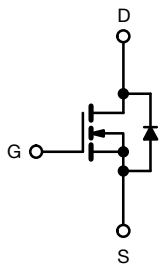
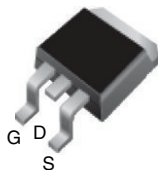


## Power MOSFET

**D<sup>2</sup>PAK (TO-263)**


N-Channel MOSFET

### PRODUCT SUMMARY

|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 60                     |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.018 |
| $Q_g$ (Max.) (nC)         | 110                    |       |
| $Q_{gs}$ (nC)             | 29                     |       |
| $Q_{gd}$ (nC)             | 36                     |       |
| Configuration             | Single                 |       |

### FEATURES

- Advanced process technology
- Dynamic  $dV/dt$
- 175 °C operating temperature
- Fast switching
- Fully avalanche rated
- Drop in replacement of the IRFZ48, SiHFZ48 for linear / audio applications
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### 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



**RoHS\***  
Available  
**HALOGEN**  
**FREE**  
Available

### DESCRIPTION

Advanced 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 D<sup>2</sup>PAK is a surface-mount power package capable of accommodating die sizes up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface-mount package. The D<sup>2</sup>PAK is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2 W in a typical surface mount application.

### ORDERING INFORMATION

|                                 |                             |
|---------------------------------|-----------------------------|
| Package                         | D <sup>2</sup> PAK (TO-263) |
| Lead (Pb)-free and halogen-free | SiHFZ48RS-GE3               |
| Lead (Pb)-free                  | IRFZ48RSPbF                 |

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

| PARAMETER                                                 | SYMBOL           | LIMIT                 | UNIT     |
|-----------------------------------------------------------|------------------|-----------------------|----------|
| Drain-Source Voltage                                      | $V_{DS}$         | 60                    | V        |
| Gate-Source Voltage                                       | $V_{GS}$         | $\pm 20$              |          |
| Continuous Drain Current <sup>a</sup>                     | $V_{GS}$ at 10 V | $T_C = 25\text{ °C}$  | A        |
|                                                           |                  | $T_C = 100\text{ °C}$ |          |
| Pulsed Drain Current <sup>a, e</sup>                      | $I_{DM}$         | 290                   |          |
| Linear Derating Factor                                    |                  | 1.3                   | W/°C     |
| Single Pulse Avalanche Energy <sup>b, e</sup>             | $E_{AS}$         | 100                   | mJ       |
| Maximum Power Dissipation                                 | $P_D$            | 190                   | W        |
| Peak Diode Recovery $dV/dt$ <sup>c, e</sup>               | $dV/dt$          | 4.5                   | V/ns     |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$   | - 55 to + 175         | °C       |
| Soldering Recommendations (Peak Temperature) <sup>d</sup> | For 10 s         | 300 <sup>d</sup>      |          |
| 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)
- $V_{DD} = 25\text{ V}$ , Starting  $T_J = 25\text{ °C}$ ,  $L = 22\text{ }\mu\text{H}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 72\text{ A}$  (see fig. 12)
- $I_{SD} \leq 72\text{ A}$ ,  $dI/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ °C}$
- 1.6 mm from case
- Current limited by the package, (die current = 72 A)

