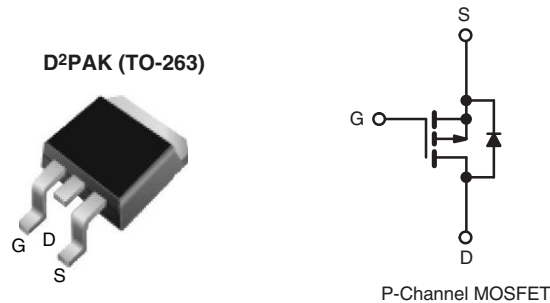


## Power MOSFET

| PRODUCT SUMMARY           |                   |      |
|---------------------------|-------------------|------|
| $V_{DS}$ (V)              | - 100             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = - 10$ V | 0.20 |
| $Q_g$ (Max.) (nC)         | 61                |      |
| $Q_{gs}$ (nC)             | 14                |      |
| $Q_{gd}$ (nC)             | 29                |      |
| Configuration             | Single            |      |



### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Available in Tape and Reel
- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- P-Channel
- 175 °C Operating Temperature
- Fast Switching
- Compliant to RoHS Directive 2002/95/EC



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

### DESCRIPTION

Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The D<sup>2</sup>PAK (TO-263) 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 (TO-263) 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 <sup>2</sup> PAK (TO-263) | D <sup>2</sup> PAK (TO-263)                                |
| Lead (Pb)-free and Halogen-free | SiHF9540S-GE3               | SiHF9540STRL-GE3 <sup>a</sup>                              |
| Lead (Pb)-free                  | IRF9540SPbF<br>SiHF9540S-E3 | IRF9540STRLPbF <sup>a</sup><br>SiHF9540STL-E3 <sup>a</sup> |

#### Note

- a. See device orientation.

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                    |                  |      |   |
|---|--------------------|------------------|------|---|
| PARAMETER   | SYMBOL             | LIMIT            | UNIT |   |
| Drain-Source Voltage  | $V_{DS}$           | - 100            | V    |   |
| Gate-Source Voltage   | $V_{GS}$           | $\pm 20$         |      |   |
| Continuous Drain Current  | $V_{GS}$ at - 10 V | $T_C = 25$ °C    | - 19 | A |
|   |                    | $T_C = 100$ °C   | - 13 |   |
| Pulsed Drain Current <sup>a</sup>                                 | $I_{DM}$           | - 72             | W/°C |   |
| Linear Derating Factor  |                    | 1.0              |      |   |
| Linear Derating Factor (PCB Mount) <sup>e</sup>                   |                    | 0.025            | mJ   |   |
| Single Pulse Avalanche Energy <sup>b</sup>                        | $E_{AS}$           | 640              |      |   |
| Repetitive Avalanche Current <sup>a</sup>                         | $I_{AR}$           | - 19             | A    |   |
| Repetitive Avalanche Energy <sup>a</sup>                          | $E_{AR}$           | 15               | mJ   |   |
| Maximum Power Dissipation   | $T_C = 25$ °C      | $P_D$            | 150  | W |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup>                |                    | 3.7              |      |   |
| Peak Diode Recovery $dV/dt$ <sup>c</sup>                          | $dV/dt$            | - 5.5            | V/ns |   |
| Operating Junction and Storage Temperature Range                  | $T_J, T_{stg}$     | - 55 to + 175    | °C   |   |
| Soldering Recommendations (Peak Temperature)                      | for 10 s           | 300 <sup>d</sup> |      |   |

#### Notes

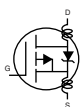
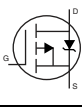
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = - 25$  V, starting  $T_J = 25$  °C,  $L = 2.7$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = - 19$  A (see fig. 12).
- $I_{SD} \leq - 19$  A,  $dI/dt \leq 200$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175$  °C.
- 1.6 mm from case.
- When mounted on 1" square PCB (FR-4 or G-10 material)

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

| THERMAL RESISTANCE RATINGS                           |            |      |      |      |      |  |
|--|------------|------|------|------|------|--|
| PARAMETER  | SYMBOL     | MIN. | TYP. | MAX. | UNIT |  |
| Maximum Junction-to-Ambient (PCB Mount) <sup>a</sup> | $R_{thJA}$ | -    | -    | 40   | °C/W |  |
| Maximum Junction-to-Case (Drain)                     | $R_{thJC}$ | -    | -    | 1.0  |      |  |

