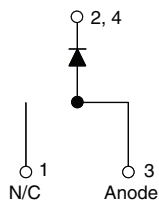


# HEXFRED®, Ultrafast Soft Recovery Diode, 4 A



DPAK (TO-252AA)



## FEATURES

- Ultrafast recovery time
- Ultrasoft recovery
- Very low  $I_{RRM}$
- Very low  $Q_{rr}$
- Guaranteed avalanche
- Specified at operating temperature
- Meets MSL level 1, per J-STD-020, LF maximum peak of 260 °C
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

## PRIMARY CHARACTERISTICS

|                       |                 |
|-----------------------|-----------------|
| $I_{F(AV)}$           | 4 A             |
| $V_R$                 | 600 V           |
| $V_F$ at $I_F$        | 1.4 V           |
| $t_{rr}$ typ.         | 17 ns           |
| $T_J$ max.            | 150 °C          |
| Package               | DPAK (TO-252AA) |
| Circuit configuration | Single          |

## BENEFITS

- Reduced RFI and EMI
- Reduced power loss in diode and switching transistor
- Higher frequency operation
- Reduced snubbing
- Reduced parts count

## DESCRIPTION / APPLICATIONS

These diodes are optimized to reduce losses and EMI / RFI in high frequency power conditioning systems. The softness of the recovery eliminates the need for a snubber in most applications. These devices are ideally suited for freewheeling, flyback, power converters, motor drives, and other applications where high speed and reduced switching losses are design requirements.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                   | SYMBOL         | TEST CONDITIONS       | VALUES      | UNITS |
|---------------------------------------------|----------------|-----------------------|-------------|-------|
| Cathode to anode voltage                    | $V_{RRM}$      |                       | 600         | V     |
| Maximum continuous forward current          | $I_{F(AV)}$    | $T_C = 100\text{ °C}$ | 4           | A     |
| Single pulse forward current                | $I_{FSM}$      |                       | 25          |       |
| Repetitive peak forward current             | $I_{FRM}$      | $T_C = 116\text{ °C}$ | 16          |       |
| Maximum power dissipation                   | $P_D$          | $T_C = 100\text{ °C}$ | 10          | W     |
| Operating junction and storage temperatures | $T_J, T_{Stg}$ |                       | -55 to +150 | °C    |

## ELECTRICAL SPECIFICATIONS ( $T_J = 25\text{ °C}$ unless otherwise specified)

| PARAMETER                           | SYMBOL        | TEST CONDITIONS                                   | MIN. | TYP. | MAX. | UNITS         |
|-------------------------------------|---------------|---------------------------------------------------|------|------|------|---------------|
| Breakdown voltage, blocking voltage | $V_{BR}, V_R$ | $I_R = 100\text{ }\mu\text{A}$                    | 600  | -    | -    | V             |
| Forward voltage<br>See fig. 1       | $V_F$         | $I_F = 4\text{ A}$                                | -    | 1.5  | 1.8  |               |
|                                     |               | $I_F = 8\text{ A}$                                | -    | 1.8  | 2.2  |               |
|                                     |               | $I_F = 4\text{ A}, T_J = 125\text{ °C}$           | -    | 1.4  | 1.7  |               |
| Maximum reverse leakage current     | $I_R$         | $V_R = V_R$ rated                                 | -    | 0.17 | 3.0  | $\mu\text{A}$ |
|                                     |               | $T_J = 125\text{ °C}, V_R = 0.8 \times V_R$ rated | -    | 44   | 300  |               |
| Junction capacitance                | $C_T$         | $V_R = 200\text{ V}$                              | -    | 4    | 8    | pF            |
| Series inductance                   | $L_S$         | Measured lead to lead 5 mm from package body      | -    | 8.0  | -    | nH            |



