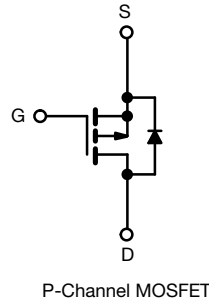


## Power MOSFET



P-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- For automatic insertion
- End stackable
- P-channel
- Fast switching
- Ease of paralleling
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

|                           |                  |     |
|---------------------------|------------------|-----|
| $V_{DS}$ (V)              | -200             |     |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = -10$ V | 1.5 |
| $Q_g$ (Max.) (nC)         | 15               |     |
| $Q_{gs}$ (nC)             | 3.2              |     |
| $Q_{gd}$ (nC)             | 8.4              |     |
| Configuration             | Single           |     |

### 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 4 pin DIP package is a low cost machine-insertable case style which can be stacked in multiple combinations on standard 0.1" pin centers. The dual drain serves as a thermal link to the mounting surface for power dissipation levels up to 1 W.

### ORDERING INFORMATION

|                |             |
|----------------|-------------|
| Package        | HVMDIP      |
| Lead (Pb)-free | IRFD9220PbF |

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)

| PARAMETER  | SYMBOL            | LIMIT          | UNIT             |       |
|--|-------------------|----------------|------------------|-------|
| Drain-source voltage                                       | $V_{DS}$          | -200           | V                |       |
| Gate-source voltage  | $V_{GS}$          | $\pm 20$       |                  |       |
| Continuous drain current                                   | $V_{GS}$ at -10 V | $T_A = 25$ °C  | A                |       |
|  |                   | $T_A = 100$ °C |                  | -0.36 |
| Pulsed drain current <sup>a</sup>                          | $I_{DM}$          | -4.5           |                  |       |
| Linear derating factor                                     |                   | 0.0083         | W/°C             |       |
| Single pulse avalanche energy <sup>b</sup>                 | $E_{AS}$          | 80             | mJ               |       |
| Repetitive avalanche current <sup>a</sup>                  | $I_{AR}$          | -0.56          | A                |       |
| Repetitive avalanche energy <sup>a</sup>                   | $E_{AR}$          | 0.10           | mJ               |       |
| Maximum power dissipation                                  | $T_A = 25$ °C     | $P_D$          | 1                | W     |
| Peak diode recovery dv/dt <sup>c</sup>                     |                   | dV/dt          | -5               | V/ns  |
| Operating junction and storage temperature range           | $T_J, T_{stg}$    |                | -55 to +150      | °C    |
| Soldering rRecommendations (peak temperature) <sup>d</sup> | For 10 s          |                | 300 <sup>d</sup> |       |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = -50$  V, starting  $T_J = 25$  °C,  $L = 17.8$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = -3$  A (see fig. 12)
- $I_{SD} \leq -3.9$  A,  $dI/dt \leq 95$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C
- 1.6 mm from case

| <b>THERMAL RESISTANCE RATINGS</b> |            |      |      |      |
|-----------------------------------|------------|------|------|------|
| PARAMETER                         | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient       | $R_{thJA}$ | -    | 120  | °C/W |