### Note

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

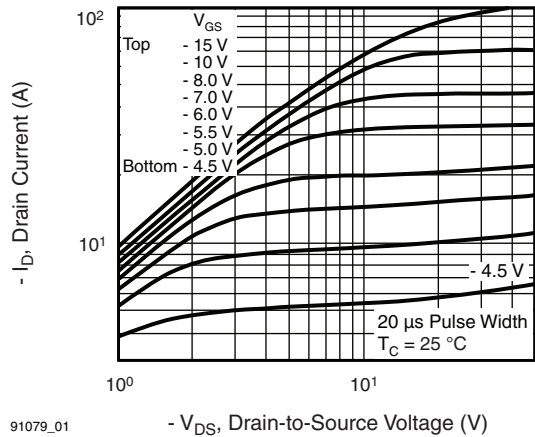
| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |  |  |       |         |           |               |
|---|---------------------|--|--|-------|---------|-----------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS  |  | MIN.  | TYP.    | MAX.      | UNIT          |
| <b>Static</b>   |                     |  |  |       |         |           |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$   |  | - 100 | -       | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$   |  | -     | - 0.087 | -         | 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   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$   |  | -     | -       | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = -100\text{ V}, V_{GS} = 0\text{ V}$  |  | -     | -       | - 100     | $\mu\text{A}$ |
|   |                     | $V_{DS} = -80\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$  |  | -     | -       | - 500     |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}$  | $I_D = -11\text{ A}^b$   | -     | -       | 0.20      | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = -50\text{ V}, I_D = -11\text{ A}$  |  | 6.2   | -       | -         | S             |
| <b>Dynamic</b>  |                     |  |  |       |         |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$ , see fig. 5  |  | -     | 1400    | -         | pF            |
| Output Capacitance  | $C_{oss}$           |  |  | -     | 590     | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |  |  | -     | 140     | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = -10\text{ V}$  | $I_D = -19\text{ A}, V_{DS} = -80\text{ V}$ , see fig. 6 and 13 <sup>b</sup> | -     | -       | 61        | nC            |
| Gate-Source Charge  | $Q_{gs}$            |  |  | -     | -       | 14        |               |
| Gate-Drain Charge   | $Q_{gd}$            |  |  | -     | -       | 29        |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = -50\text{ V}, I_D = -19\text{ A}, R_G = 9.1\text{ }\Omega, R_D = 2.4\text{ }\Omega$ , see fig. 10 <sup>b</sup>                               |  | -     | 16      | -         | ns            |
| Rise Time   | $t_r$               |  |  | -     | 73      | -         |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |  |  | -     | 34      | -         |               |
| Fall Time   | $t_f$               |  |  | -     | 57      | -         |               |
| 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     | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |  |  |       |         |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode    |  | -     | -       | - 19      | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |  |  | -     | -       | - 72      |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = -19\text{ A}, V_{GS} = 0\text{ V}^b$  |  | -     | -       | - 5.0     | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = -19\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$   |  | -     | 130     | 260       | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |  |  | -     | 0.35    | 0.70      | 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).

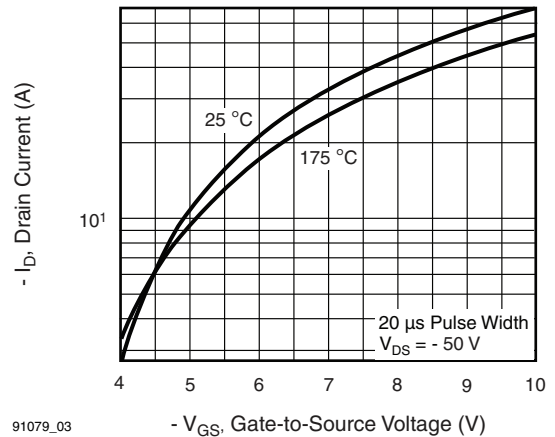
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

