

Power MOSFET

| PRODUCT SUMMARY | | |
|---------------------------|-------------------|-----|
| V_{DS} (V) | - 400 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = - 10$ V | 7.0 |
| Q_g (Max.) (nC) | 13 | |
| Q_{gs} (nC) | 3.2 | |
| Q_{gd} (nC) | 5.0 | |
| Configuration | Single | |

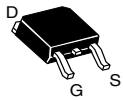
FEATURES

- P-Channel
- Surface Mount (IRFR9310, SiHFR9310)
- Straight Lead (IRFU9310, SiHFU9310)
- Advanced Process Technology
- Fast Switching
- Fully Avalanche Rated
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

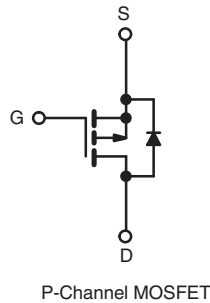
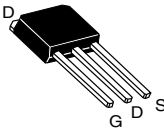


RoHS
COMPLIANT
HALOGEN
FREE
Available

DPAK (TO-252)



IPAK (TO-251)



DESCRIPTION

Third generation power MOSFETs from Vishay utilize advanced processing techniques to achieve 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 DPAK is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU/SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface mount applications.

| ORDERING INFORMATION | | | | | |
|---------------------------------|---------------|-----------------------------|----------------------------|-----------------------------|---------------|
| Package | DPAK (TO-252) | DPAK (TO-252) | DPAK (TO-252) | DPAK (TO-252) | IPAK (TO-251) |
| Lead (Pb)-free and Halogen-free | SiHFR9310-GE3 | SiHFR9310TRL-GE3 | SiHFR9310TR-GE3 | SiHFR9310TRR-GE3 | SiHFU9310-GE3 |
| Lead (Pb)-free | IRFR9310PbF | IRFR9310TRLPbF ^a | IRFR9310TRPbF ^a | IRFR9310TRRPbF ^a | IRFU9310PbF |
| | SiHFR9310-E3 | SiHFR9310TL-E3 ^a | SiHFR9310T-E3 ^a | SiHFR9310TR-E3 ^a | SiHFU9310-E3 |

Note

- a. See device orientation.

| ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted) | | | | |
|---|--------------------|----------------|-------|---|
| PARAMETER | SYMBOL | LIMIT | UNIT | |
| Drain-Source Voltage | V_{DS} | - 400 | V | |
| Gate-Source Voltage | V_{GS} | ± 20 | | |
| Continuous Drain Current | V_{GS} at - 10 V | $T_C = 25$ °C | - 1.8 | |
| | | $T_C = 100$ °C | - 1.1 | |
| Pulsed Drain Current ^a | I_{DM} | - 7.2 | A | |
| Linear Derating Factor | | 0.40 | W/°C | |
| Single Pulse Avalanche Energy ^b | E_{AS} | 92 | mJ | |
| Repetitive Avalanche Current ^a | I_{AR} | - 1.8 | A | |
| Repetitive Avalanche Energy ^a | E_{AR} | 5.0 | mJ | |
| Maximum Power Dissipation | $T_C = 25$ °C | P_D | 50 | W |
| Peak Diode Recovery dV/dt ^c | dV/dt | - 24 | V/ns | |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | - 55 to + 150 | °C | |
| Soldering Recommendations (Peak Temperature) ^d | for 10 s | 300 | | |

Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
 b. Starting $T_J = 25$ °C, $L = 57$ mH, $R_g = 25$ Ω , $I_{AS} = - 1.8$ A (see fig. 12).
 c. $I_{SD} \leq - 1.1$ A, $dI/dt \leq 450$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 150$ °C.
 d. 1.6 mm from case.



| THERMAL RESISTANCE RATINGS | | | | | |
|--|------------|------|------|------|------|
| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient | R_{thJA} | - | - | 110 | °C/W |
| Maximum Junction-to-Ambient (PCB Mount) ^a | R_{thJA} | - | - | 50 | |
| Maximum Junction-to-Case (Drain) | R_{thJC} | - | - | 2.5 | |