| <b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |  |  |      |       |           |               |
|--|---------------------|--|--|------|-------|-----------|---------------|
| PARAMETER  | SYMBOL              | TEST CONDITIONS  |  | MIN. | TYP.  | MAX.      | UNIT          |
| <b>Static</b>  |                     |  |  |      |       |           |               |
| Drain-Source Breakdown Voltage   | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$   |  | -200 | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient   | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$   |  | -    | -0.22 | -         | V/°C          |
| Gate-Source Threshold Voltage  | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$   |  | -2   | -     | -4        | V             |
| Gate-Source Leakage  | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$   |  | -    | -     | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current  | $I_{DSS}$           | $V_{DS} = -200\text{ V}, V_{GS} = 0\text{ V}$  |  | -    | -     | -100      | $\mu\text{A}$ |
|  |                     | $V_{DS} = -160\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$   |  | -    | -     | -500      |               |
| Drain-Source On-State Resistance   | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}$  | $I_D = -0.34\text{ A}^b$   | -    | -     | 1.5       | $\Omega$      |
| Forward Transconductance   | $g_{fs}$            | $V_{DS} = -50\text{ V}, I_D = -0.35\text{ A}^b$  |  | 0.55 | -     | -         | S             |
| <b>Dynamic</b>   |                     |  |  |      |       |           |               |
| Input Capacitance  | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = -25\text{ V},$<br>$f = 1\text{ MHz},$ see fig. 5   |  | -    | 340   | -         | $\mu\text{F}$ |
| Output Capacitance   | $C_{oss}$           |  |  | -    | 110   | -         |               |
| Reverse Transfer Capacitance   | $C_{rss}$           |  |  | -    | 33    | -         |               |
| Total Gate Charge  | $Q_g$               | $V_{GS} = -10\text{ V}$  | $I_D = -2.1\text{ A}, V_{DS} = -160\text{ V},$<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 15        | nC            |
| Gate-Source Charge   | $Q_{gs}$            |  |  | -    | -     | 3.2       |               |
| Gate-Drain Charge  | $Q_{gd}$            |  |  | -    | -     | 8.4       |               |
| Turn-On Delay Time   | $t_{d(on)}$         | $V_{DD} = -100\text{ V}, I_D = -3.9\text{ A},$<br>$R_g = 18\text{ }\Omega, R_D = 24\text{ }\Omega,$ see fig. 10 <sup>b</sup> |  | -    | 8.8   | -         | ns            |
| Rise Time  | $t_r$               |  |  | -    | 27    | -         |               |
| Turn-Off Delay Time  | $t_{d(off)}$        |  |  | -    | 7.3   | -         |               |
| Fall Time  | $t_f$               |  |  | -    | 19    | -         |               |
| Internal Drain Inductance  | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact   |  | -    | 4     | -         | nH            |
| Internal Source Inductance   | $L_S$               |  |  | -    | 6     | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                                     |                     |  |  |      |       |           |               |
| Continuous Source-Drain Diode Current  | $I_S$               | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode   |  | -    | -     | -0.56     | A             |
| Pulsed Diode Forward Current <sup>a</sup>  | $I_{SM}$            |  |  | -    | -     | -4.5      |               |
| Body Diode Voltage   | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = -0.56\text{ A}, V_{GS} = 0\text{ V}^b$  |  | -    | -     | -6.3      | V             |
| Body Diode Reverse Recovery Time   | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = -3.9\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$                                    |  | -    | 150   | 300       | ns            |
| Body Diode Reverse Recovery Charge   | $Q_{rr}$            |  |  | -    | 0.97  | 2         | $\mu\text{C}$ |

