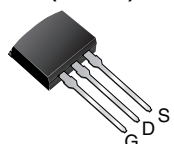
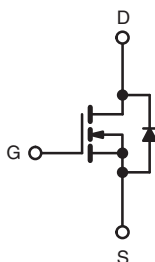
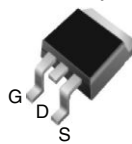


## Power MOSFET

### 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                 |       |

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

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


N-Channel MOSFET

### FEATURES

- Halogen-free According to IEC 61249-2-21

#### Definition

- 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
- Compliant to RoHS Directive 2002/95/EC



**RoHS\***  
COMPLIANT  
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) | I <sup>2</sup> PAK (TO-262) |
| Lead (Pb)-free and Halogen-free | SiHFZ48RS-GE3               | -                           |
| Lead (Pb)-free                  | IRFZ48RSPbF<br>SiHFZ48RS-E3 | IRFZ48RLPbF<br>SiHFZ48RL-E3 |

### 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>e</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).

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

| 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 <sub>J</sub> = 25 °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

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- Current limited by the package, (die current = 72 A).



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

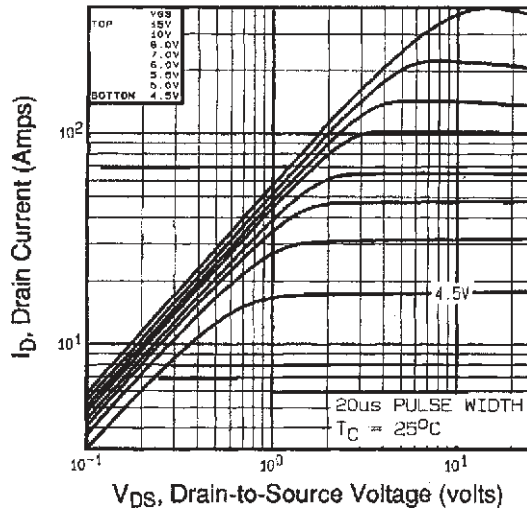


Fig. 1 - Typical Output Characteristics

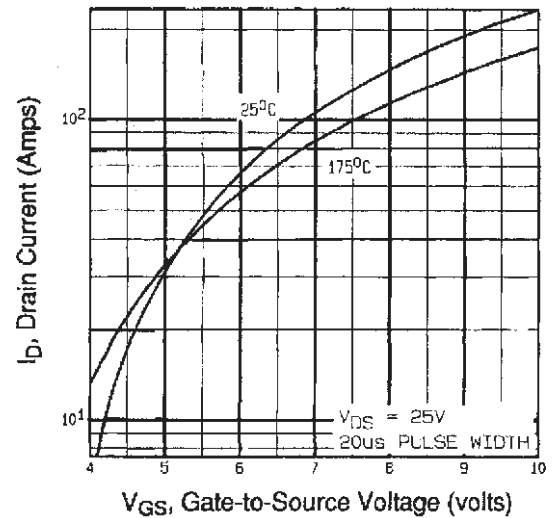


Fig. 3 - Typical Transfer Characteristics

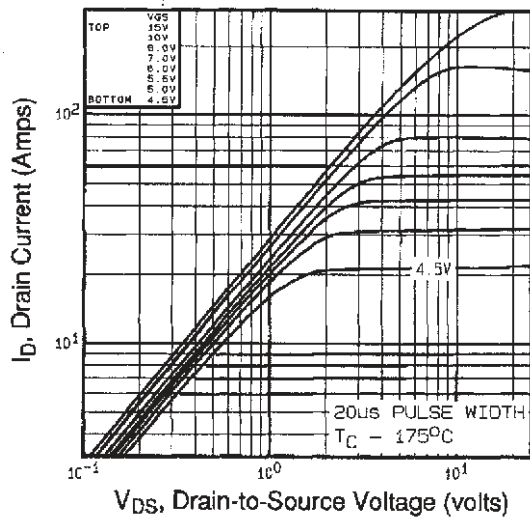


Fig. 2 - Typical Output Characteristics

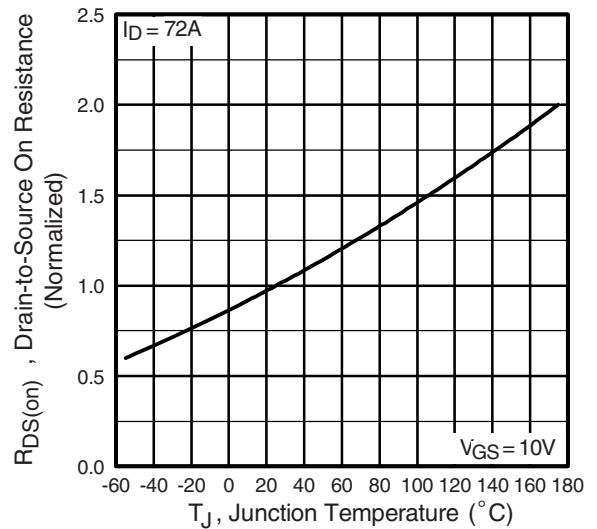


Fig. 4 - Normalized On-Resistance vs. Temperature

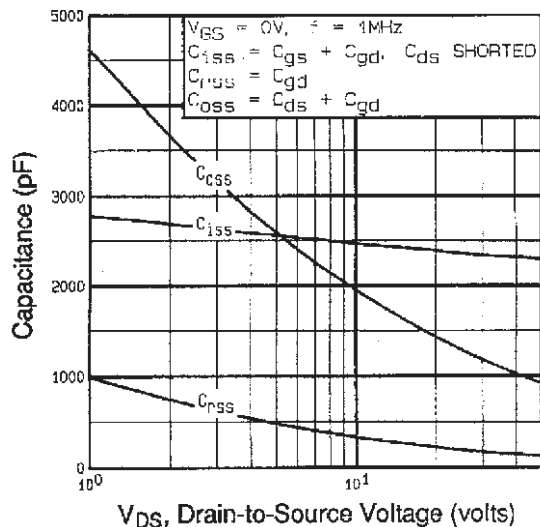


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

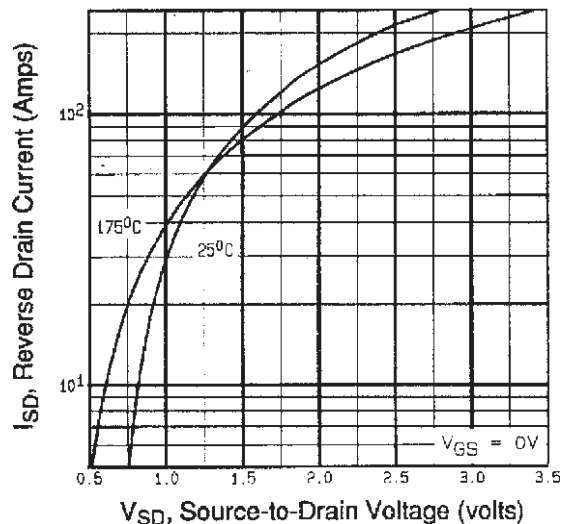


Fig. 7 - Typical Source-Drain Diode Forward Voltage

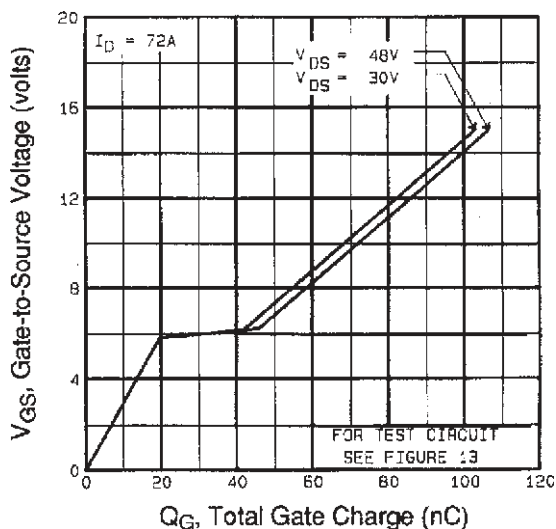