Note

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

| SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | | | | |
|---|---------------------|---|--|-------|--------|-----------|---------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$ | | - 400 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$ | | - | - 0.41 | - | V/°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} | $V_{DS} = -400\text{ V}, V_{GS} = 0\text{ V}$ | | - | - | - 100 | μA |
| | | $V_{DS} = -320\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | | - | - | - 500 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = -10\text{ V}$ | $I_D = -1.1\text{ A}^b$ | - | - | 7.0 | Ω |
| Forward Transconductance | g_{fs} | $V_{DS} = -50\text{ V}, I_D = -1.1\text{ A}$ | | 0.91 | - | - | S |
| Dynamic | | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$, see fig. 5 | | - | 270 | - | pF |
| Output Capacitance | C_{oss} | | | - | 50 | - | |
| Reverse Transfer Capacitance | C_{rss} | | | - | 8.0 | - | |
| Total Gate Charge | Q_g | $V_{GS} = -10\text{ V}$ | $I_D = -1.1\text{ A}, V_{DS} = -320\text{ V}$, see fig. 6 and 13 ^b | - | - | 13 | nC |
| Gate-Source Charge | Q_{gs} | | | - | - | 3.2 | |
| Gate-Drain Charge | Q_{gd} | | | - | - | 5.0 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = -200\text{ V}, I_D = -1.1\text{ A}, R_g = 21\text{ }\Omega, R_D = 180\text{ }\Omega$, see fig. 10 ^b | | - | 11 | - | ns |
| Rise Time | t_r | | | - | 10 | - | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 25 | - | |
| Fall Time | t_f | | | - | 24 | - | |
| Internal Drain Inductance | L_D | Between lead, 6 mm (0.25") from package and center of die contact ^c | | - | 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 | | - | - | - 1.9 | A |
| Pulsed Diode Forward Current ^a | I_{SM} | | | - | - | - 7.6 | |
| Body Diode Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = -1.1\text{ A}, V_{GS} = 0\text{ V}^b$ | | - | - | - 4.0 | V |
| Body Diode Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = -1.1\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$ | | - | 170 | 260 | ns |
| Body Diode Reverse Recovery Charge | Q_{rr} | | | - | 640 | 960 | nC |
| 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 $\leq 2\%$.
- c. This is applied for IPAK, L_S of DPAK is measured between lead and center of die contact.