**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)

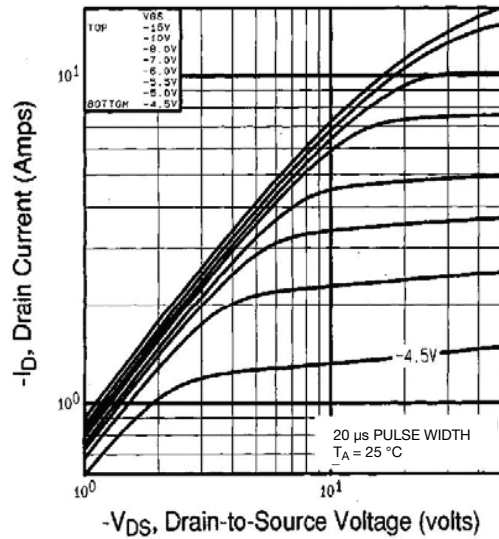


Fig. 1 - Typical Output Characteristics,  $T_A = 25^\circ\text{C}$

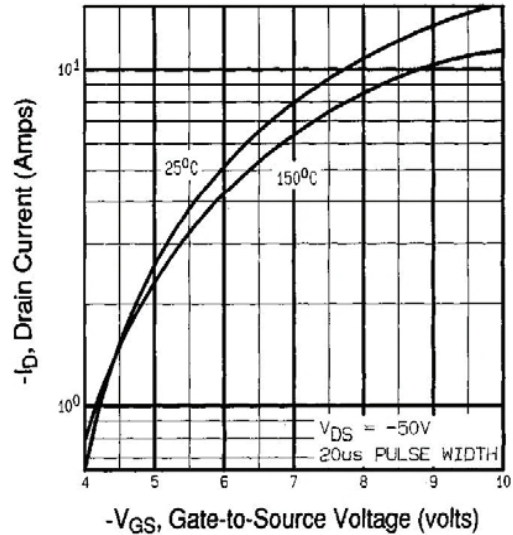


Fig. 2 - Typical Transfer Characteristics

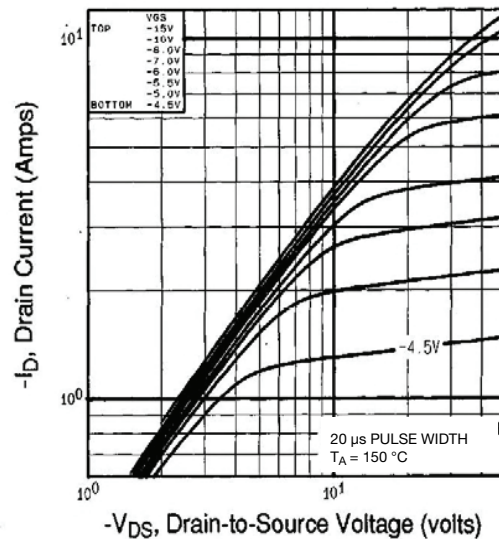


Fig. 1 - Typical Output Characteristics,  $T_A = 150^\circ\text{C}$

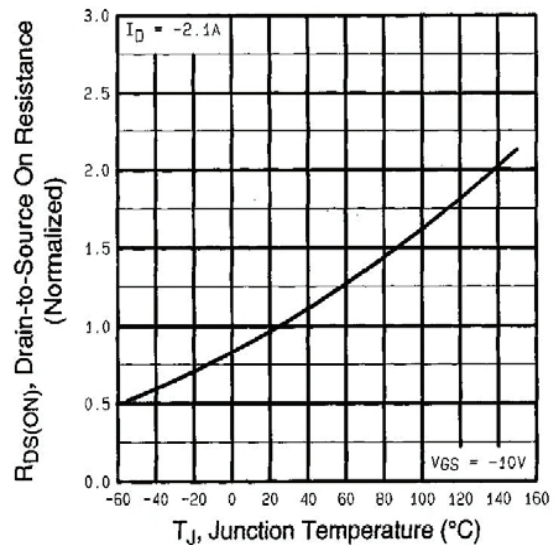


Fig. 3 - Normalized On-Resistance vs. Temperature

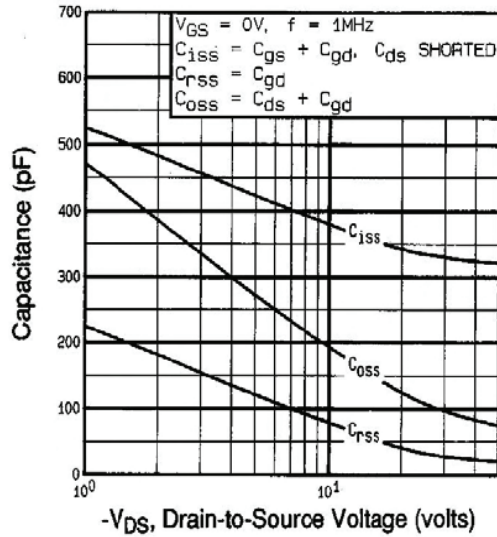


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

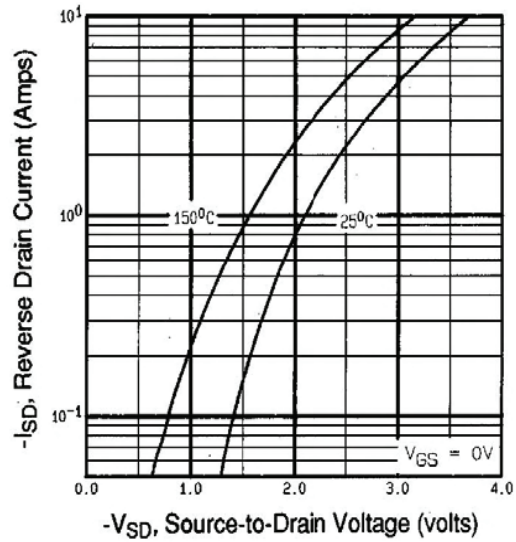