**THERMAL RESISTANCE RATINGS**

| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.8  |      |

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

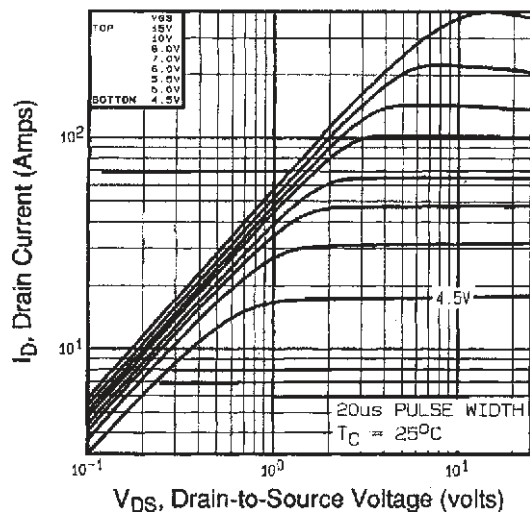
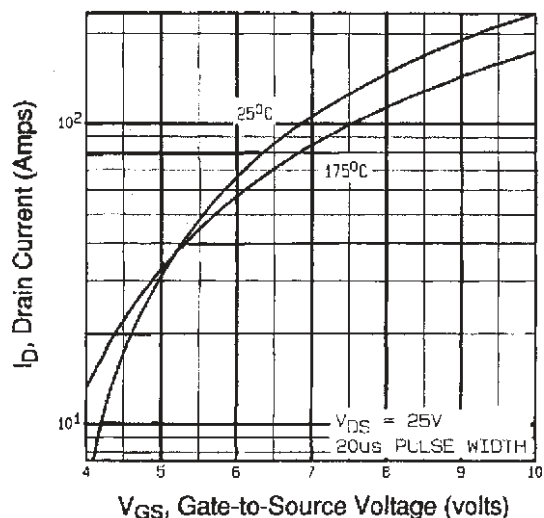
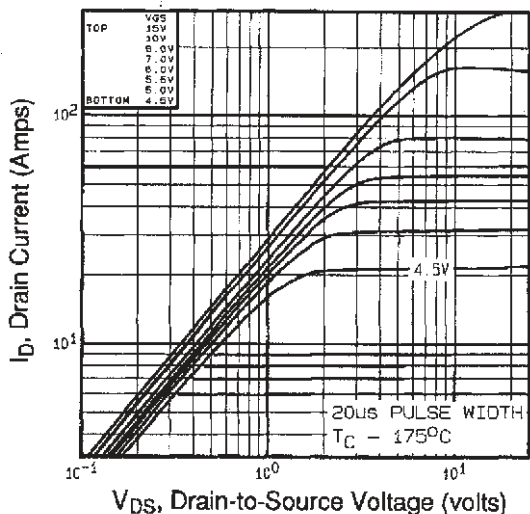
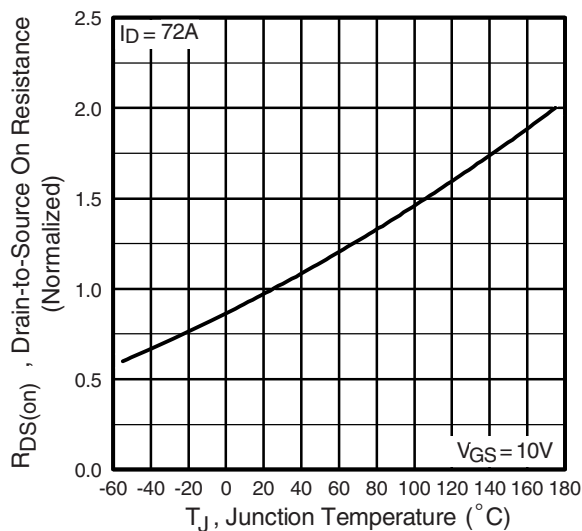
| PARAMETER                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                |                                                                                     | MIN. | TYP. | MAX.            | UNIT |
|-------------------------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|------|-----------------|------|
| Static                                    |                                  |                                                                                                                                |                                                                                     |      |      |                 |      |
| Drain-Source Breakdown Voltage            | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                 |                                                                                     | 60   | -    | -               | 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 <sup>c</sup>                                                                         |                                                                                     | -    | 0.60 | -               | V/°C |
| Gate-Source Threshold Voltage             | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                    |                                                                                     | 2.0  | -    | 4.0             | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                       |                                                                                     | -    | -    | ± 100           | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                                  |                                                                                     | -    | -    | 25              | μA   |
|                                           |                                  | V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150 °C                                                         |                                                                                     | -    | -    | 250             |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                         | I <sub>D</sub> = 43 A <sup>b</sup>                                                  | -    | -    | 0.018           | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 25 V, I <sub>D</sub> = 43 A <sup>b</sup>                                                                     |                                                                                     | 27   | -    | -               | S    |
| Dynamic                                   |                                  |                                                                                                                                |                                                                                     |      |      |                 |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5 <sup>c</sup>                                      |                                                                                     | -    | 2400 | -               | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                |                                                                                     | -    | 1300 | -               |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                |                                                                                     | -    | 190  | -               |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                         | I <sub>D</sub> = 72 A, V <sub>DS</sub> = 48 V,<br>see fig. 6 and 13 <sup>b, c</sup> | -    | -    | 110             | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                |                                                                                     | -    | -    | 29              |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                |                                                                                     | -    | -    | 36              |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 30 V, I <sub>D</sub> = 72 A,<br>R <sub>g</sub> = 9.1 Ω, R <sub>D</sub> = 0.34 Ω, see fig. 10 <sup>b, c</sup> |                                                                                     | -    | 8.1  | -               | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                |                                                                                     | -    | 250  | -               |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                |                                                                                     | -    | 210  | -               |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                |                                                                                     | -    | 250  | -               |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact                                                     |                                                                                     | -    | 4.5  | -               | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                                |                                                                                     | -    | 7.5  | -               |      |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                                |                                                                                     |      |      |                 |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode                                                       |                                                                                     | -    | -    | 50 <sup>c</sup> | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                |                                                                                     | -    | -    | 290             |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 72 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                              |                                                                                     | -    | -    | 2.0             | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 72 A, dI/dt = 100 A/μs <sup>b, c</sup>                                                |                                                                                     | -    | 120  | 180             | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                |                                                                                     | -    | 0.50 | 0.80            | μC   |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                              |                                                                                     |      |      |                 |      |