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

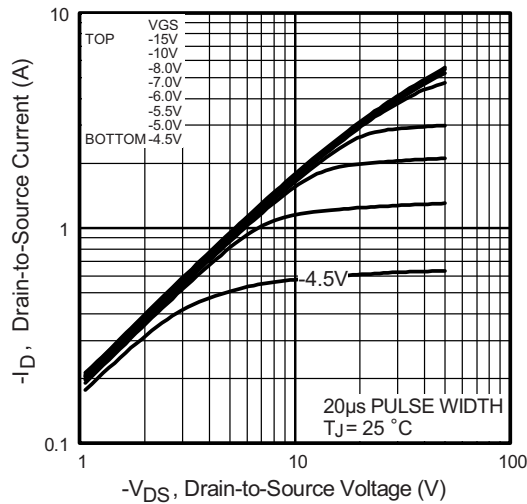


Fig. 1 - Typical Output Characteristics

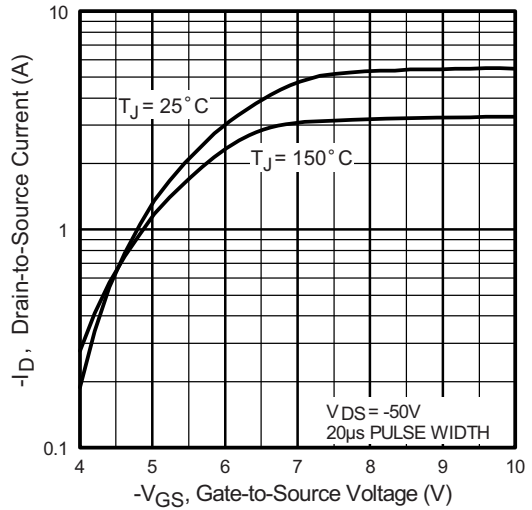


Fig. 3 - Typical Transfer Characteristics

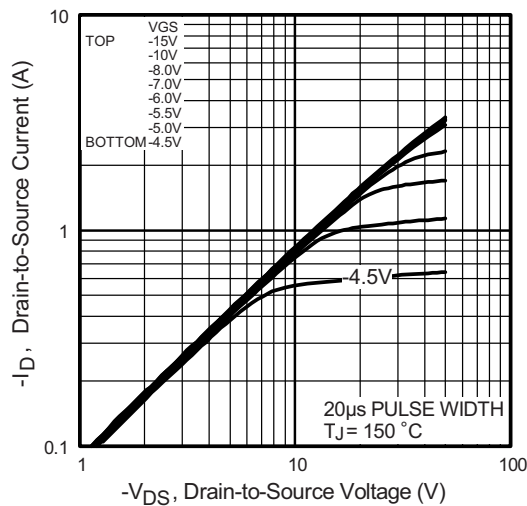


Fig. 2 - Typical Output Characteristics

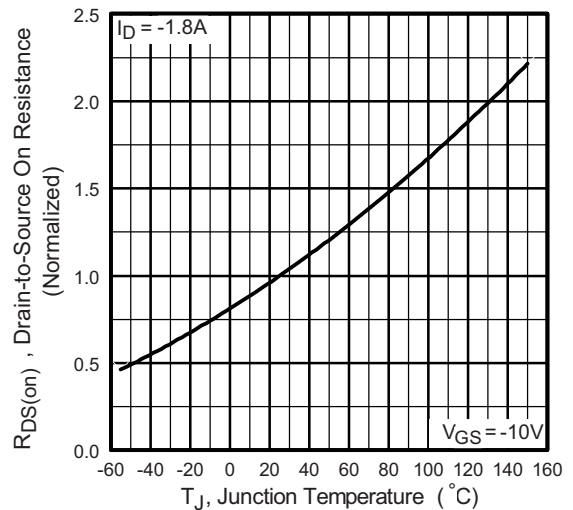


Fig. 4 - Normalized On-Resistance vs. Temperature

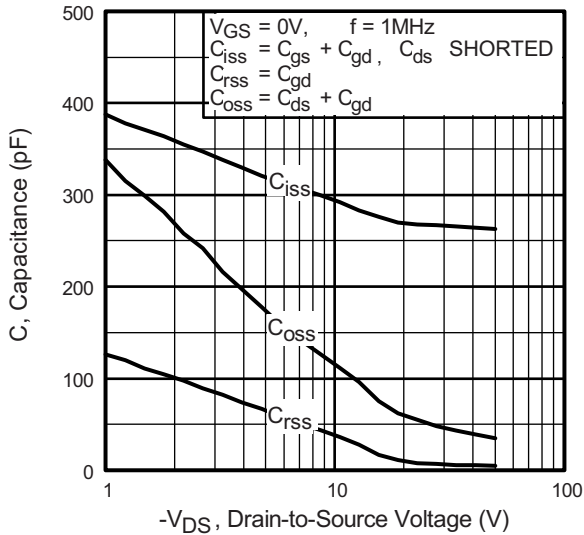


