

FR9224TF-VB Datasheet

Power MOSFET

PRODUCT SUMMARY

| | | |
|---------------------------|-------------------------|-----|
| V_{DS} (V) | - 250 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = -10\text{ V}$ | 1.0 |
| Q_g (Max.) (nC) | 38 | |
| Q_{gs} (nC) | 8.0 | |
| Q_{gd} (nC) | 18 | |
| Configuration | Single | |

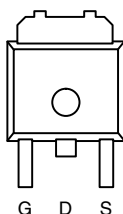
FEATURES

- Advanced Process Technology
- Dynamic dV/dt Rating
- 150 °C Operating Temperature
- Fast Switching
- P-Channel
- Fully Avalanche Rated
- Lead (Pb)-free Available



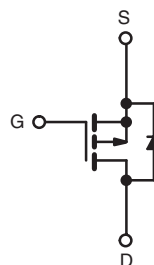
Available
RoHS*
 COMPLIANT

TO-252



Top View

Drain Connected to Tab



P-Channel MOSFET

ABSOLUTE MAXIMUM RATINGS $T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted

| PARAMETER | SYMBOL | LIMIT | UNIT |
|--|--------------------|-----------------------------------|----------|
| Drain-Source Voltage | V_{DS} | - 250 | V |
| Gate-Source Voltage | V_{GS} | ± 20 | |
| Continuous Drain Current | V_{GS} at - 10 V | $T_C = 25\text{ }^\circ\text{C}$ | A |
| | | $T_C = 100\text{ }^\circ\text{C}$ | |
| Pulsed Drain Current ^a | I_{DM} | - 16 | |
| Linear Derating Factor | | 0.28 | W/°C |
| Single Pulse Avalanche Energy ^b | E_{AS} | 520 | mJ |
| Repetitive Avalanche Current ^a | I_{AR} | - 4.1 | A |
| Repetitive Avalanche Energy ^a | E_{AR} | 3.5 | mJ |
| Maximum Power Dissipation | P_D | 85 | W |
| Peak Diode Recovery dV/dt ^c | dV/dt | - 5.0 | V/ns |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | - 55 to + 150 | °C |
| Soldering Recommendations (Peak Temperature) | for 10 s | 300 ^d | |
| Mounting Torque | 6-32 or M3 screw | 10 | lbf · in |
| | | 1.1 | N · m |

Notes


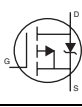
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 62\text{ mH}$, $R_G = 25\text{ }\Omega$, $I_{AS} = -4.1\text{ A}$ (see fig. 12).
- $I_{SD} \leq -4.1\text{ A}$, $dI/dt \leq -640\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$.
- 1.6 mm from case.

* Pb containing terminations are not RoHS compliant, exemptions may apply

THERMAL RESISTANCE RATINGS

| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient | R_{thJA} | - | 65 | °C/W |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | 3.6 | |