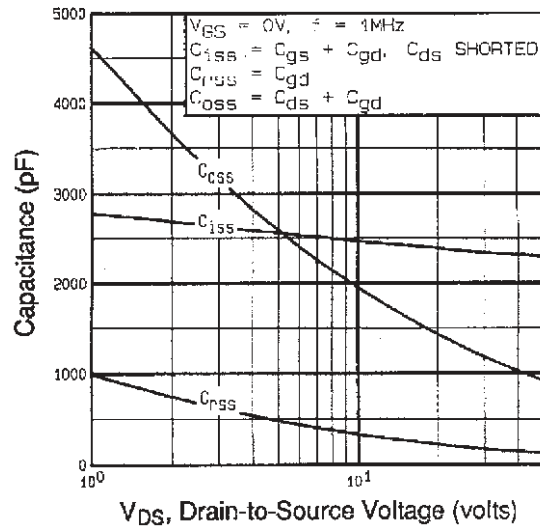
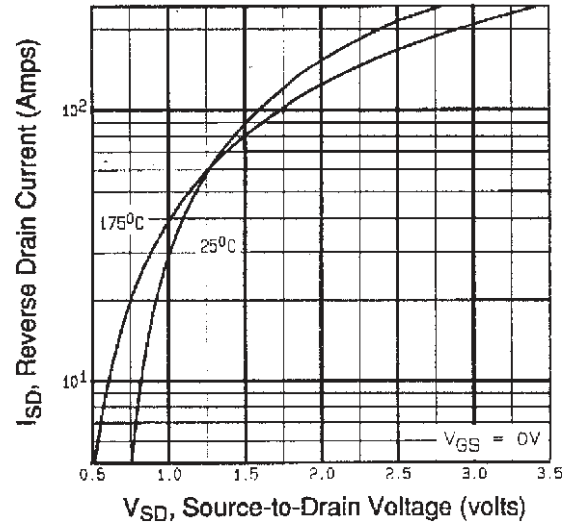
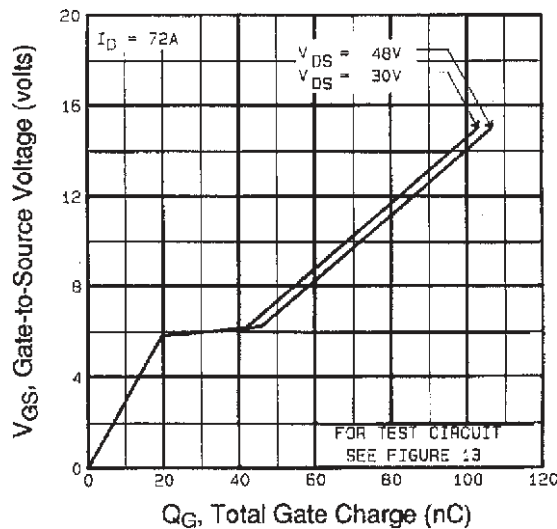
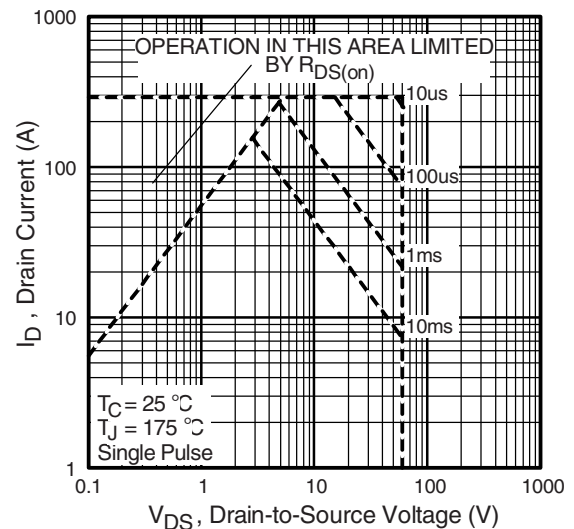
**Notes**