Fig. 6 - Typical Source-Drain Diode Forward Voltage

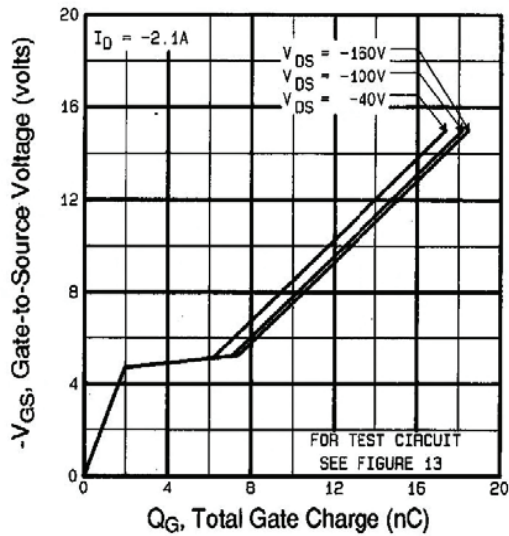


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

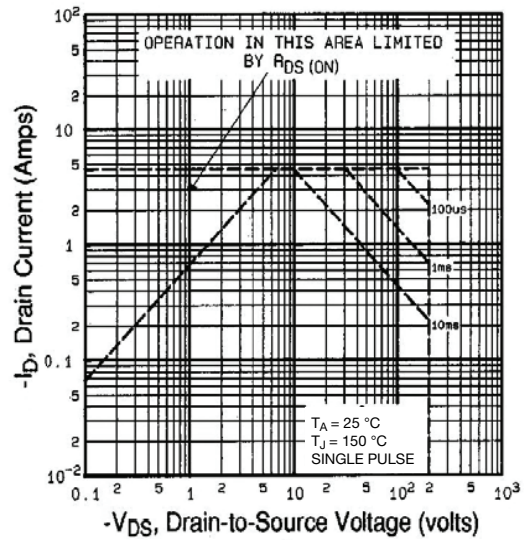


Fig. 7 - Maximum Safe Operating Area

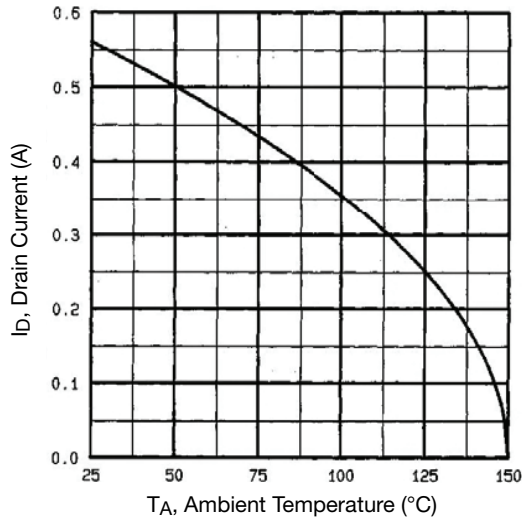


Fig. 8 - Maximum Drain Current vs. Ambient Temperature

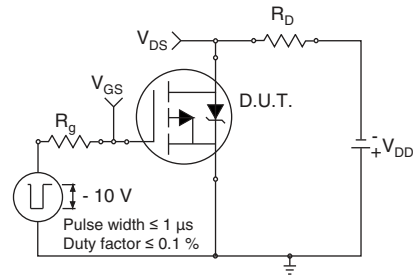


Fig. 9 - Switching Time Test Circuit

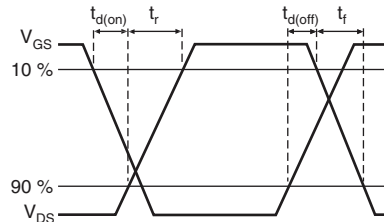


Fig. 10 - Switching Time Waveforms

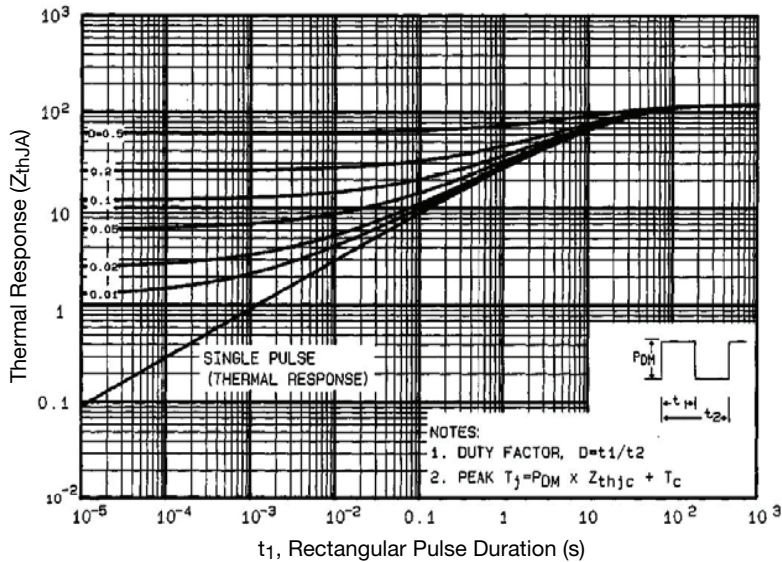


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

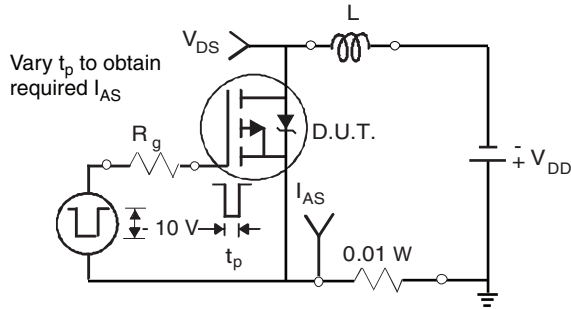