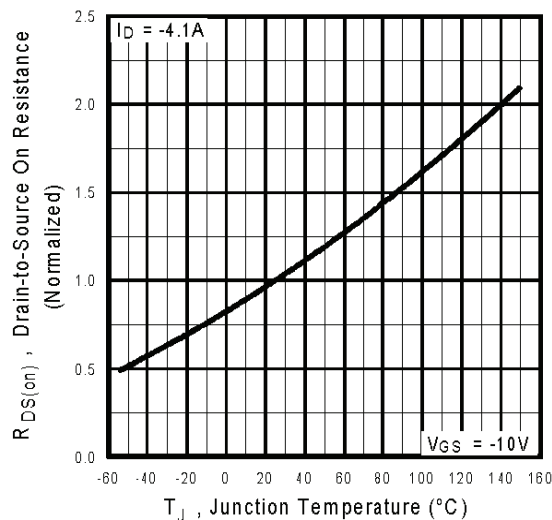
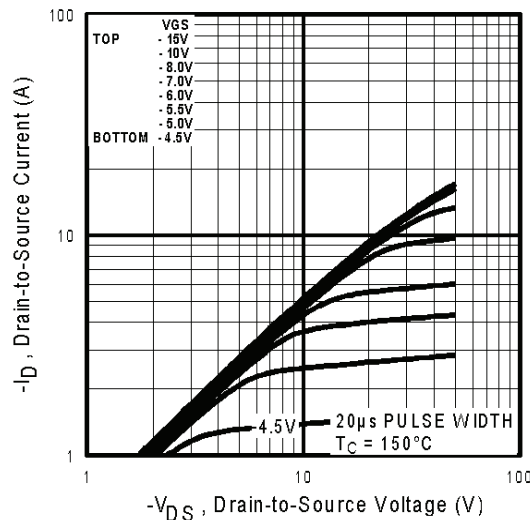
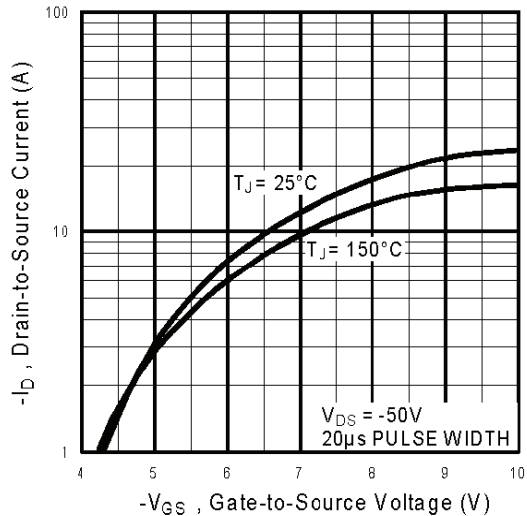
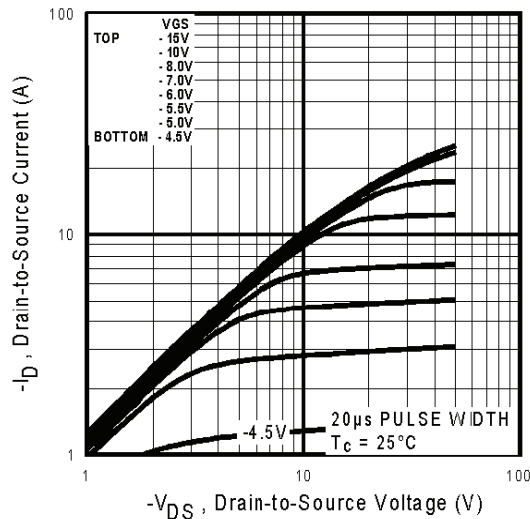
SPECIFICATIONS $T_J = 25\text{ }^{\circ}\text{C}$, unless otherwise noted

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
|---|---------------------|--|--|-------|--------|-----------|-----------------------------|
| Static | | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}$, $I_D = 250\text{ }\mu\text{A}$ | | - 250 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$, $I_D = 1\text{ mA}$ | | - | - 0.27 | - | $\text{V}/^{\circ}\text{C}$ |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | | - 2.0 | - | - 4.0 | V |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | | - | - | ± 100 | nA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = -250\text{ V}$, $V_{GS} = 0\text{ V}$ | | - | - | - 25 | μA |
| | | $V_{DS} = -200\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$ | | - | - | - 250 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = -10\text{ V}$ | $I_D = -2.5\text{ A}^b$ | - | 1.0 | - | Ω |
| Forward Transconductance | g_{fs} | $V_{DS} = -50\text{ V}$, $I_D = -4.1\text{ A}^b$ | | 2.2 | - | - | S |
| Dynamic | | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V}$, $V_{DS} = -25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5 | | - | 680 | - | pF |
| Output Capacitance | C_{oss} | | | - | 170 | - | |
| Reverse Transfer Capacitance | C_{rss} | | | - | 40 | - | |
| Drain to Sink Capacitance | C | $f = 1.0\text{ MHz}$ | | - | 12 | - | |
| Total Gate Charge | Q_g | $V_{GS} = -10\text{ V}$ | $I_D = -4.1\text{ A}$, $V_{DS} = -200\text{ V}$, see fig. 6 and 13 ^b | - | - | 38 | nC |
| Gate-Source Charge | Q_{gs} | | | - | - | 8.0 | |
| Gate-Drain Charge | Q_{gd} | | | - | - | 18 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = -130\text{ V}$, $I_D = -4.1\text{ A}$, $R_G = 12\text{ }\Omega$, $R_D = 31\text{ }\Omega$, see fig. 10 ^b | | - | 12 | - | ns |
| Rise Time | t_r | | | - | 23 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 34 | - | |
| Fall Time | t_f | | | - | 21 | - | |
| Internal Drain Inductance | L_D | Between lead, 6 mm (0.25") from package and center of die contact  | | - | 4.5 | - | nH |
| Internal Source Inductance | L_S | | | - | 7.5 | - | |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | - 4.1 | A |
| Pulsed Diode Forward Current ^a | I_{SM} | | | - | - | - 16 | |
| Body Diode Voltage | V_{SD} | $T_J = 25\text{ }^{\circ}\text{C}$, $I_S = -4.1\text{ A}$, $V_{GS} = 0\text{ V}^b$ | | - | - | - 6.5 | V |
| Body Diode Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^{\circ}\text{C}$, $I_F = -4.1\text{ A}$, $dI/dt = -100\text{ A}/\mu\text{s}^b$ | | - | 190 | 290 | ns |
| Body Diode Reverse Recovery Charge | Q_{rr} | | | - | 1.5 | 2.2 | μC |
| 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 $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



