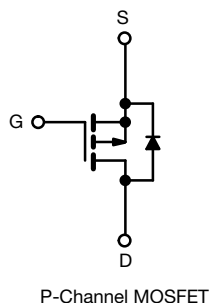
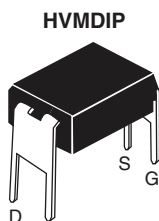


# Power MOSFET



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                                   | $I_D$          | $T_A = 25$ °C    | A    |
|                                                            |                | $T_A = 100$ °C   |      |
| 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                                  | $P_D$          | 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> |      |

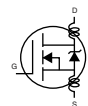
### Notes

- 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

**THERMAL RESISTANCE RATINGS**

| PARAMETER                   | SYMBOL     | TYP. | MAX. | UNIT |
|-----------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient | $R_{thJA}$ | -    | 120  | °C/W |

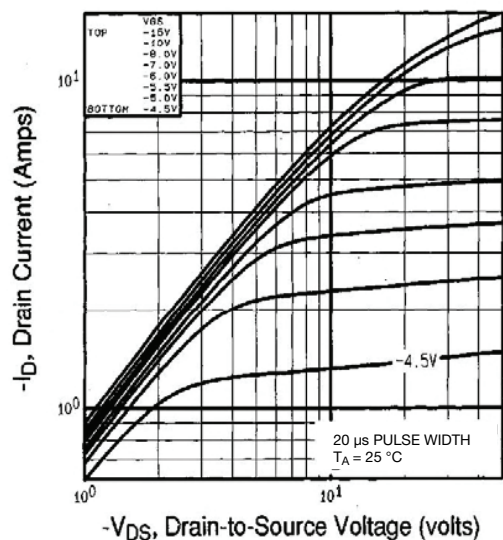
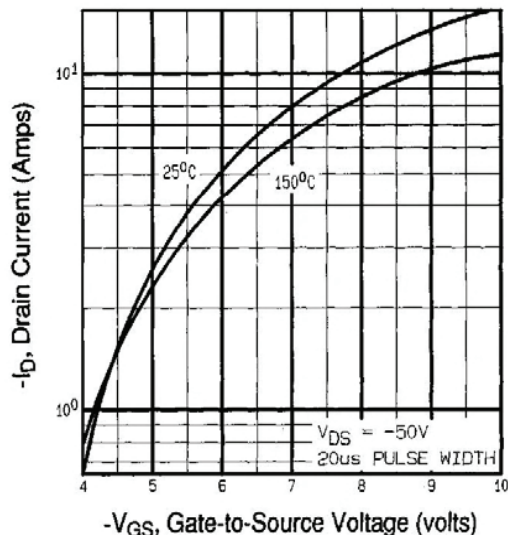
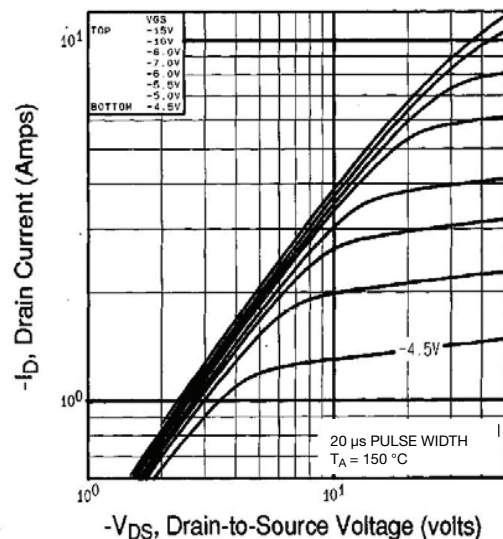
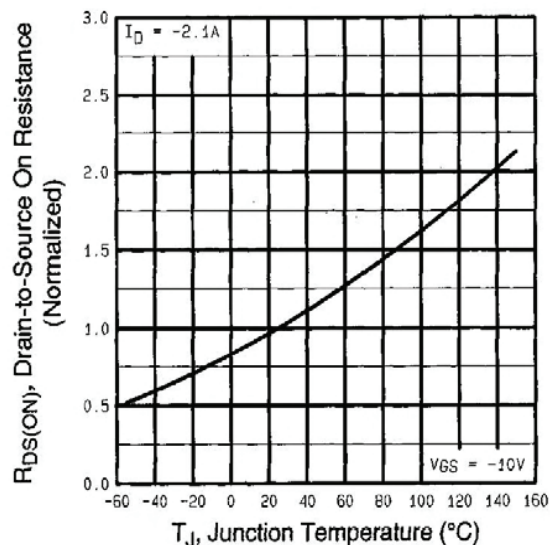
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| 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                                                                                                                     |                                                                                      | -200 | -     | -     | 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                                                                                                                          |                                                                                      | -    | -0.22 | -     | 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   | -     | -4    | 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> = -200 V, V <sub>GS</sub> = 0 V                                                                                                                     |                                                                                      | -    | -     | -100  | μA   |
|                                           |                                  | V <sub>DS</sub> = -160 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                            |                                                                                      | -    | -     | -500  |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = -10 V                                                                                                                                             | I <sub>D</sub> = -0.34 A <sup>b</sup>                                                | -    | -     | 1.5   | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = -50 V, I <sub>D</sub> = -0.35 A <sup>b</sup>                                                                                                      |                                                                                      | 0.55 | -     | -     | S    |
| Dynamic                                   |                                  |                                                                                                                                                                     |                                                                                      |      |       |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = -25 V,<br>f = 1 MHz, see fig. 5                                                                                         |                                                                                      | -    | 340   | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                                     |                                                                                      | -    | 110   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                                     |                                                                                      | -    | 33    | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = -10 V                                                                                                                                             | I <sub>D</sub> = -2.1 A, V <sub>DS</sub> = -160 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 15    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                                     |                                                                                      | -    | -     | 3.2   |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                                     |                                                                                      | -    | -     | 8.4   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = -100 V, I <sub>D</sub> = -3.9 A,<br>R <sub>g</sub> = 18 Ω, R <sub>D</sub> = 24 Ω, see fig. 10 <sup>b</sup>                                        |                                                                                      | -    | 8.8   | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                                     |                                                                                      | -    | 27    | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                                     |                                                                                      | -    | 7.3   | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                                     |                                                                                      | -    | 19    | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                      | -    | 4     | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                                                                     |                                                                                      | -    | 6     | -     |      |
| 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<br>   |                                                                                      | -    | -     | -0.56 | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                                     |                                                                                      | -    | -     | -4.5  |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = -0.56 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                                |                                                                                      | -    | -     | -6.3  | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = -3.9 A, dI/dt = 100 A/μs <sup>b</sup>                                                                                      |                                                                                      | -    | 150   | 300   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                                     |                                                                                      | -    | 0.97  | 2     | μC   |