| DYNAMIC RECOVERY CHARACTERISTICS ( $T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified) |                  |                                                                                   |      |      |      |                  |
|---------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------------------|------|------|------|------------------|
| PARAMETER                                                                                         | SYMBOL           | TEST CONDITIONS                                                                   | MIN. | TYP. | MAX. | UNITS            |
| Reverse recovery time                                                                             | $t_{rr}$         | $I_F = 1.0\text{ A}$ , $dI_F/dt = 200\text{ A}/\mu\text{A}$ , $V_R = 30\text{ V}$ | -    | 17   | -    | ns               |
|                                                                                                   |                  | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 28   | 42   |                  |
|                                                                                                   |                  | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 38   | 57   |                  |
| Peak recovery current                                                                             | $I_{RRM}$        | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 2.9  | 5.2  | A                |
|                                                                                                   |                  | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 3.7  | 6.7  |                  |
| Reverse recovery charge                                                                           | $Q_{rr}$         | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 40   | 60   | nC               |
|                                                                                                   |                  | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 70   | 105  |                  |
| Rate of fall of recovery current                                                                  | $di_{(rec)M}/dt$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                | -    | 280  | -    | A/ $\mu\text{s}$ |
|                                                                                                   |                  | $T_J = 125\text{ }^{\circ}\text{C}$                                               | -    | 235  | -    |                  |

| THERMAL - MECHANICAL SPECIFICATIONS            |                   |                            |              |      |            |                             |
|------------------------------------------------|-------------------|----------------------------|--------------|------|------------|-----------------------------|
| PARAMETER                                      | SYMBOL            | TEST CONDITIONS            | MIN.         | TYP. | MAX.       | UNITS                       |
| Maximum junction and storage temperature range | $T_J$ , $T_{Stg}$ |                            | -55          | -    | 150        | $^{\circ}\text{C}$          |
| Thermal resistance, junction to case           | $R_{thJC}$        |                            | -            | -    | 5.0        | $^{\circ}\text{C}/\text{W}$ |
| Thermal resistance, junction to ambient        | $R_{thJA}$        | Typical socket mount       | -            | -    | 80         |                             |
| Weight                                         |                   |                            | -            | 2.0  | -          | g                           |
|                                                |                   |                            | -            | 0.07 | -          | oz.                         |
| Mounting torque                                |                   |                            | 6.0<br>(5.0) | -    | 12<br>(10) | kgf · cm<br>(lbf · in)      |
| Marking device                                 |                   | Case style DPAK (TO-252AA) | HFA04SD60S   |      |            |                             |