Fig. 12 - Unclamped Inductive Test Circuit

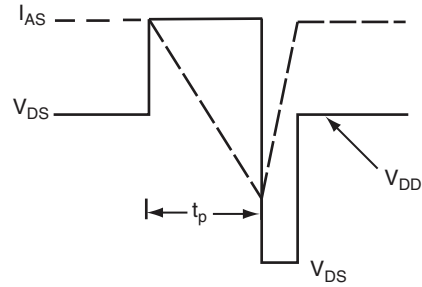


Fig. 13 - Unclamped Inductive Waveforms

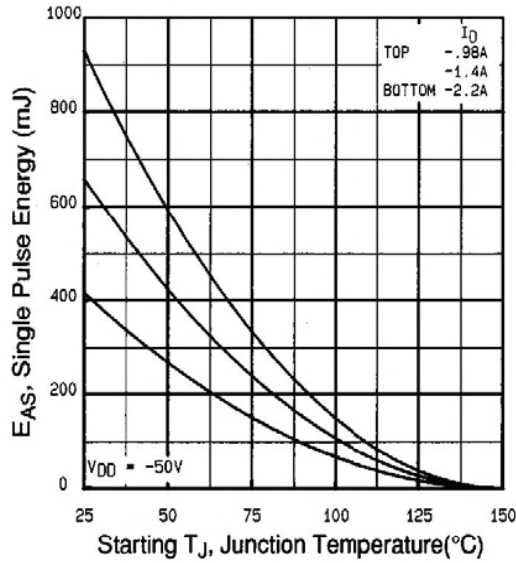


Fig. 14 - Maximum Avalanche Energy vs. Drain Current

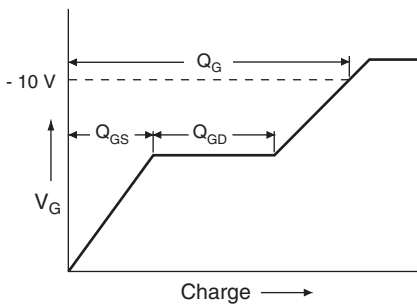


Fig. 15 - Basic Gate Charge Waveform

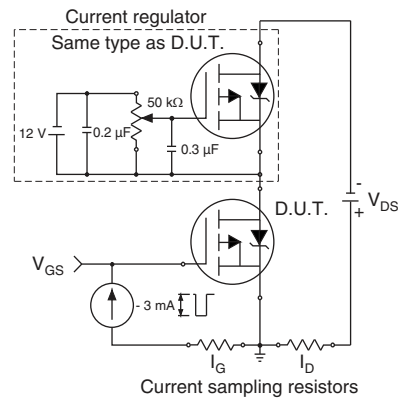
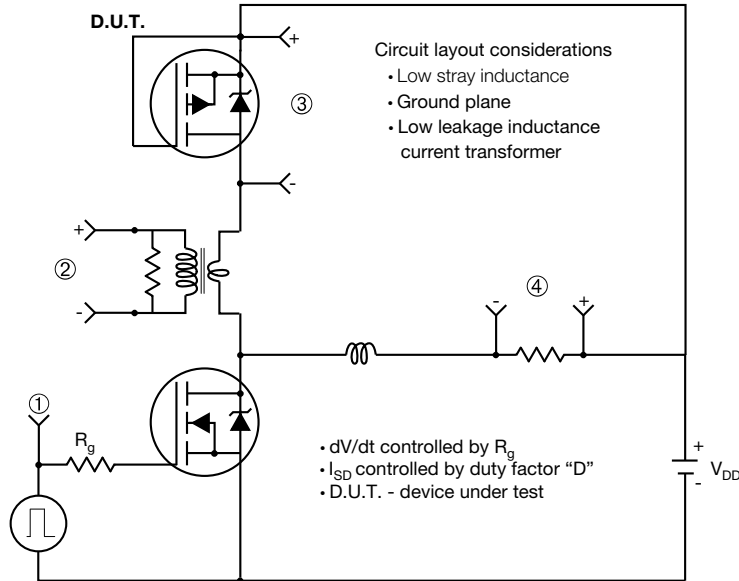
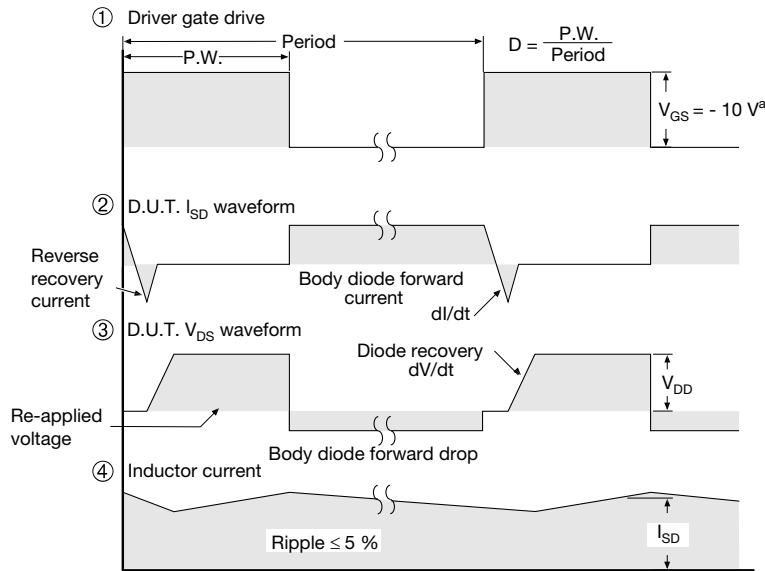


Fig. 16 - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



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



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

**Fig. 17 - For P-Channel**

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## HVM DIP (High voltage)



| DIM. | INCHES |       | MILLIMETERS |       |
|------|--------|-------|-------------|-------|
|      | MIN.   | MAX.  | MIN.        | MAX.  |
| A    | 0.310  | 0.330 | 7.87        | 8.38  |
| E    | 0.300  | 0.425 | 7.62        | 10.79 |
| L    | 0.270  | 0.290 | 6.86        | 7.36  |

ECN: X10-0386-Rev. B, 06-Sep-10  
DWG: 5974

### Note

- Package length does not include mold flash, protrusions or gate burrs. Package width does not include interlead flash or protrusions.





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