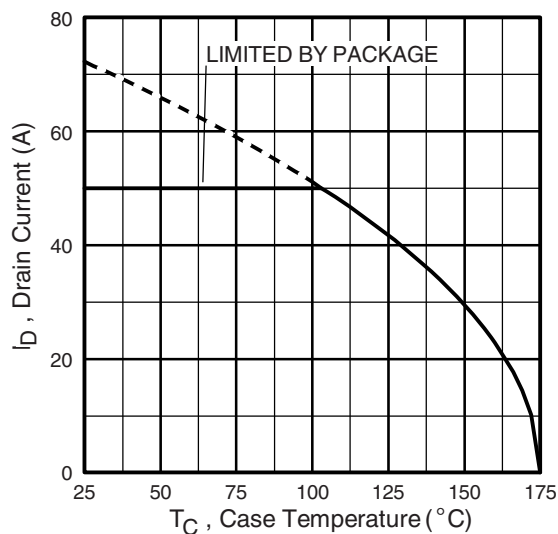
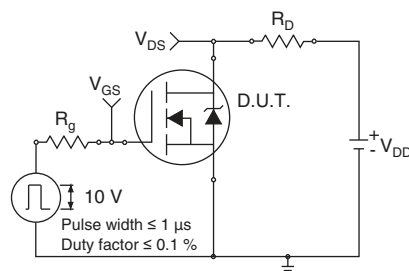
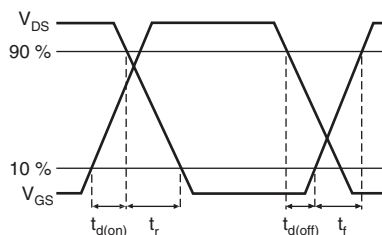
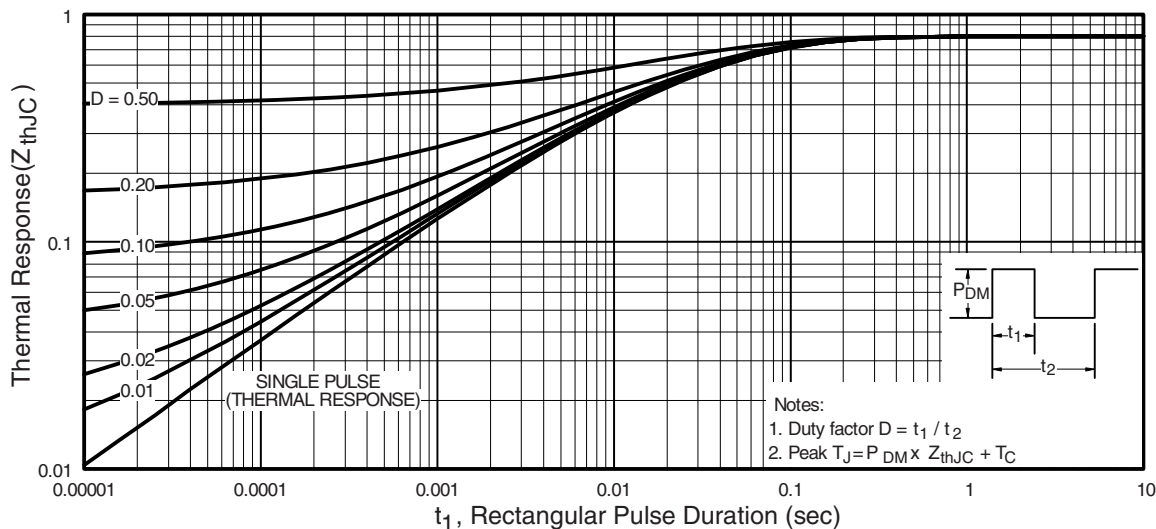
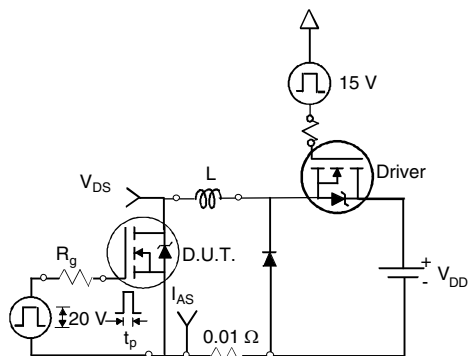
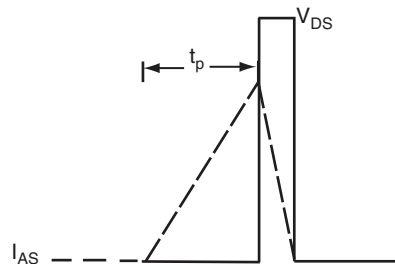
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