**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,  $T_A = 25\text{ }^{\circ}\text{C}$** 

**Fig. 2 - Typical Transfer Characteristics**

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

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

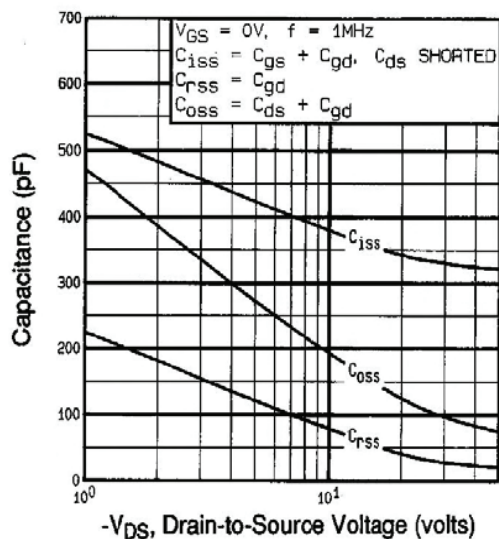


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

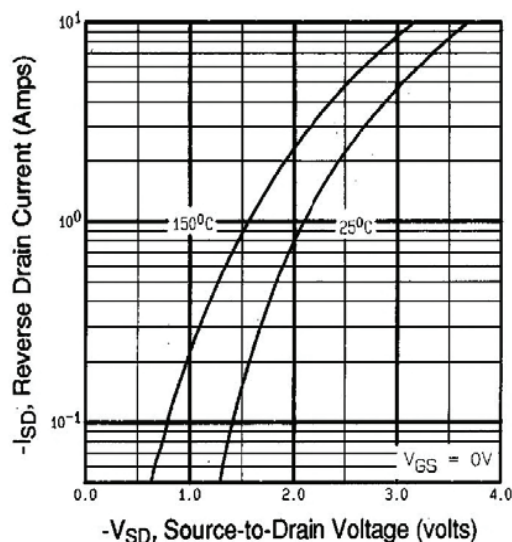


Fig. 6 - Typical Source-Drain Diode Forward Voltage

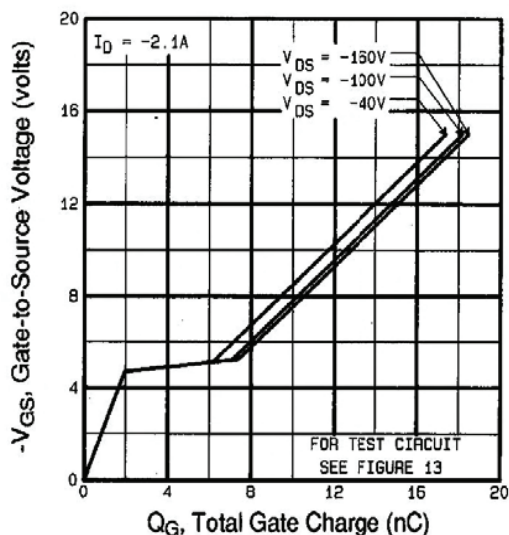


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

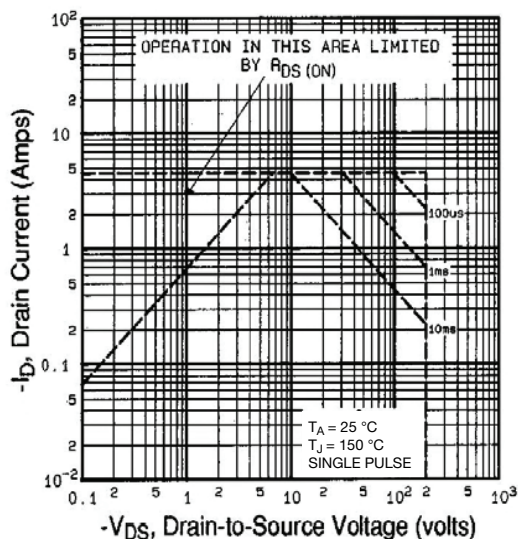
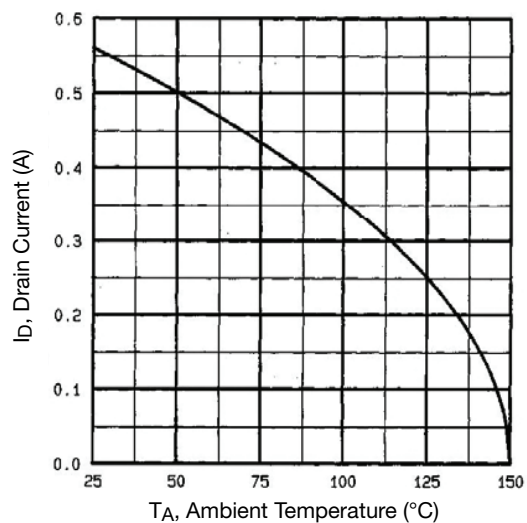
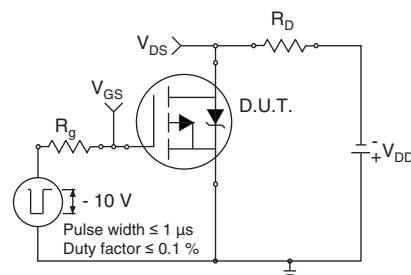