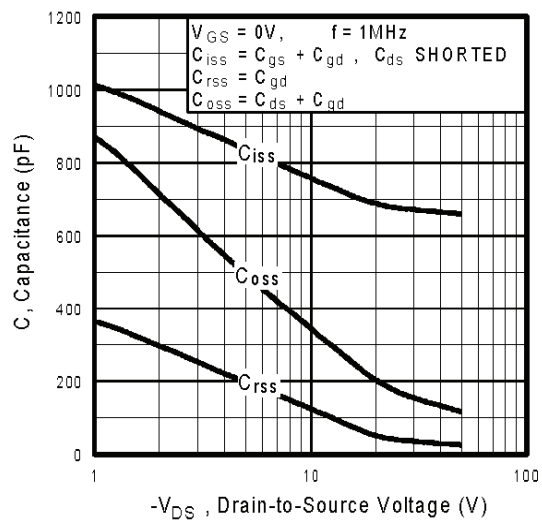


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

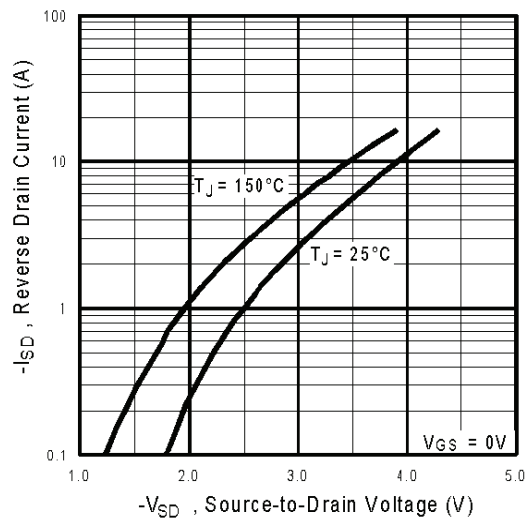


Fig. 7 - Typical Source-Drain Diode Forward Voltage

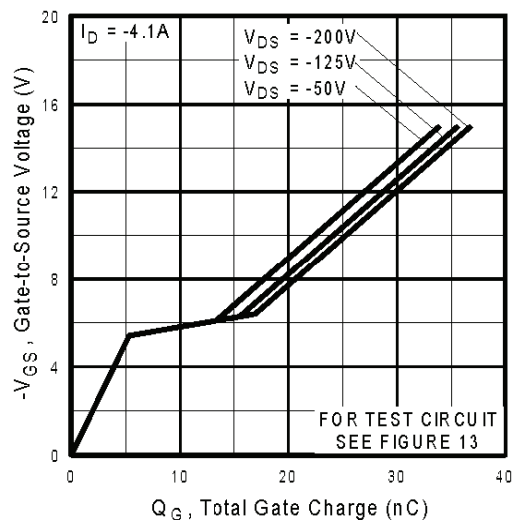


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

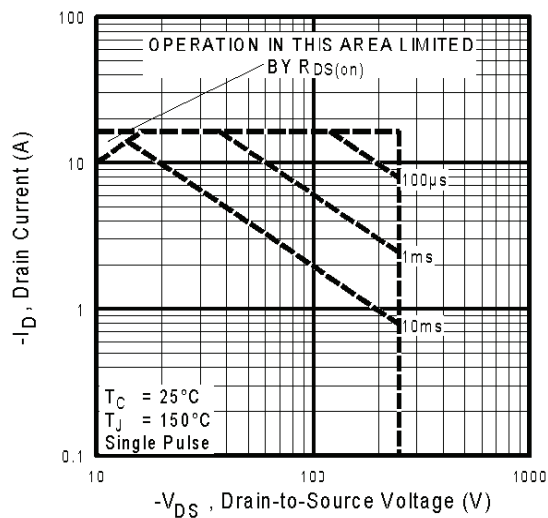


Fig. 8 - Maximum Safe Operating Area