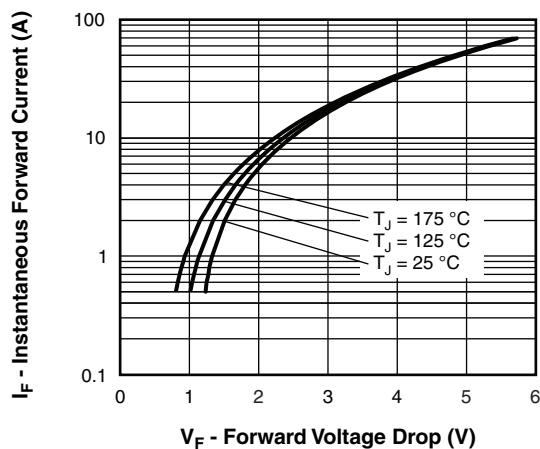


Fig. 1 - Typical Forward Voltage Drop Characteristics

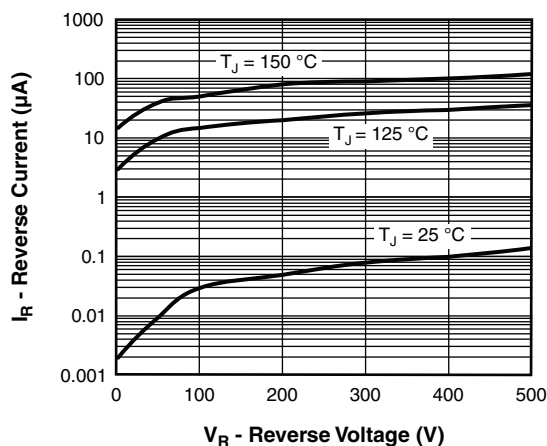


Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage

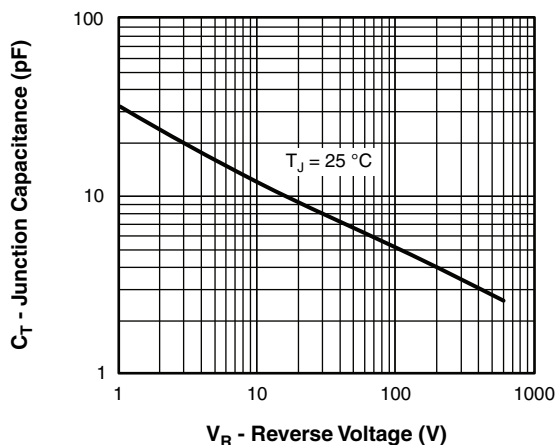