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



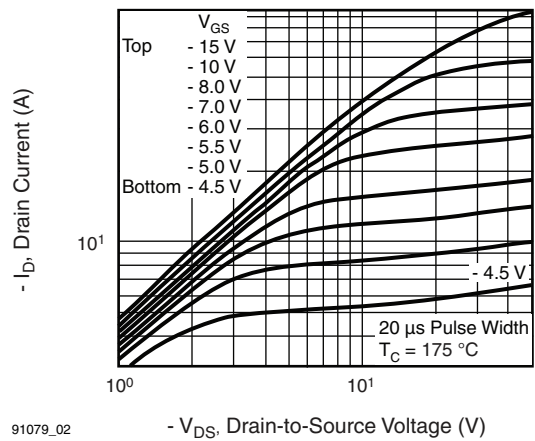
91079\_01

**Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$**



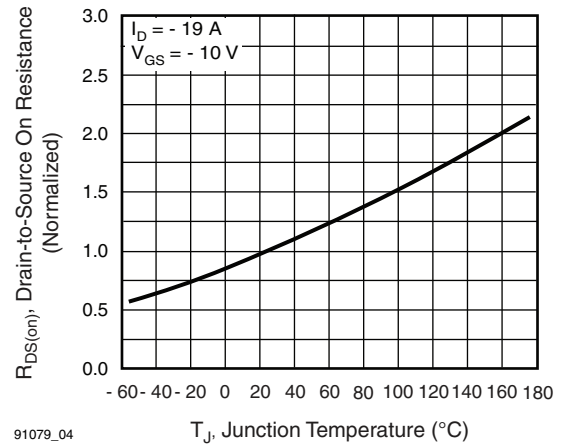
91079\_03

**Fig. 3 - Typical Transfer Characteristics**



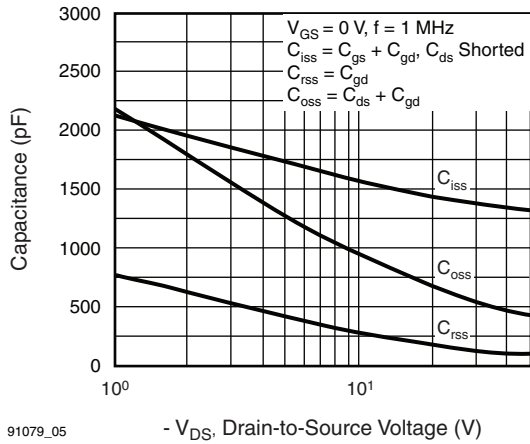
91079\_02

**Fig. 2 - Typical Output Characteristics,  $T_C = 175\text{ }^\circ\text{C}$**

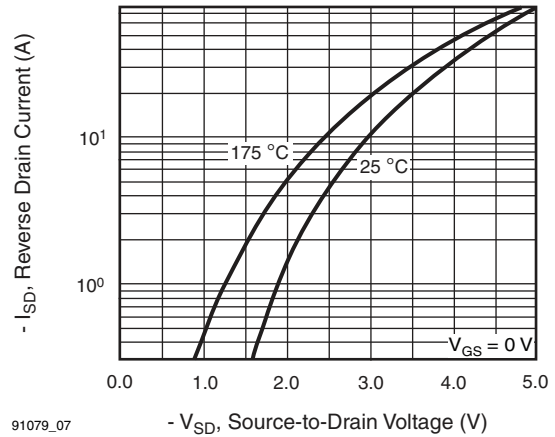


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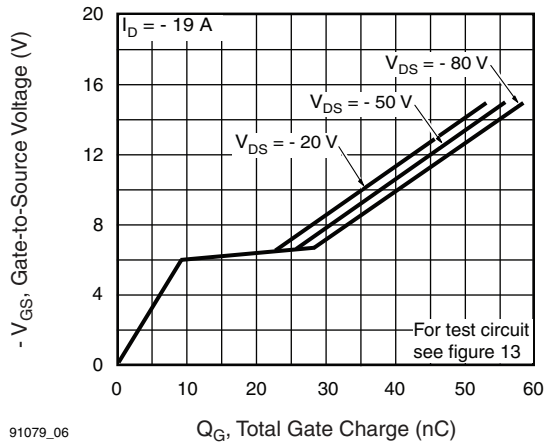
**Fig. 4 - Normalized On-Resistance vs. Temperature**



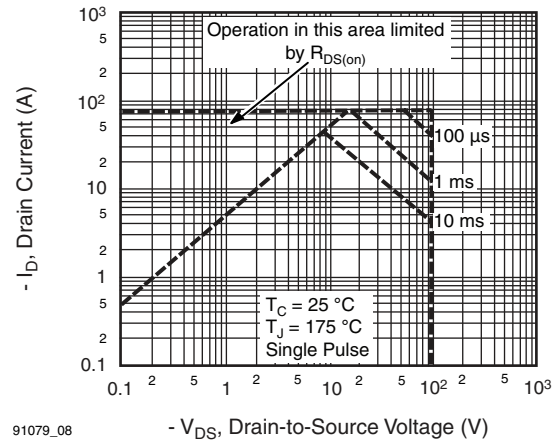
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



