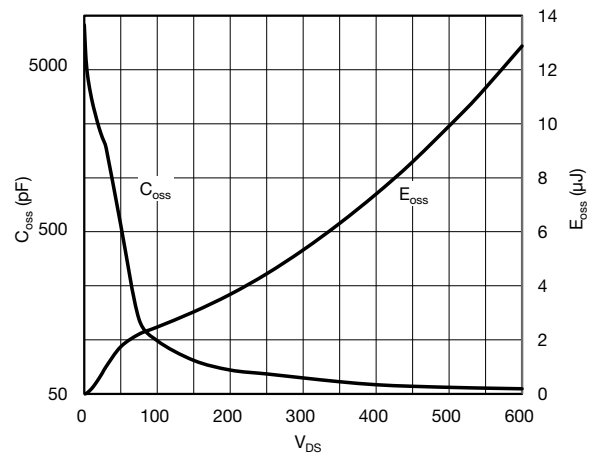


Fig. 6 -  $C_{oss}$  and  $E_{oss}$  vs.  $V_{DS}$



Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

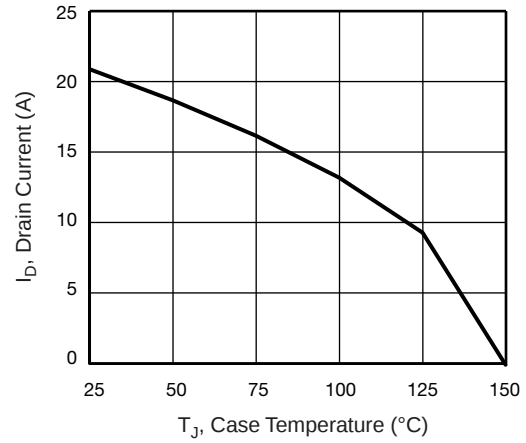


Fig. 10 - Maximum Drain Current vs. Case Temperature

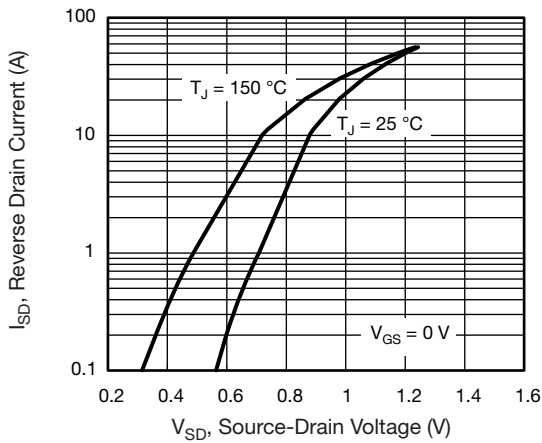


Fig. 8 - Typical Source-Drain Diode Forward Voltage



Fig. 11 - Temperature vs. Drain-to-Source Voltage

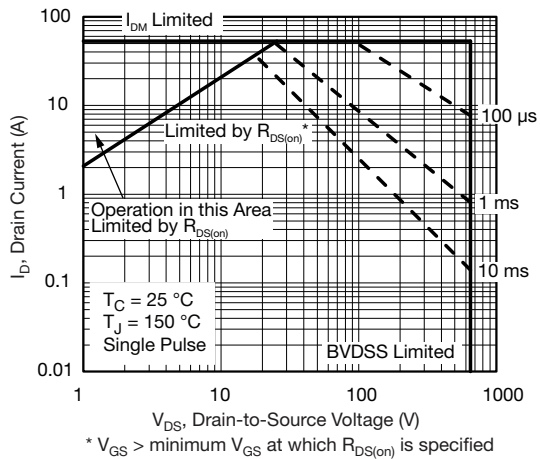
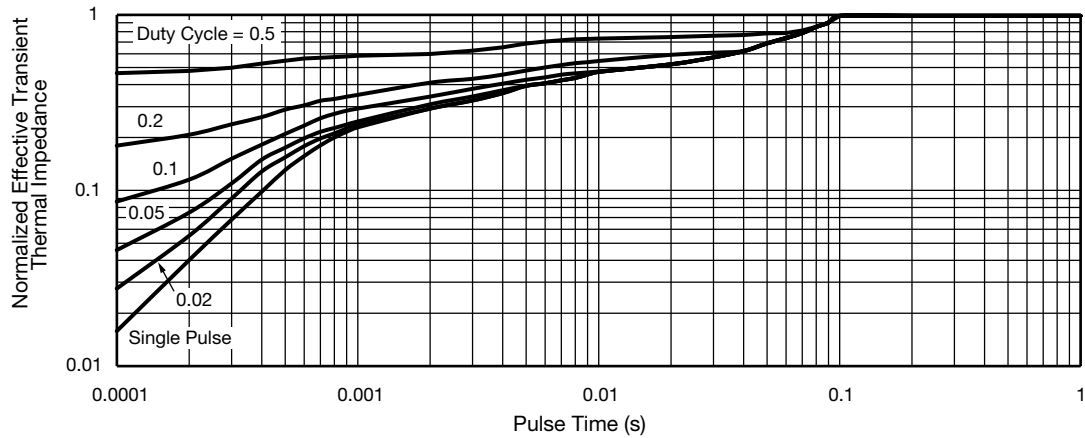
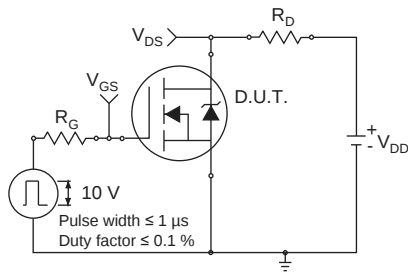