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

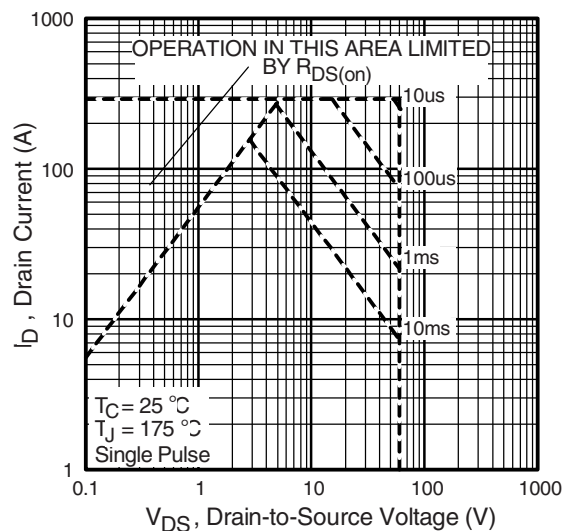


Fig. 8 - Maximum Safe Operating Area

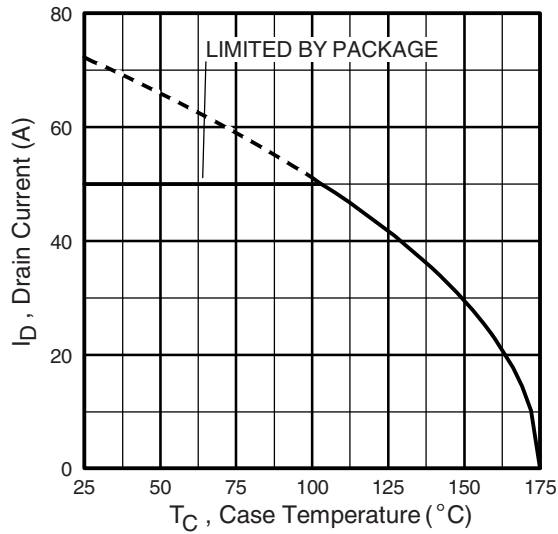


Fig. 9 - Maximum Drain Current vs. Case Temperature

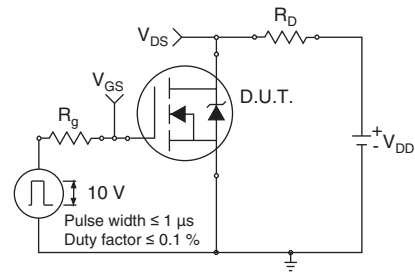


Fig. 10a - Switching Time Test Circuit

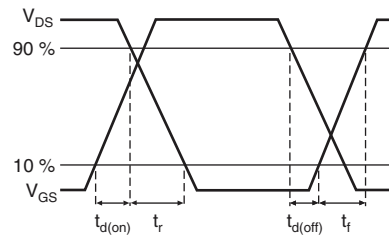


Fig. 10b - Switching Time Waveforms

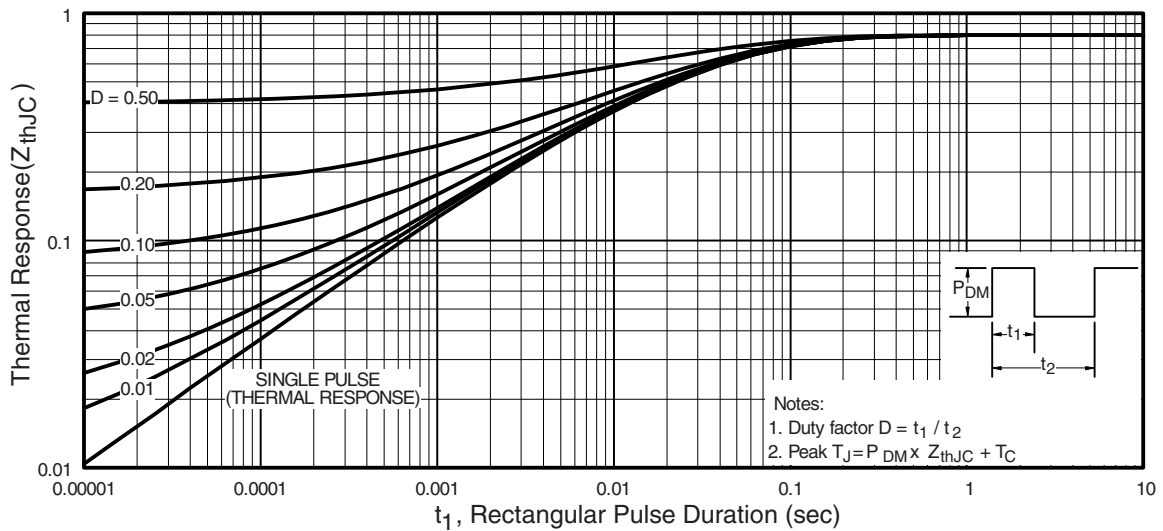


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

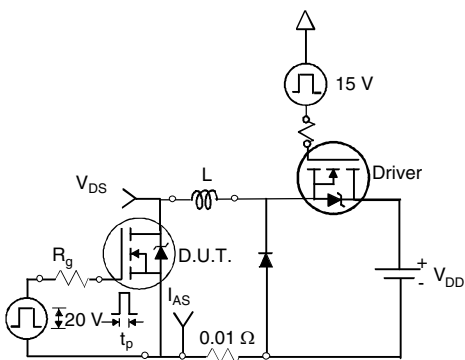


Fig. 12a - Unclamped Inductive Test Circuit

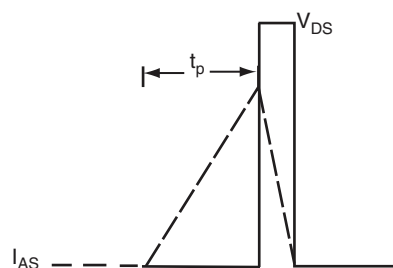


Fig. 12b - Unclamped Inductive Waveforms