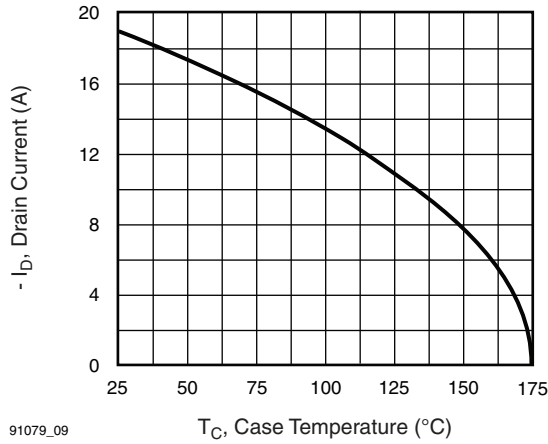
**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



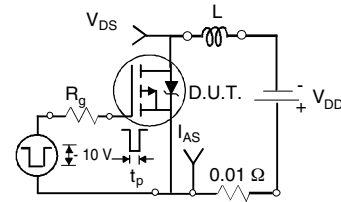
**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**



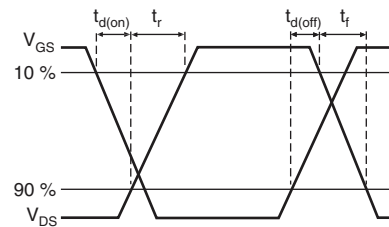
**Fig. 8 - Maximum Safe Operating Area**



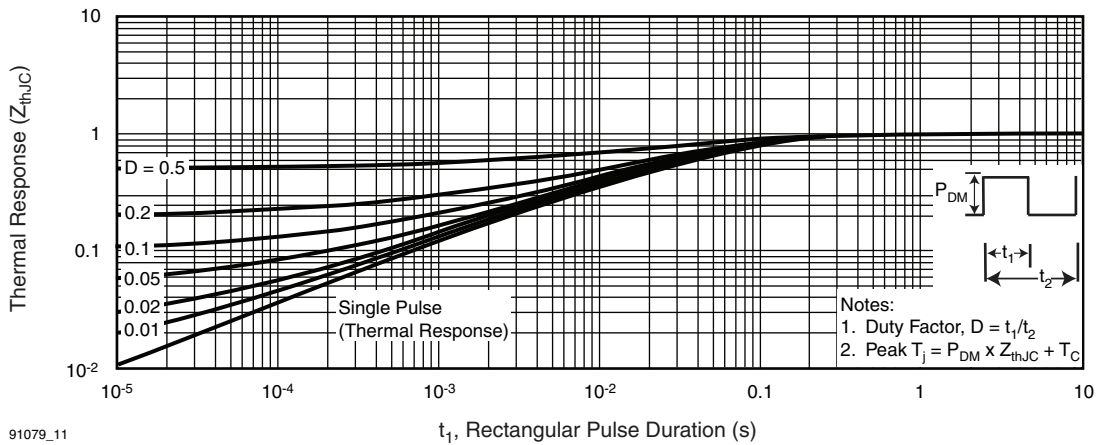
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



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



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



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

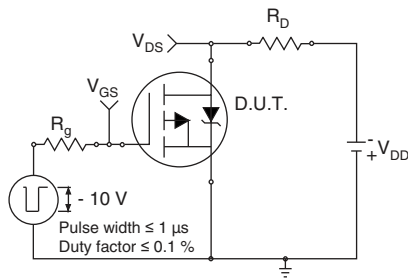


Fig. 12a - Unclamped Inductive Test Circuit

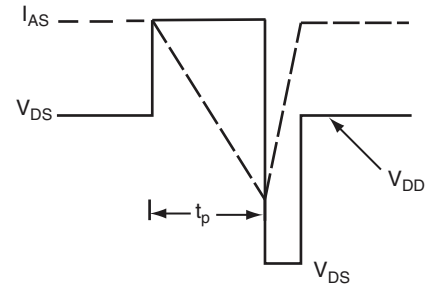
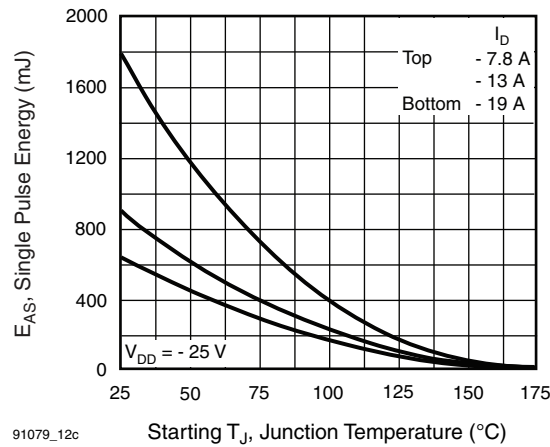