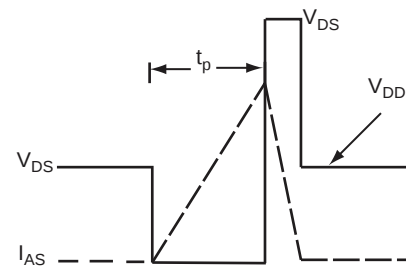
Fig. 9 - Maximum Safe Operating Area



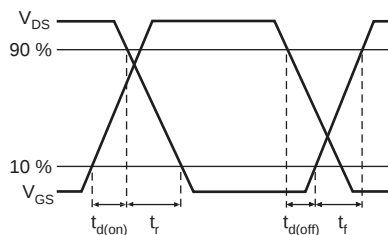
**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**



**Fig. 13 - Switching Time Test Circuit**



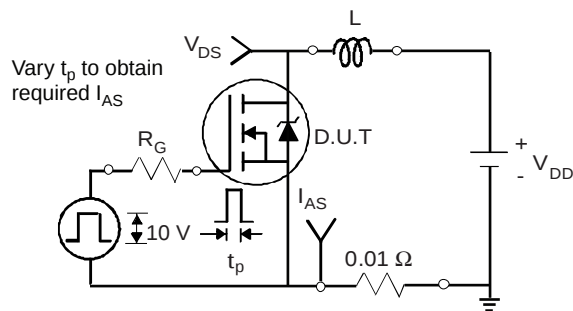
**Fig. 16 - Unclamped Inductive Waveforms**



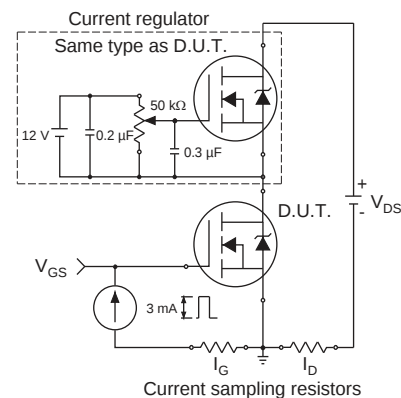
**Fig. 14 - Switching Time Waveforms**



**Fig. 17 - Basic Gate Charge Waveform**



**Fig. 15 - Unclamped Inductive Test Circuit**



**Fig. 18 - Gate Charge Test Circuit**



**Note**

a.  $V_{GS} = 5 V$  for logic level devices

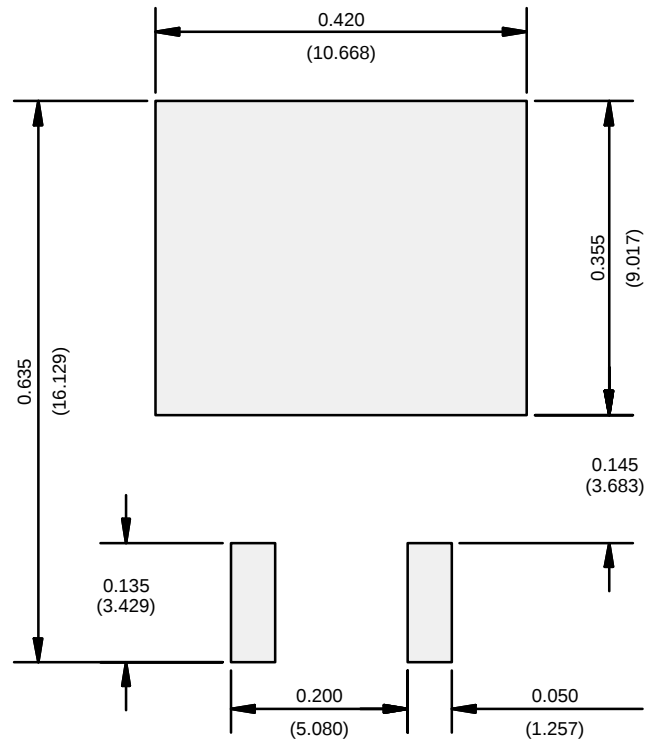
**Fig. 19 - For N-Channel**

[illegible]

|      | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
| DIM. | MIN.        | MAX.  | MIN.      | MAX.  |
| D1   | 6.86        | -     | 0.270     | -     |
| E    | 9.65        | 10.67 | 0.380     | 0.420 |
| E1   | 6.22        | -     | 0.245     | -     |
| e    | 2.54 BSC    |       | 0.100 BSC |       |
| H    | 14.61       | 15.88 | 0.575     | 0.625 |
| L    | 1.78        | 2.79  | 0.070     | 0.110 |
| L1   | -           | 1.65  | -         | 0.066 |
| L2   | -           | 1.78  | -         | 0.070 |
| L3   | 0.25 BSC    |       | 0.010 BSC |       |
| L4   | 4.78        | 5.28  | 0.188     | 0.208 |

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body at datum A.
4. Thermal PAD contour optional within dimension E, L1, D1 and E1.
5. Dimension b1 and c1 apply to base metal only.
6. Datum A and B to be determined at datum plane H.
7. Outline conforms to JEDEC outline to TO-263AB.

**RECOMMENDED MINIMUM PADS FOR D<sup>2</sup>PAK: 3-Lead**



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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