

Power MOSFET

| PRODUCT SUMMARY | |
|---------------------------|-------------------------|
| V_{DS} (V) | - 60 |
| $R_{DS(on)}$ (Ω) | $V_{GS} = -10$ V 0.28 |
| Q_g max. (nC) | 19 |
| Q_{gs} (nC) | 5.4 |
| Q_{gd} (nC) | 11 |
| Configuration | Single |

FEATURES

- Advanced process technology
- Surface mount (IRF9Z24S, SiHF9Z24S)
- 175 °C operating temperature
- Fast switching
- P-channel
- Fully avalanche rated
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS*
Available
HALOGEN FREE
Available

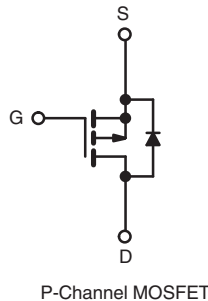
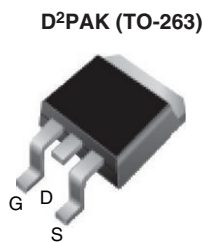
Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details.

DESCRIPTION

Third generation power MOSFETs from Vishay utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The D²PAK is a surface mount power package capable of accommodating die size up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The D²PAK is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0 W in a typical surface mount application.



| ORDERING INFORMATION | | | |
|---------------------------------|-----------------------------|-------------------------------|-------------------------------|
| Package | D ² PAK (TO-263) | D ² PAK (TO-263) | D ² PAK (TO-263) |
| Lead (Pb)-free and Halogen-free | SiHF9Z24S-GE3 | SiHF9Z24STRL-GE3 ^a | SiHF9Z24STRR-GE3 ^a |
| Lead (Pb)-free | IRF9Z24SPbF | IRF9Z24STRLPbF ^a | IRF9Z24STRRPbF ^a |

Note

a. See device orientation.

| ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted) | | | | |
|---|-------------------|----------------|------|---|
| PARAMETER | SYMBOL | LIMIT | UNIT | |
| Drain-Source Voltage | V_{DS} | -60 | V | |
| Gate-Source Voltage | V_{GS} | ± 20 | | |
| Continuous Drain Current ^e | V_{GS} at -10 V | $T_C = 25$ °C | -11 | A |
| | | $T_C = 100$ °C | -7.7 | |
| Pulsed Drain Current ^{a, e} | I_{DM} | -44 | | |
| Linear Derating Factor | | 0.40 | W/°C | |
| Single Pulse Avalanche Energy ^{b, e} | E_{AS} | 240 | mJ | |
| Repetitive Avalanche Current ^a | I_{AR} | -11 | A | |
| Repetitive Avalanche Energy ^a | E_{AR} | 6.0 | mJ | |
| Maximum Power Dissipation | P_D | $T_A = 25$ °C | 3.7 | W |
| | | $T_C = 25$ °C | 60 | W |
| Peak Diode Recovery dV/dt ^{c, e} | dV/dt | -4.5 | V/ns | |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | -55 to +175 | °C | |
| Soldering Recommendations (Peak temperature) ^d | for 10 s | 300 | | |

Notes


- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = -25$ V, starting $T_J = 25$ °C, $L = 2.3$ mH, $R_g = 25$ Ω , $I_{AS} = -11$ A (see fig. 12).
- $I_{SD} \leq -11$ A, $dI/dt \leq 140$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 175$ °C.
- 1.6 mm from case.
- Uses IRF9Z24, SiHF9Z24 data and test conditions.



| THERMAL RESISTANCE RATINGS | | | | | | |
|--|-------------------|------|------|------|------|--|
| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT | |
| Maximum Junction-to-Ambient (PCB mount) ^a | R _{thJA} | - | - | 40 | °C/W | |
| Maximum Junction-to-Case (Drain) | R _{thJC} | - | - | 2.5 | | |

Note

a. When mounted on 1" square PCB (FR-4 or G-10 material).