Fig. 9 - Maximum Drain Current vs. Case Temperature

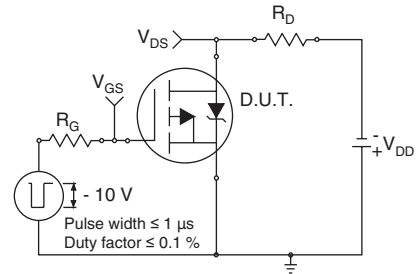


Fig. 10a - Switching Time Test Circuit

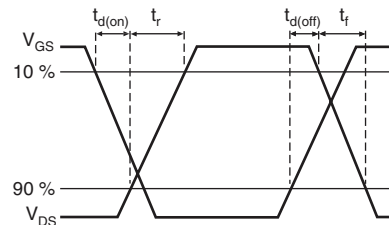


Fig. 10b - Switching Time Waveforms



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

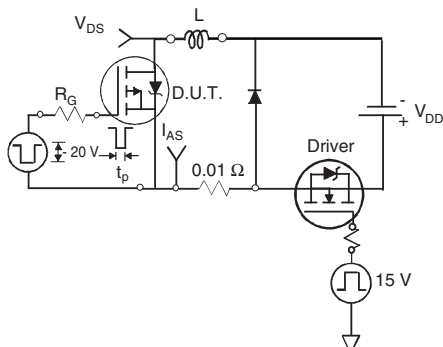


Fig. 12a - Unclamped Inductive Test Circuit