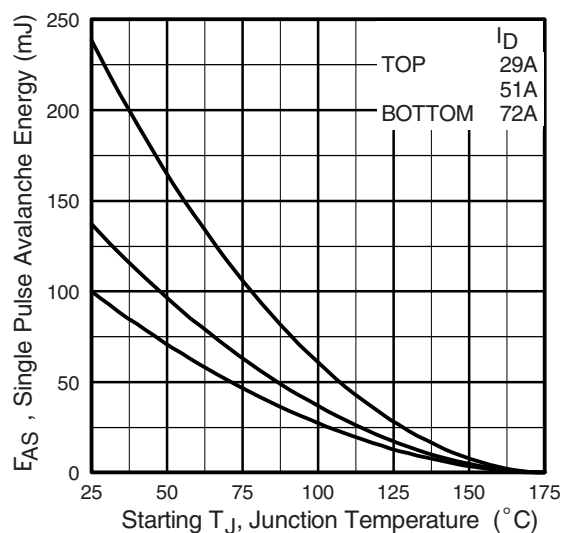


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

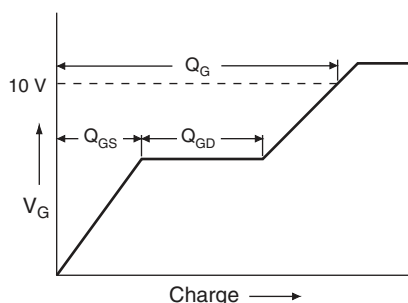


Fig. 13a - Maximum Avalanche Energy vs. Drain Current

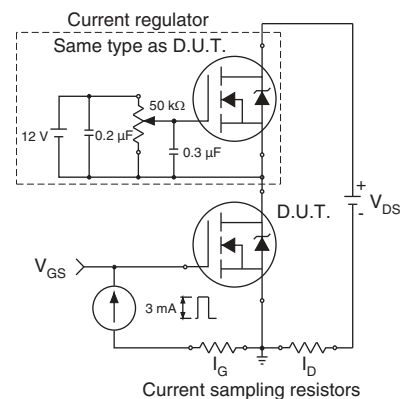
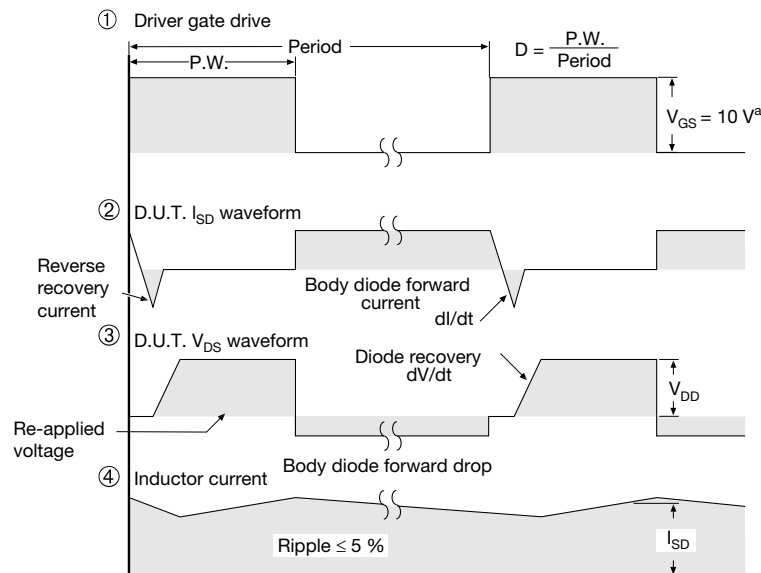
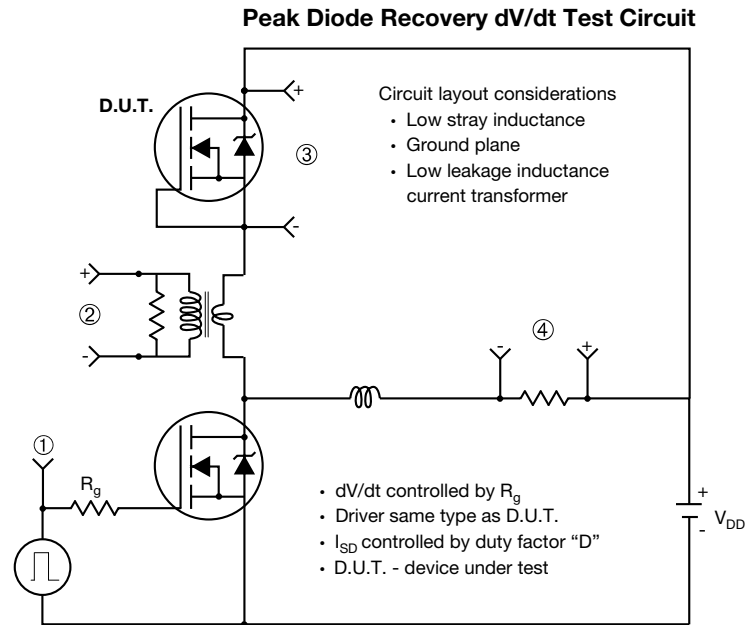


Fig. 13b - Gate Charge Test Circuit



**Note**

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

**Fig. 14 - For N-Channel**

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

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

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