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

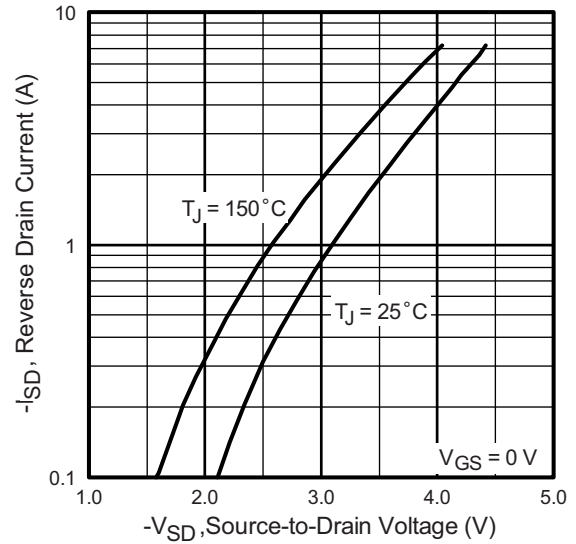


Fig. 7 - Typical Source-Drain Diode Forward Voltage

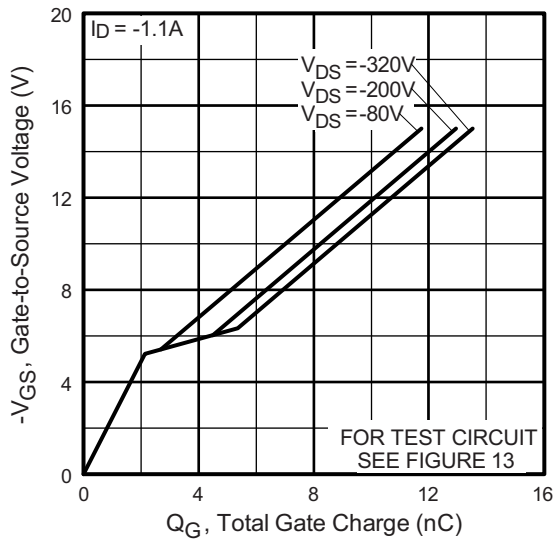


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

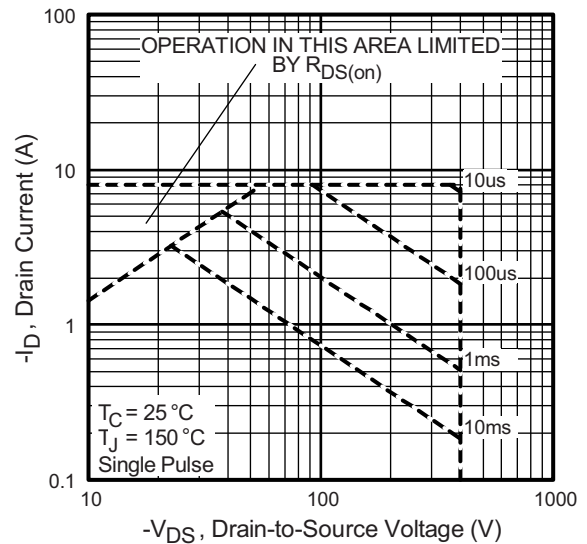


Fig. 8 - Maximum Safe Operating Area

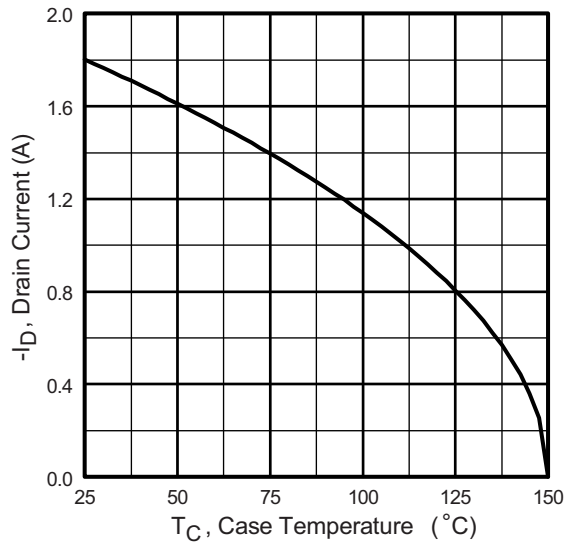


Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 10a - Switching Time Test Circuit