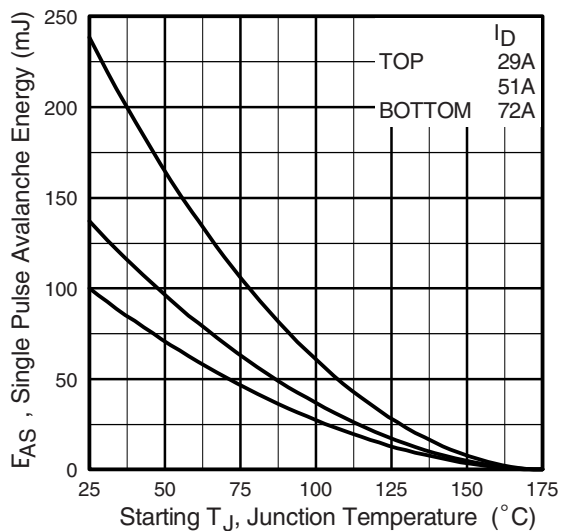
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ 

c. Current limited by the package, (die current = 72 A)

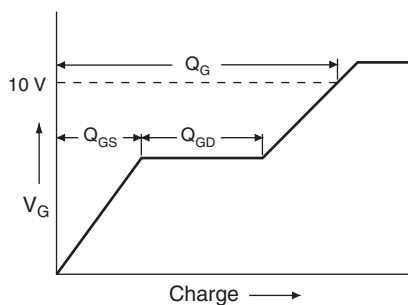
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