Fig. 12b - Unclamped Inductive Waveforms



91079\_12c

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

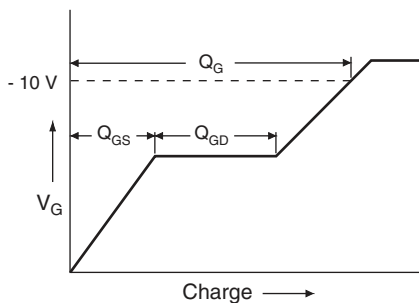


Fig. 13a - Basic Gate Charge Waveform

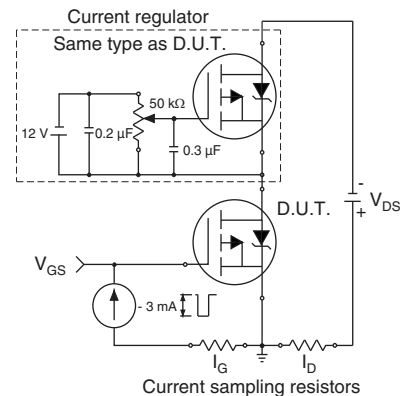
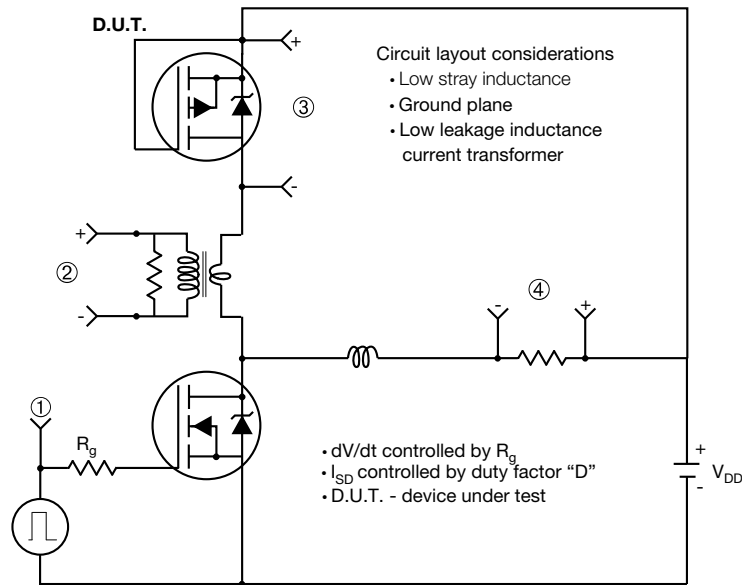
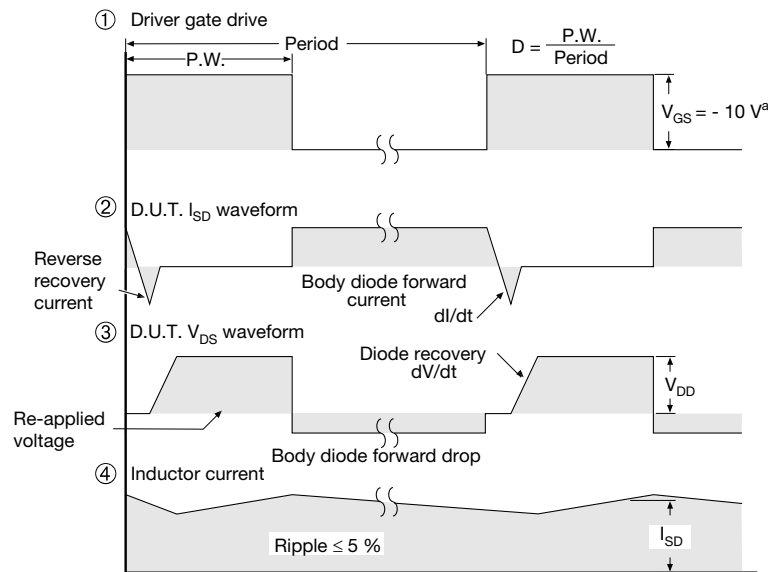


Fig. 13b - Gate Charge Test Circuit

### 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-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 D<sup>2</sup>PAK: 3-Lead**



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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