| SPECIFICATIONS (T _J = 25 °C, unless otherwise noted) | | | | | | | |
|---|----------------------------------|---|---|------|--------|-------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | | |
| Drain-Source Breakdown Voltage | V _{DS} | V _{GS} = 0, I _D = -250 μA | | -60 | - | - | V |
| V _{DS} Temperature Coefficient | ΔV _{DS} /T _J | Reference to 25 °C, I _D = -1 mA ^c | | - | -0.056 | - | V/°C |
| Gate-Source Threshold Voltage | V _{GS(th)} | V _{DS} = V _{GS} , I _D = -250 μA | | -2.0 | - | -4.0 | V |
| Gate-Source Leakage | I _{GSS} | V _{GS} = ± 20 V | | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | I _{DSS} | V _{DS} = -60 V, V _{GS} = 0 V | | - | - | -100 | μA |
| | | V _{DS} = -48 V, V _{GS} = 0 V, T _J = 150 °C | | - | - | -500 | |
| Drain-Source On-State Resistance | R _{DS(on)} | V _{GS} = -10 V | I _D = -6.6 A ^b | - | - | 0.28 | Ω |
| Forward Transconductance | g _{fs} | V _{DS} = -25 V, I _D = -6.6 A ^c | | 1.4 | - | - | S |
| Dynamic | | | | | | | |
| Input Capacitance | C _{iss} | V _{GS} = 0 V, V _{DS} = -25 V, f = 1.0 MHz, see fig. 5 ^c | | - | 570 | - | pF |
| Output Capacitance | C _{oss} | | | - | 360 | - | |
| Reverse Transfer Capacitance | C _{rss} | | | - | 65 | - | |
| Total Gate Charge | Q _g | V _{GS} = -10 V | I _D = -11 A, V _{DS} = -48 V, see fig. 6 and 13 ^{b, c} | - | - | 19 | nC |
| Gate-Source Charge | Q _{gs} | | | - | - | 5.4 | |
| Gate-Drain Charge | Q _{gd} | | | - | - | 11 | |
| Turn-On Delay Time | t _{d(on)} | V _{DD} = -30 V, I _D = -11 A, R _g = 18 Ω, R _D = 2.5 Ω, see fig. 10 ^b | | - | 13 | - | ns |
| Rise Time | t _r | | | - | 68 | - | |
| Turn-Off Delay Time | t _{d(off)} | | | - | 15 | - | |
| Fall Time | t _f | | | - | 29 | - | |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous Source-Drain Diode Current | I _S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | -11 | A |
| Pulsed Diode Forward Current ^a | I _{SM} | | | - | - | -44 | |
| Body Diode Voltage | V _{SD} | T _J = 25 °C, I _S = -11 A, V _{GS} = 0 V ^b | | - | - | -6.3 | V |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Body Diode Reverse Recovery Time | t _{rr} | T _J = 25 °C, I _F = -11 A, dI/dt = 100 A/μs ^{b, c} | | - | 100 | 200 | ns |
| Body Diode Reverse Recovery Charge | Q _{rr} | | | - | 320 | 640 | |
| Forward Turn-On Time | t _{on} | Intrinsic turn-on time is negligible (turn-on is dominated by L _S and L _D) | | | | | |

Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %.
- c. Uses IRF9Z24, SiHF9Z24 data and test conditions.