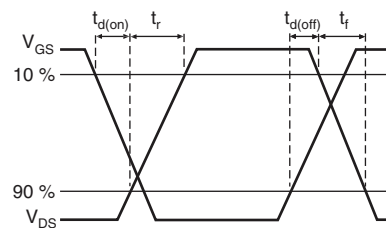


Fig. 10b - Switching Time Waveforms

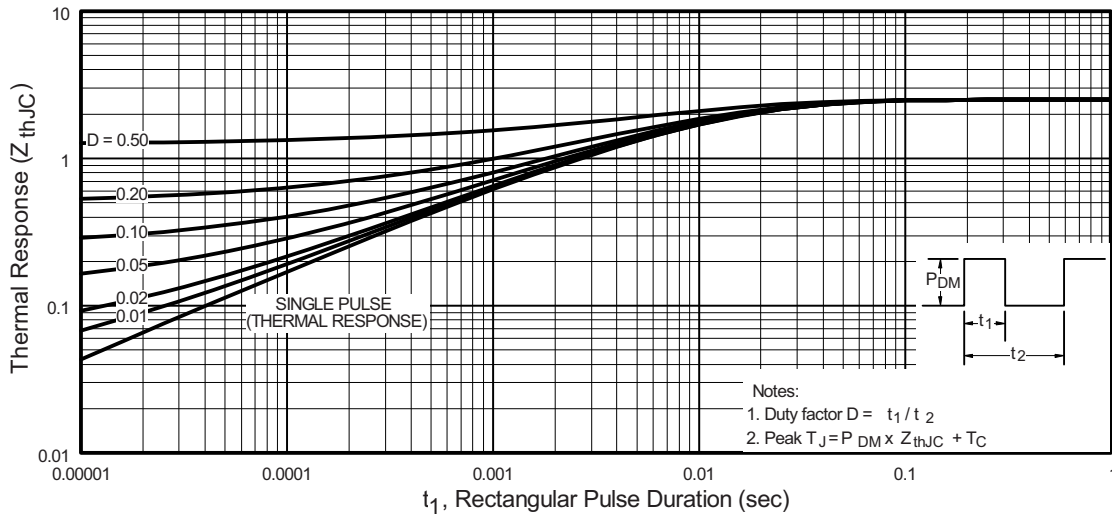


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

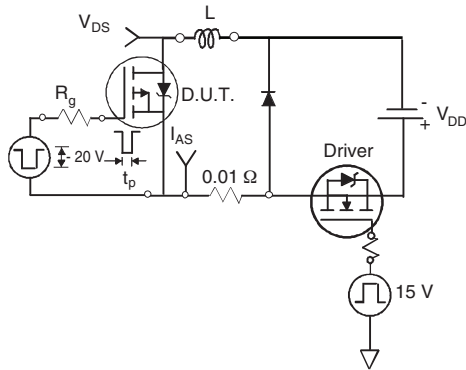


Fig. 12a - Unclamped Inductive Test Circuit

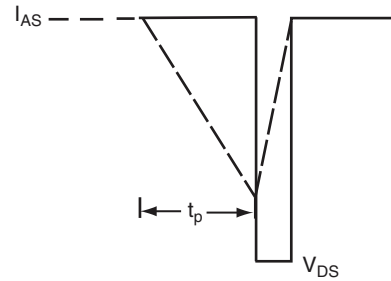


Fig. 12b - Unclamped Inductive Waveforms

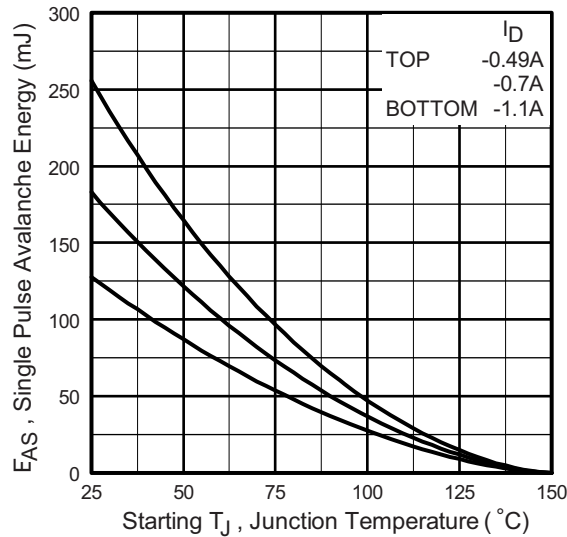


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

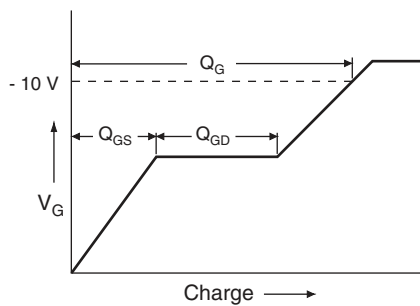


Fig. 13a - Basic Gate Charge Waveform

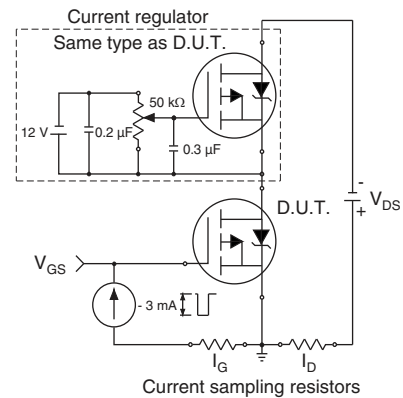
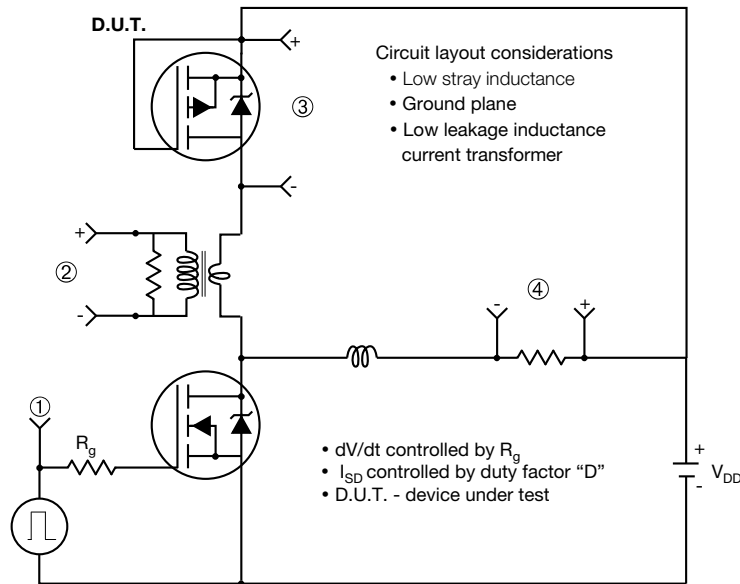


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note
• Compliment N-Channel of D.U.T. for driver



Fig. 14 - For P-Channel