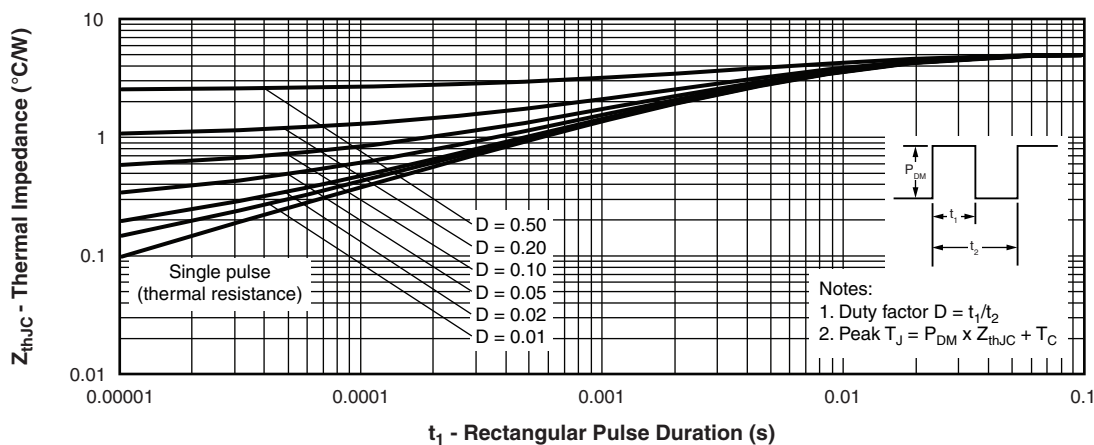
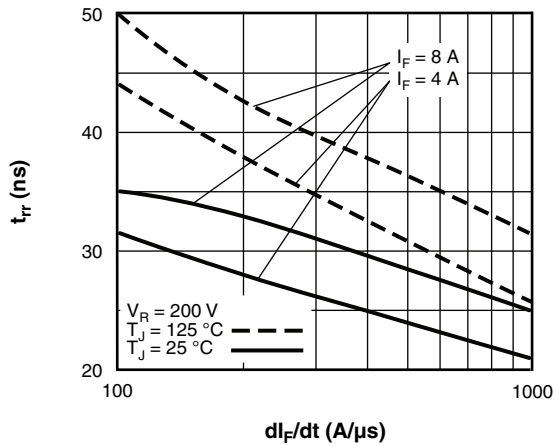
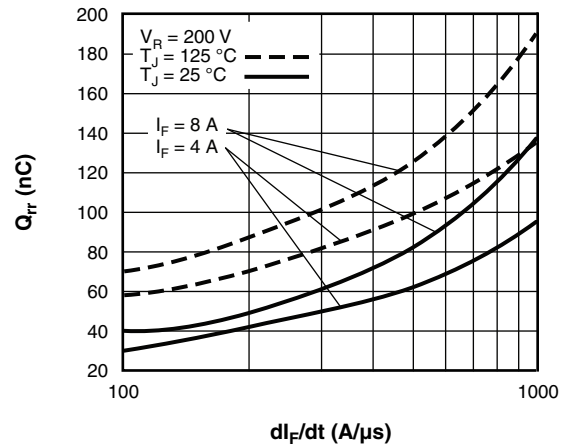
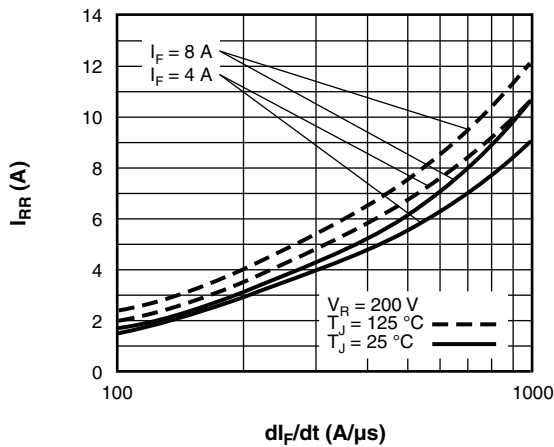
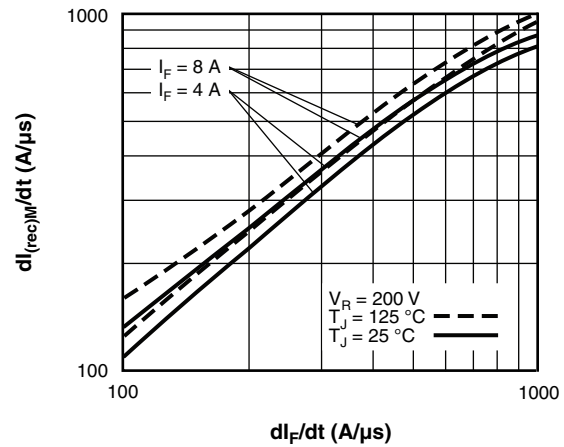


Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage


Fig. 4 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics


Fig. 5 - Typical Reverse Recovery Time vs.  $dI_F/dt$ 

Fig. 7 - Typical Stored Charge vs.  $dI_F/dt$ 

Fig. 6 - Typical Recovery Current vs.  $dI_F/dt$ 

Fig. 8 - Typical  $dI_{(rec)M}/dt$  vs.  $dI_F/dt$

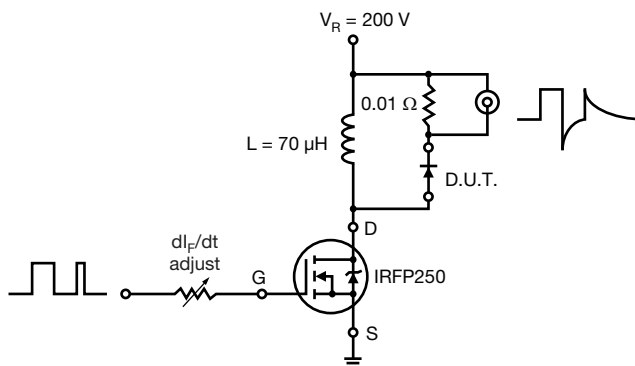


Fig. 9 - Reverse Recovery Parameter Test Circuit

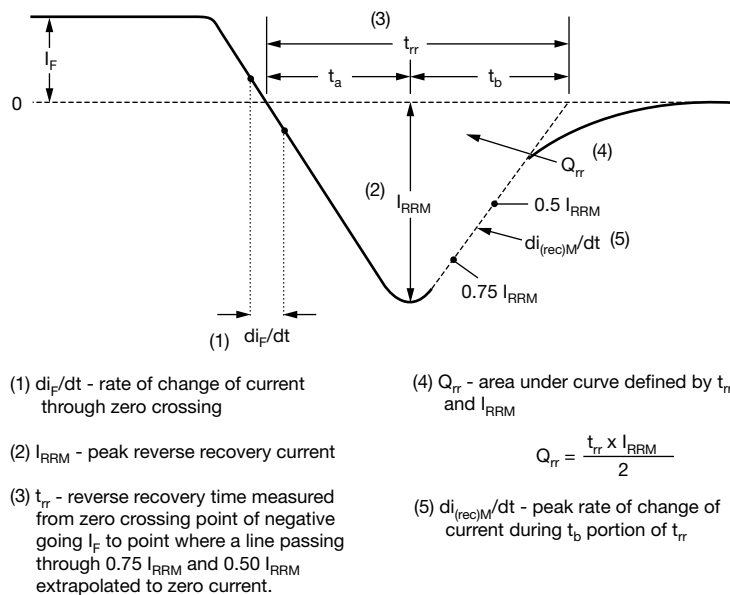


Fig. 10 - Reverse Recovery Waveform and Definitions

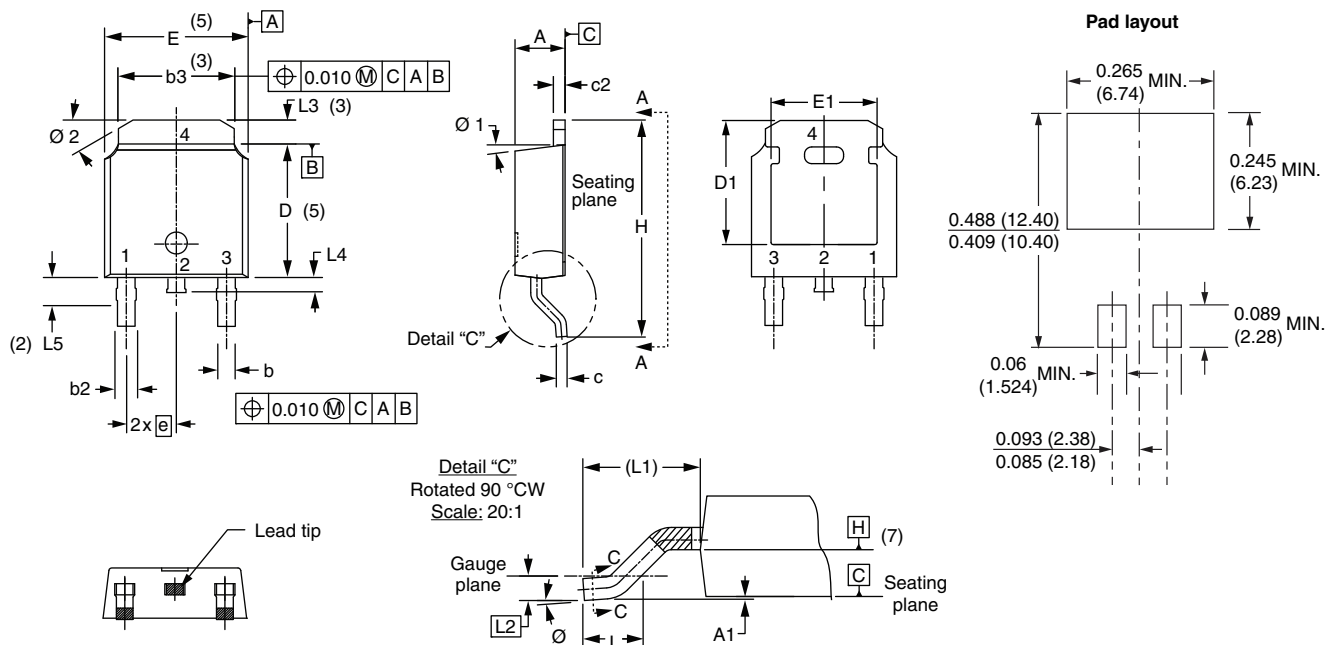
**ORDERING INFORMATION TABLE**

|             |            |           |          |           |           |           |          |           |            |
|-------------|------------|-----------|----------|-----------|-----------|-----------|----------|-----------|------------|
| Device code | <b>VS-</b> | <b>HF</b> | <b>A</b> | <b>04</b> | <b>SD</b> | <b>60</b> | <b>S</b> | <b>TR</b> | <b>-M3</b> |
|             | 1          | 2         | 3        | 4         | 5         | 6         | 7        | 8         | 9          |

- |          |   |                                                                                                                                                               |
|----------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | - | Vishay Semiconductors product                                                                                                                                 |
| <b>2</b> | - | HEXFRED® family                                                                                                                                               |
| <b>3</b> | - | Electron irradiated                                                                                                                                           |
| <b>4</b> | - | Current rating (04 = 4 A)                                                                                                                                     |
| <b>5</b> | - | D-PAK                                                                                                                                                         |
| <b>6</b> | - | Voltage rating (60 = 600 V)                                                                                                                                   |
| <b>7</b> | - | S = D-PAK                                                                                                                                                     |
| <b>8</b> | - | <ul style="list-style-type: none"><li>• TR = tape and reel</li><li>• R = tape and reel (right oriented)</li><li>• L = tape and reel (left oriented)</li></ul> |
| <b>9</b> | - | Environmental digit:<br>-M3 = halogen-free, RoHS-compliant, and terminations lead (Pb)-free                                                                   |