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

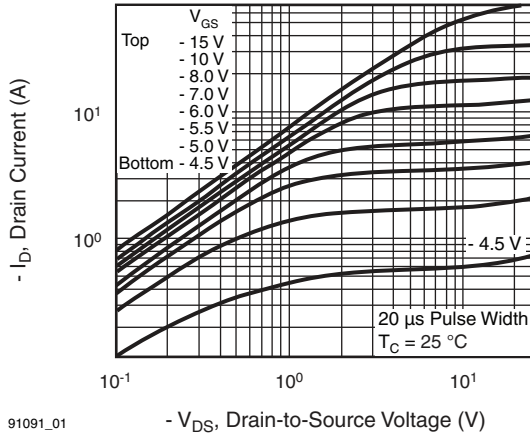


Fig. 1 - Typical Output Characteristics

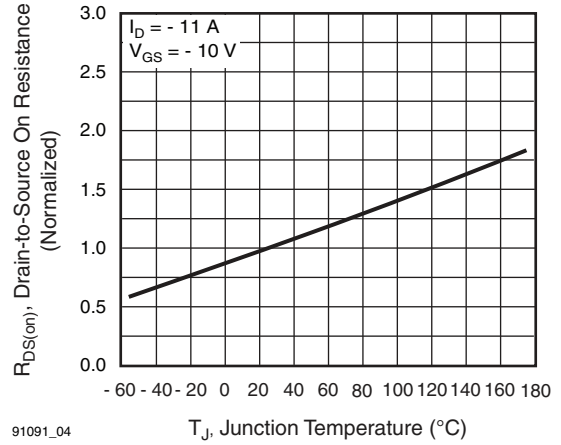


Fig. 4 - Normalized On-Resistance vs. Temperature

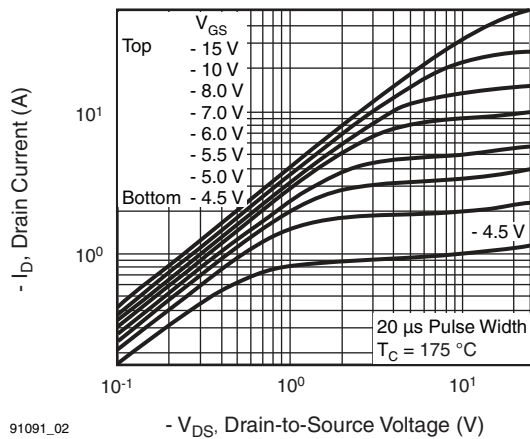


Fig. 2 - Typical Output Characteristics

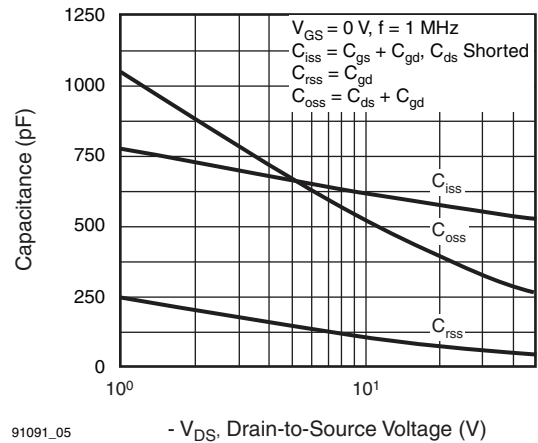


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

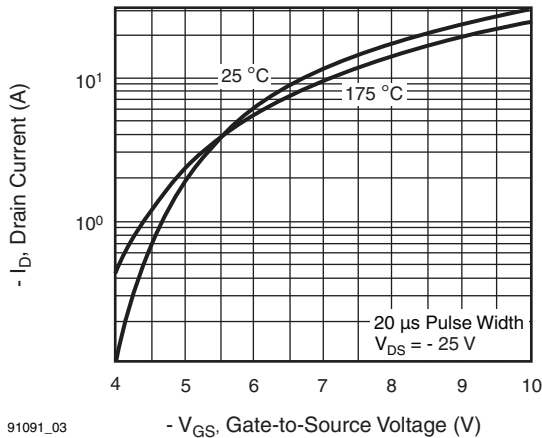


Fig. 3 - Typical Transfer Characteristics

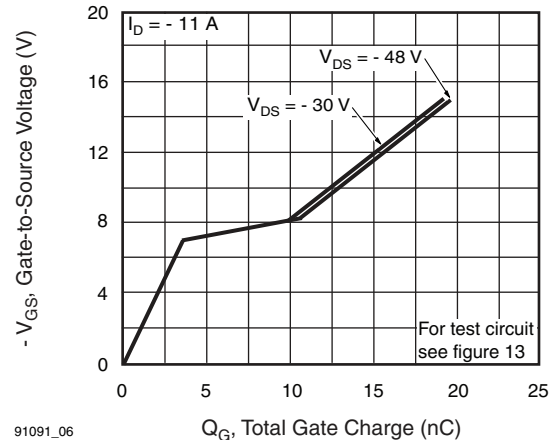


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

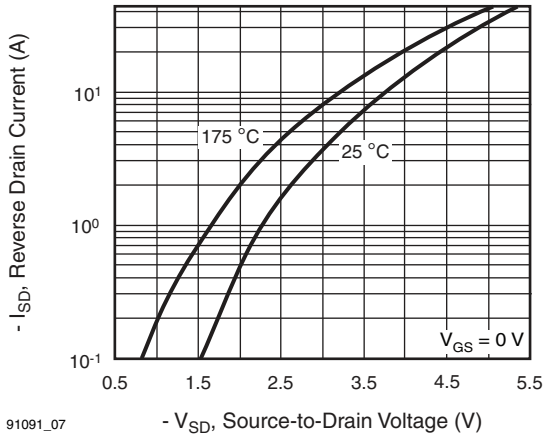