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TO-252AA (HIGH VOLTAGE)



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| E | 6.40 | 6.73 | 0.252 | 0.265 |
| L | 1.40 | 1.77 | 0.055 | 0.070 |
| L1 | 2.743 REF | | 0.108 REF | |
| L2 | 0.508 BSC | | 0.020 BSC | |
| L3 | 0.89 | 1.27 | 0.035 | 0.050 |
| L4 | 0.64 | 1.01 | 0.025 | 0.040 |
| D | 6.00 | 6.22 | 0.236 | 0.245 |
| H | 9.40 | 10.40 | 0.370 | 0.409 |
| b | 0.64 | 0.88 | 0.025 | 0.035 |
| b2 | 0.77 | 1.14 | 0.030 | 0.045 |
| b3 | 5.21 | 5.46 | 0.205 | 0.215 |
| e | 2.286 BSC | | 0.090 BSC | |
| A | 2.20 | 2.38 | 0.087 | 0.094 |
| A1 | 0.00 | 0.13 | 0.000 | 0.005 |
| c | 0.45 | 0.60 | 0.018 | 0.024 |
| c2 | 0.45 | 0.58 | 0.018 | 0.023 |
| D1 | 5.30 | - | 0.209 | - |
| E1 | 4.40 | - | 0.173 | - |
| θ | 0' | 10' | 0' | 10' |