**Fig. 1 - Typical Output Characteristics**

**Fig. 2 - Typical Transfer Characteristics**

**Fig. 1 - Typical Output Characteristics**

**Fig. 3 - Normalized On-Resistance vs. Temperature**


**Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage**

**Fig. 6 - Typical Source-Drain Diode Forward Voltage**

**Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage**

**Fig. 7 - Maximum Safe Operating Area**

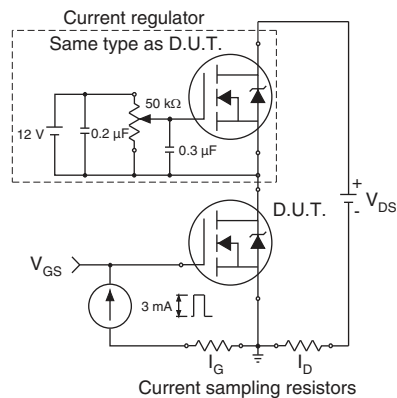

**Fig. 8 - Maximum Drain Current vs. Case Temperature**

**Fig. 10a - Switching Time Test Circuit**

**Fig. 10b - Switching Time Waveforms**

**Fig. 9 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

**Fig. 12a - Unclamped Inductive Test Circuit**

**Fig. 12b - Unclamped Inductive Waveforms**



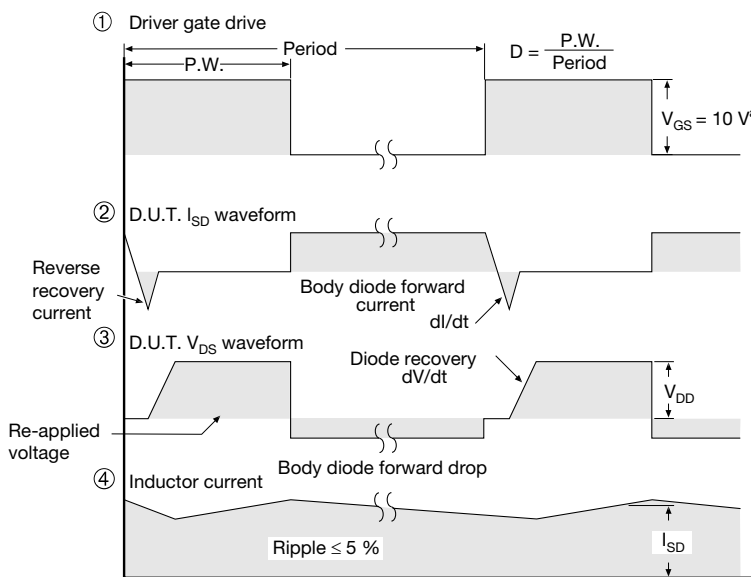
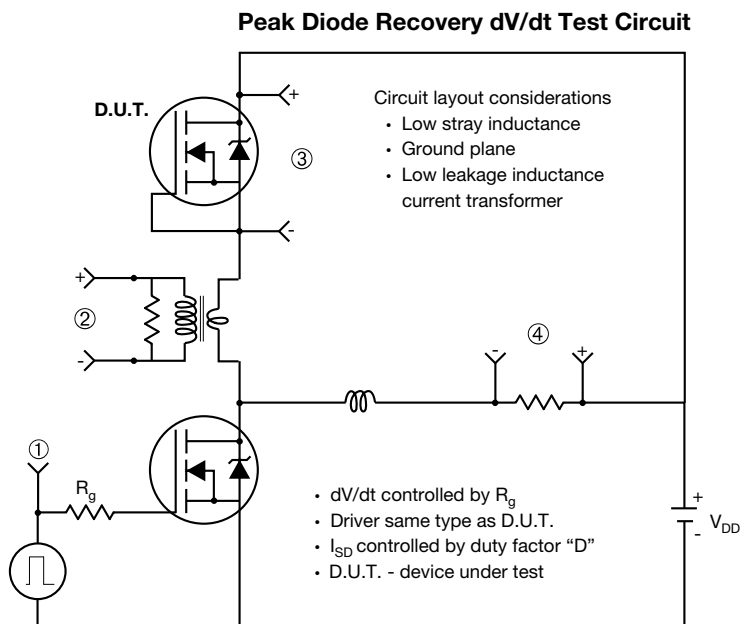
**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**



**Fig. 13a - Maximum Avalanche Energy vs. Drain Current**



**Fig. 13b - Gate Charge Test Circuit**



**Note**

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

**Fig. 10 - For N-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.

## I<sup>2</sup>PAK (TO-262) (HIGH VOLTAGE)



|      | MILLIMETERS |      | INCHES |       |
|------|-------------|------|--------|-------|
| DIM. | MIN.        | MAX. | MIN.   | MAX.  |
| A    | 4.06        | 4.83 | 0.160  | 0.190 |
| A1   | 2.03        | 3.02 | 0.080  | 0.119 |
| 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 |

|      | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
| DIM. | MIN.        | MAX.  | MIN.      | MAX.  |
| D    | 8.38        | 9.65  | 0.330     | 0.380 |
| 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 |       |
| L    | 13.46       | 14.10 | 0.530     | 0.555 |
| L1   | -           | 1.65  | -         | 0.065 |
| L2   | 3.56        | 3.71  | 0.140     | 0.146 |

ECN: S-82442-Rev. A, 27-Oct-08  
DWG: 5977

### Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outmost extremes of the plastic body.
3. Thermal pad contour optional within dimension E, L1, D1, and E1.
4. Dimension b1 and c1 apply to base metal only.

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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