Fig. 7 - Typical Source-Drain Diode Forward Voltage

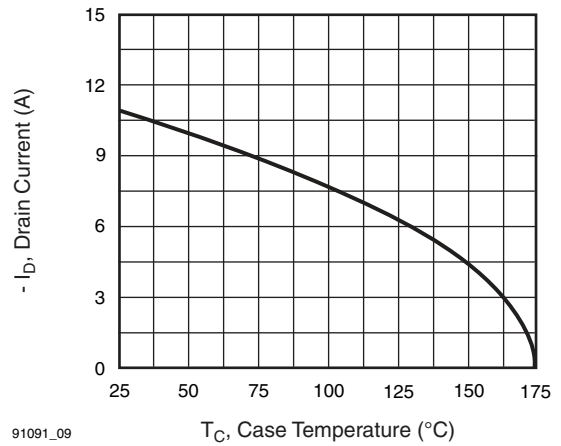


Fig. 9 - Maximum Drain Current vs. Case Temperature

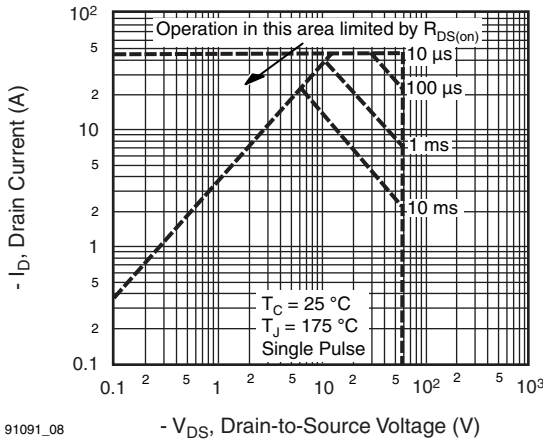


Fig. 8 - Maximum Safe Operating Area

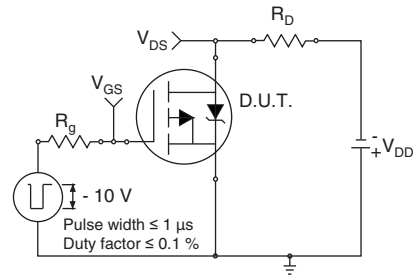


Fig. 10a - Switching Time Test Circuit

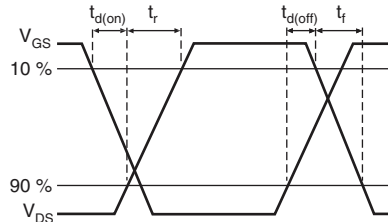


Fig. 10b - Switching Time Waveforms

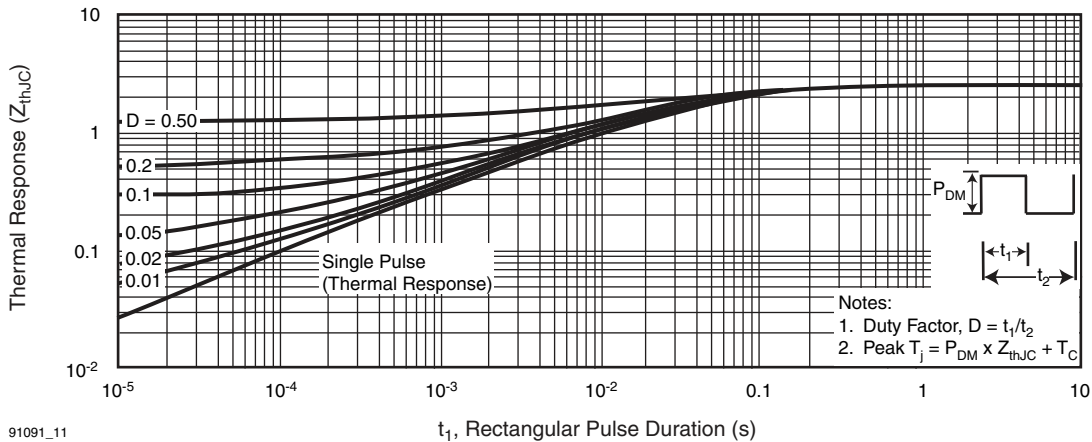


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

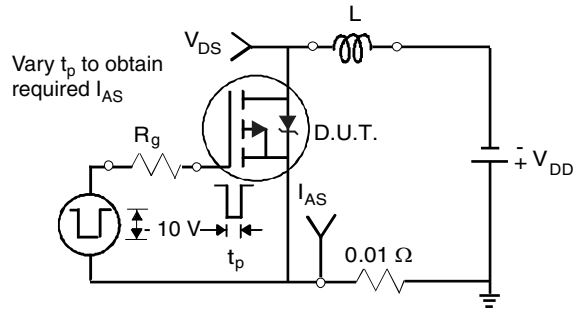


Fig. 12a - Unclamped Inductive Test Circuit

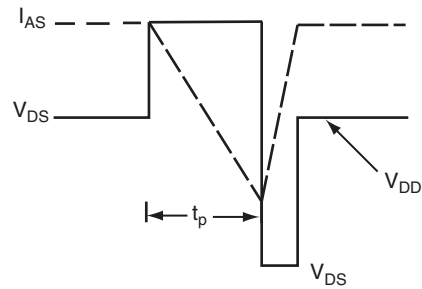