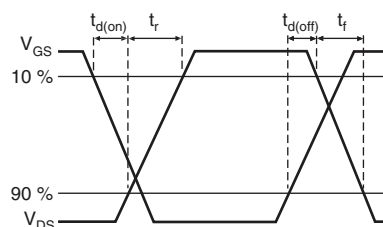
Fig. 7 - Maximum Safe Operating Area



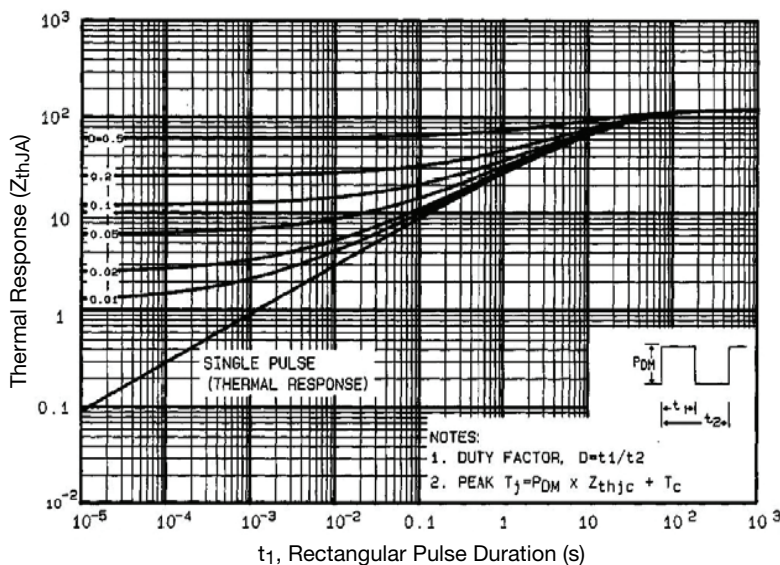
**Fig. 8 - Maximum Drain Current vs. Ambient Temperature**



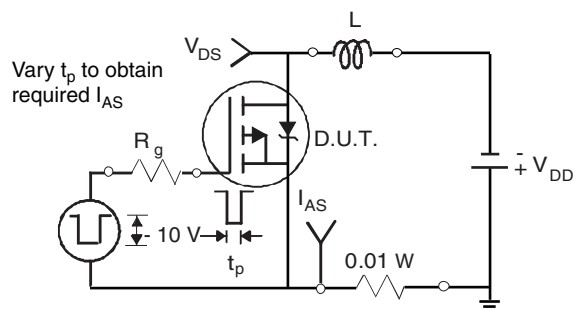
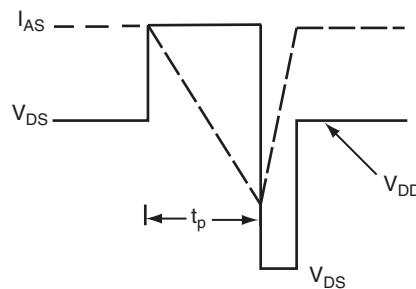
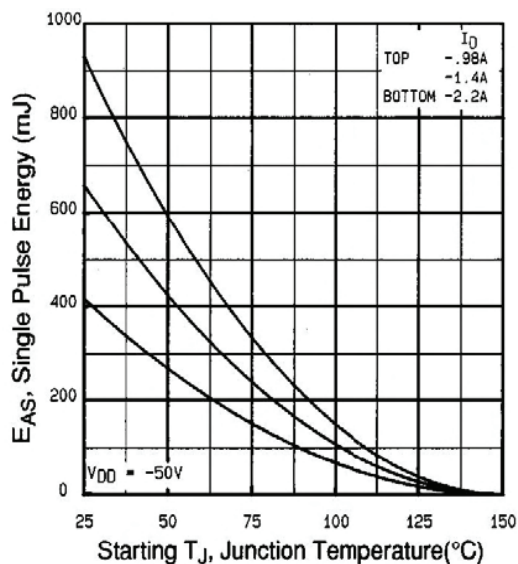
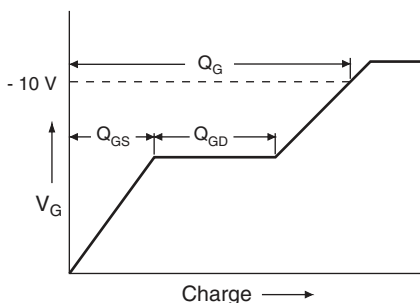
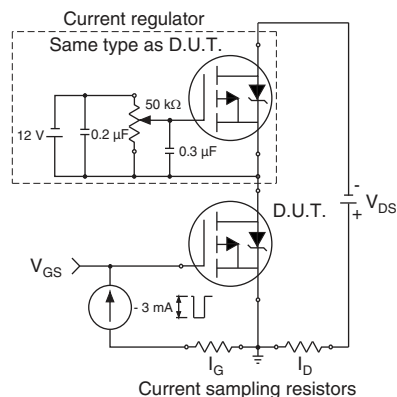
**Fig. 9 - Switching Time Test Circuit**