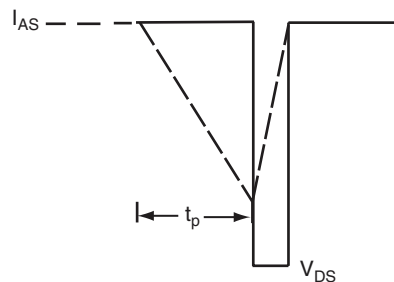


Fig. 12b - Unclamped Inductive Waveforms

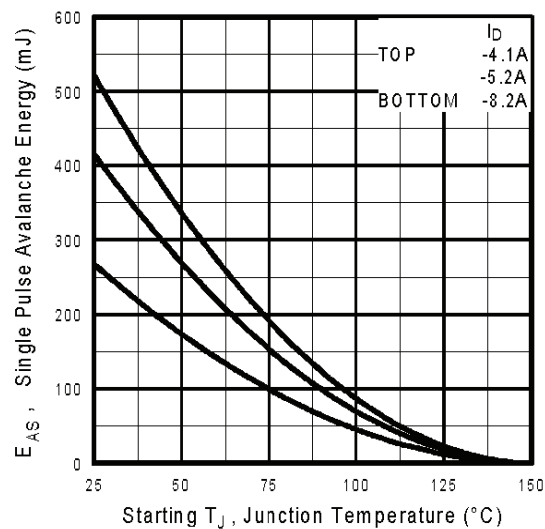


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

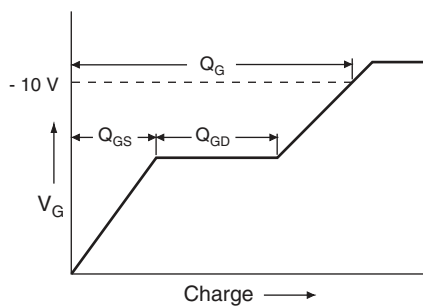


Fig. 13a - Basic Gate Charge Waveform

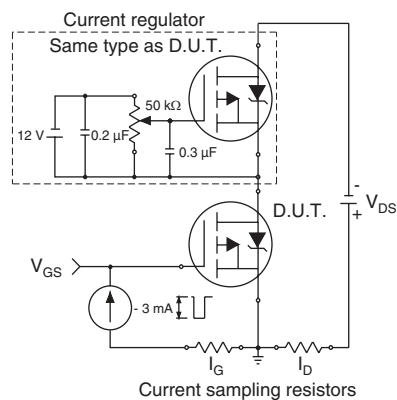
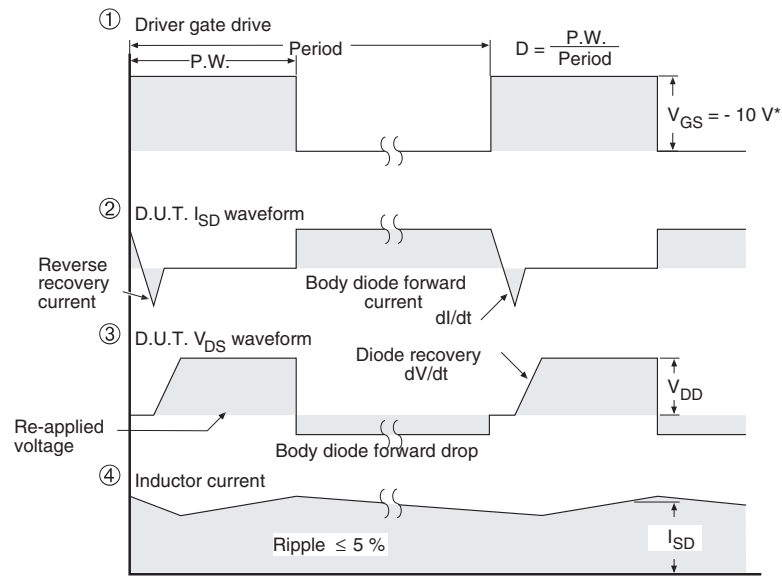
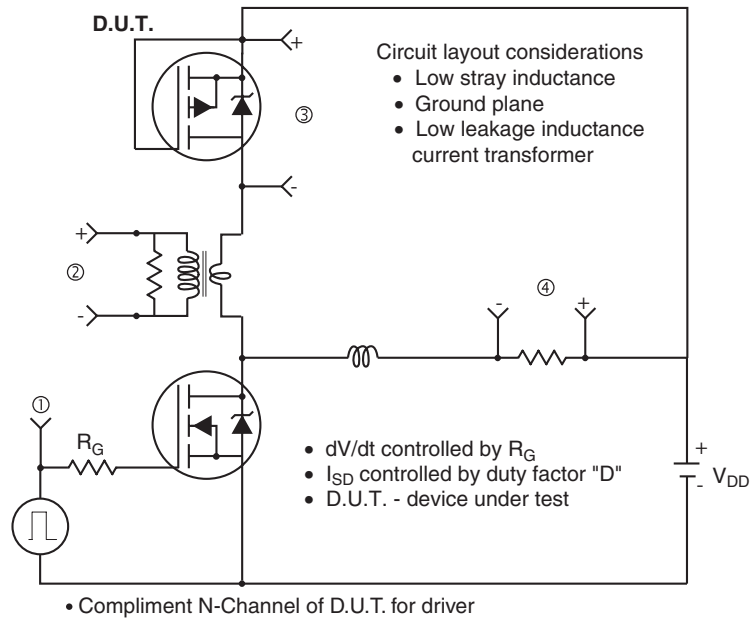