Fig. 12b - Unclamped Inductive Waveforms

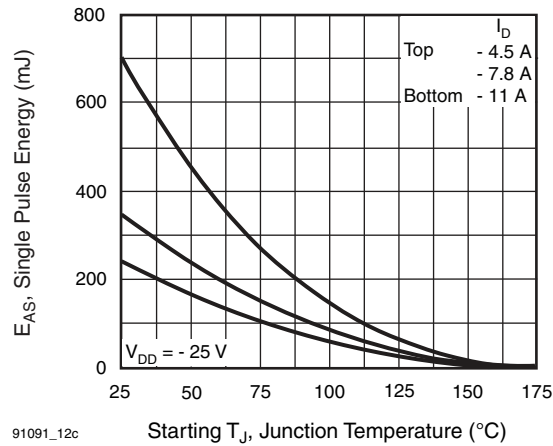


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

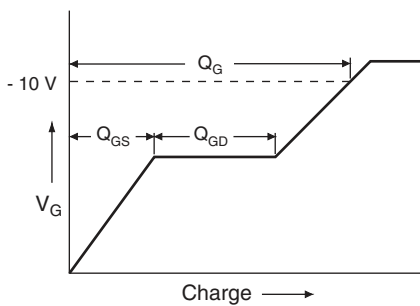


Fig. 13a - Basic Gate Charge Waveform

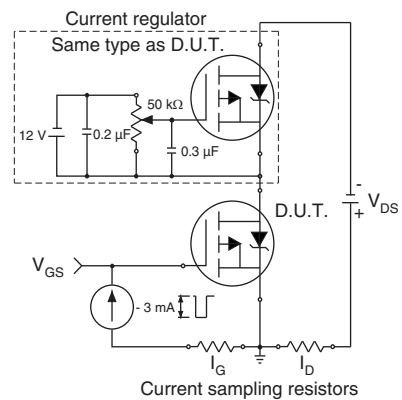


Fig. 13b - Gate Charge Test Circuit

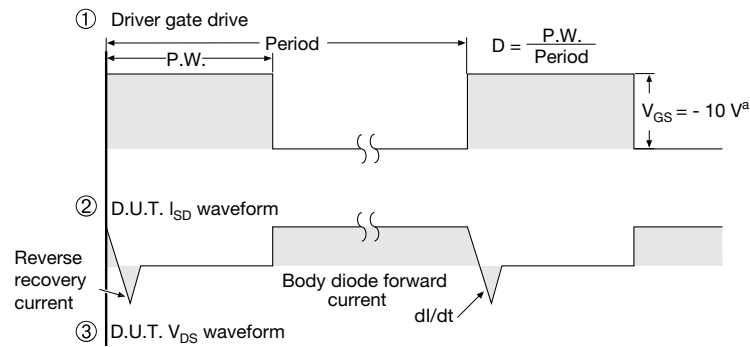
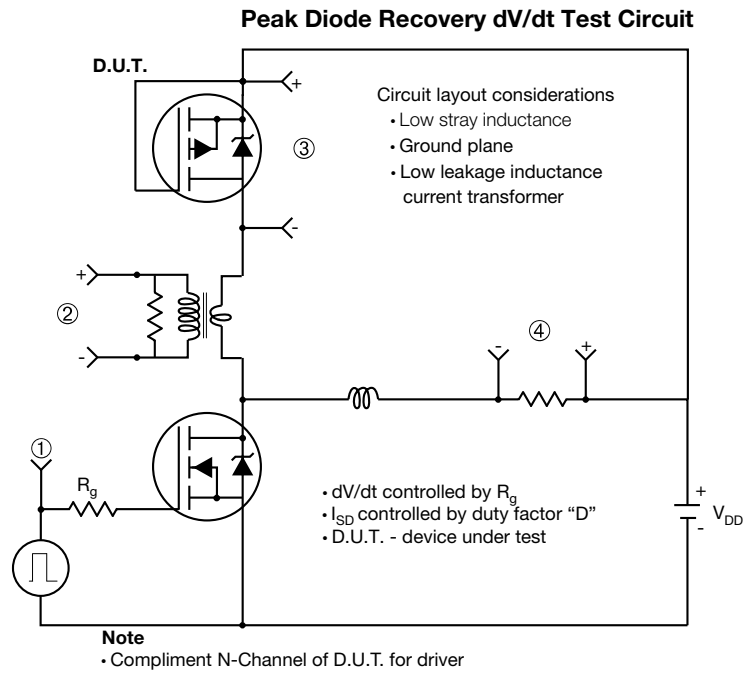


Fig. 14 - For P-Channel

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TO-263AB (HIGH VOLTAGE)



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.06 | 4.83 | 0.160 | 0.190 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.51 | 0.99 | 0.020 | 0.039 |
| b1 | 0.51 | 0.89 | 0.020 | 0.035 |
| b2 | 1.14 | 1.78 | 0.045 | 0.070 |
| b3 | 1.14 | 1.73 | 0.045 | 0.068 |
| c | 0.38 | 0.74 | 0.015 | 0.029 |
| c1 | 0.38 | 0.58 | 0.015 | 0.023 |
| c2 | 1.14 | 1.65 | 0.045 | 0.065 |
| D | 8.38 | 9.65 | 0.330 | 0.380 |

| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|-----------|-------|
| | 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 |

ECN: S-82110-Rev. A, 15-Sep-08
DWG: 5970

Notes

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 D²PAK: 3-Lead



Recommended Minimum Pads
Dimensions in Inches/(mm)

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