| <b>ORDERING INFORMATION (Example)</b> |                      |                              |
|---------------------------------------|----------------------|------------------------------|
| <b>PREFERRED P/N</b>                  | <b>BASE QUANTITY</b> | <b>PACKAGING DESCRIPTION</b> |
| VS-HFA04SD60S-M3                      | 75                   | Antistatic plastic tube      |
| VS-HFA04SD60STR-M3                    | 2000                 | 13" diameter reel            |
| VS-HFA04SD60SL-M3                     | 3000                 | 13" diameter reel            |
| VS-HFA04SD60SR-M3                     | 3000                 | 13" diameter reel            |

| <b>LINKS TO RELATED DOCUMENTS</b> |                                                                        |
|-----------------------------------|------------------------------------------------------------------------|
| Dimensions                        | <a href="http://www.vishay.com/doc?95627">www.vishay.com/doc?95627</a> |
| Part marking information          | <a href="http://www.vishay.com/doc?95176">www.vishay.com/doc?95176</a> |
| Packaging information             | <a href="http://www.vishay.com/doc?95033">www.vishay.com/doc?95033</a> |

**D-PAK (TO-252AA) “M”****DIMENSIONS** in millimeters and inches

| SYMBOL | MILLIMETERS |      | INCHES |       | NOTES |
|--------|-------------|------|--------|-------|-------|
|        | MIN.        | MAX. | MIN.   | MAX.  |       |
| A      | 2.18        | 2.39 | 0.086  | 0.094 |       |
| A1     | -           | 0.13 | -      | 0.005 |       |
| b      | 0.64        | 0.89 | 0.025  | 0.035 |       |
| b2     | 0.76        | 1.14 | 0.030  | 0.045 |       |
| b3     | 4.95        | 5.46 | 0.195  | 0.215 | 3     |
| c      | 0.46        | 0.61 | 0.018  | 0.024 |       |
| c2     | 0.46        | 0.89 | 0.018  | 0.035 |       |
| D      | 5.97        | 6.22 | 0.235  | 0.245 | 5     |
| D1     | 5.21        | -    | 0.205  | -     | 3     |
| E      | 6.35        | 6.73 | 0.250  | 0.265 | 5     |
| E1     | 4.32        | -    | 0.170  | -     | 3     |

| SYMBOL | MILLIMETERS |       | INCHES     |       | NOTES |
|--------|-------------|-------|------------|-------|-------|
|        | MIN.        | MAX.  | MIN.       | MAX.  |       |
| e      | 2.29 BSC    |       | 0.090 BSC  |       |       |
| H      | 9.40        | 10.41 | 0.370      | 0.410 |       |
| L      | 1.40        | 1.78  | 0.055      | 0.070 |       |
| L1     | 2.74 BSC    |       | 0.108 REF. |       |       |
| L2     | 0.51 BSC    |       | 0.020 BSC  |       |       |
| L3     | 0.89        | 1.27  | 0.035      | 0.050 | 3     |
| L4     | -           | 1.02  | -          | 0.040 |       |
| L5     | 1.14        | 1.52  | 0.045      | 0.060 | 2     |
| Ø      | 0°          | 10°   | 0°         | 10°   |       |
| Ø1     | 0°          | 15°   | 0°         | 15°   |       |
| Ø2     | 25°         | 35°   | 25°        | 35°   |       |

**Notes**

- (1) Dimensioning and tolerancing as per ASME Y14.5M-1994
- (2) Lead dimension uncontrolled in L5
- (3) Dimension D1, E1, L3 and b3 establish a minimum mounting surface for thermal pad
- (4) Section C - C dimension apply to the flat section of the lead between 0.13 and 0.25 mm (0.005 and 0.010") from the lead tip
- (5) 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 outermost extremes of the plastic body
- (6) Dimension b1 and c1 applied to base metal only
- (7) Datum A and B to be determined at datum plane H
- (8) Outline conforms to JEDEC® outline TO-252AA



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