Fig. 13b - Gate Charge Test Circuit

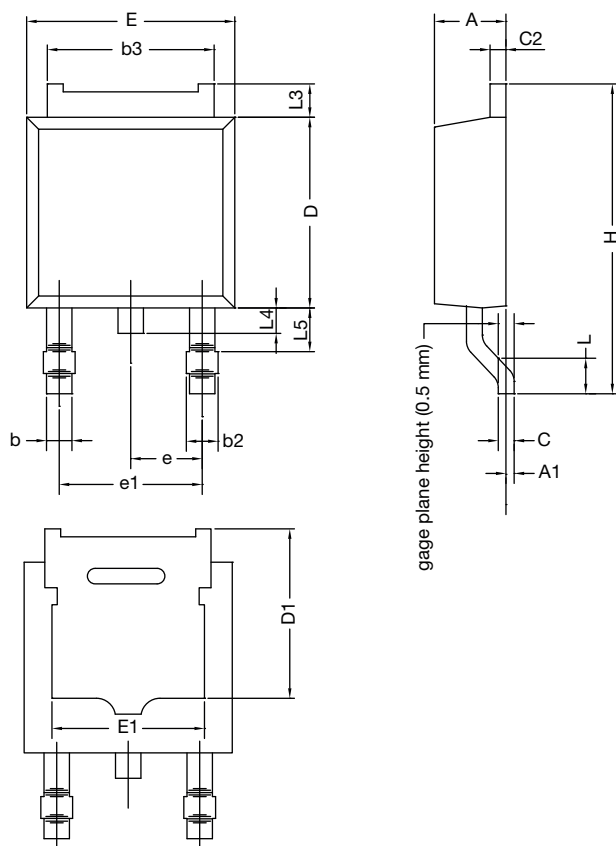
Peak Diode Recovery dV/dt Test Circuit



* $V_{GS} = -5 V$ for logic level and $-3 V$ drive devices

Fig. 14 - For P-Channel

TO-252AA CASE OUTLINE

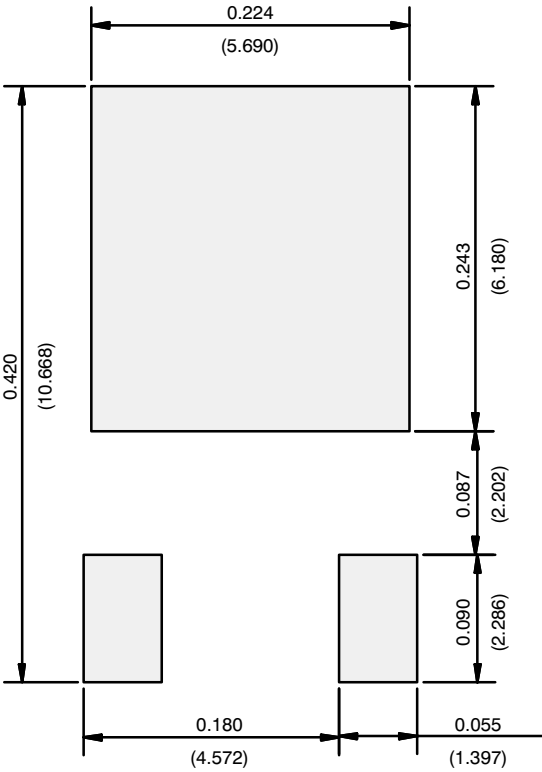


| DIM. | MILLIMETERS | | INCHES | |
|---------------------------------|-------------|-------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 2.18 | 2.38 | 0.086 | 0.094 |
| A1 | - | 0.127 | - | 0.005 |
| b | 0.64 | 0.88 | 0.025 | 0.035 |
| b2 | 0.76 | 1.14 | 0.030 | 0.045 |
| b3 | 4.95 | 5.46 | 0.195 | 0.215 |
| 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 |
| D1 | 5.21 | - | 0.205 | - |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.32 | - | 0.170 | - |
| H | 9.40 | 10.41 | 0.370 | 0.410 |
| e | 2.28 BSC | | 0.090 BSC | |
| e1 | 4.56 BSC | | 0.180 BSC | |
| L | 1.40 | 1.78 | 0.055 | 0.070 |
| L3 | 0.89 | 1.27 | 0.035 | 0.050 |
| L4 | - | 1.02 | - | 0.040 |
| L5 | 1.14 | 1.52 | 0.045 | 0.060 |
| ECN: X12-0247-Rev. M, 24-Dec-12 | | | | |
| DWG: 5347 | | | | |

Note

- Dimension L3 is for reference only.

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads
Dimensions in Inches/(mm)

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