ECN: S-81965-Rev. A, 15-Sep-08
DWG: 5973

Notes

1. Package body sizes exclude mold flash, protrusion or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.10 mm per side.
2. Package body sizes determined at the outermost extremes of the plastic body exclusive of mold flash, gate burrs and interlead flash, but including any mismatch between the top and bottom of the plastic body.
3. The package top may be smaller than the package bottom.
4. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.10 mm total in excess of "b" dimension at maximum material condition. The dambar cannot be located on the lower radius of the foot.

TO-251AA (HIGH VOLTAGE)



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 2.18 | 2.39 | 0.086 | 0.094 |
| A1 | 0.89 | 1.14 | 0.035 | 0.045 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b1 | 0.65 | 0.79 | 0.026 | 0.031 |
| b2 | 0.76 | 1.14 | 0.030 | 0.045 |
| b3 | 0.76 | 1.04 | 0.030 | 0.041 |
| b4 | 4.95 | 5.46 | 0.195 | 0.215 |
| c | 0.46 | 0.61 | 0.018 | 0.024 |
| c1 | 0.41 | 0.56 | 0.016 | 0.022 |
| c2 | 0.46 | 0.86 | 0.018 | 0.034 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |

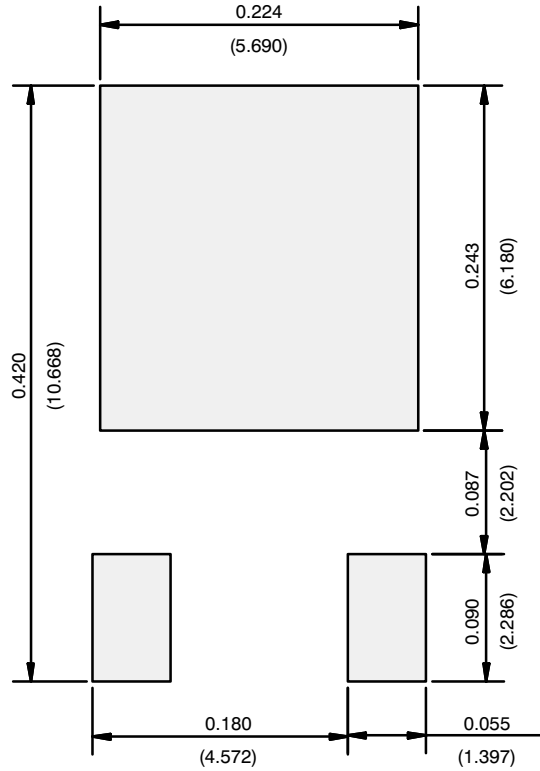
| DIM. | MILLIMETERS | | INCHES | |
|--------|-------------|------|----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| D1 | 5.21 | - | 0.205 | - |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.32 | - | 0.170 | - |
| e | 2.29 BSC | | 2.29 BSC | |
| L | 8.89 | 9.65 | 0.350 | 0.380 |
| L1 | 1.91 | 2.29 | 0.075 | 0.090 |
| L2 | 0.89 | 1.27 | 0.035 | 0.050 |
| L3 | 1.14 | 1.52 | 0.045 | 0.060 |
| theta1 | 0' | 15' | 0' | 15' |
| theta2 | 25' | 35' | 25' | 35' |

ECN: S-82111-Rev. A, 15-Sep-08
 DWG: 5968

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension are shown in inches and millimeters.
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.13 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body.
4. Thermal pad contour optional with dimensions b4, L2, E1 and D1.
5. Lead dimension uncontrolled in L3.
6. Dimension b1, b3 and c1 apply to base metal only.
7. Outline conforms to JEDEC outline TO-251AA.

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads
Dimensions in Inches/(mm)

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- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.