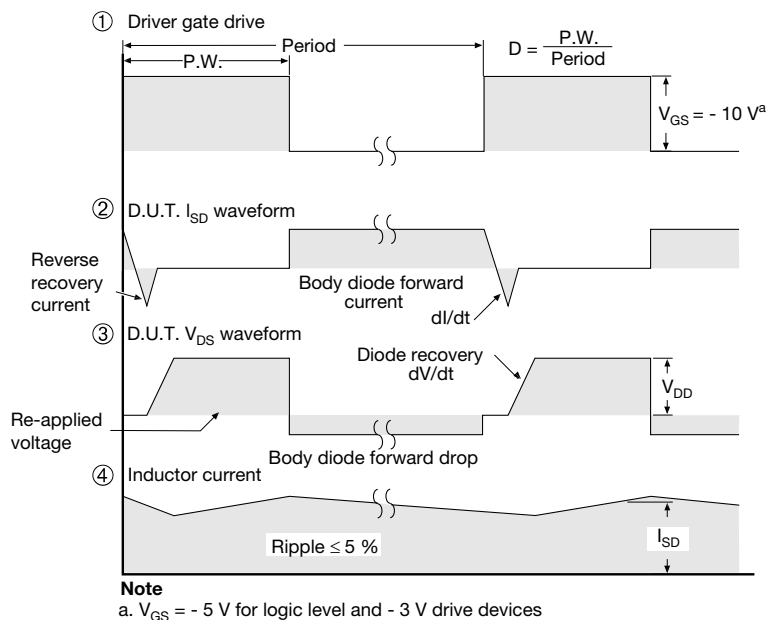
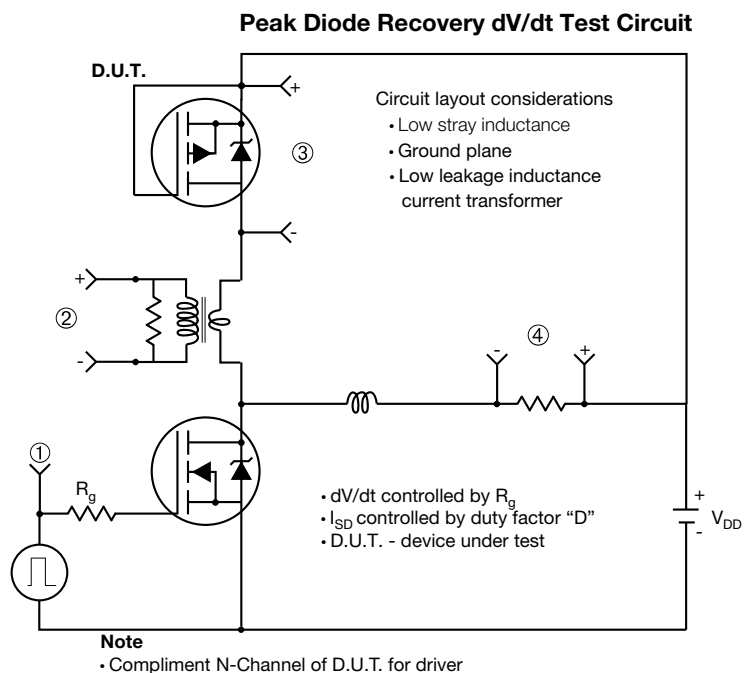


**Fig. 10 - Switching Time Waveforms**



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

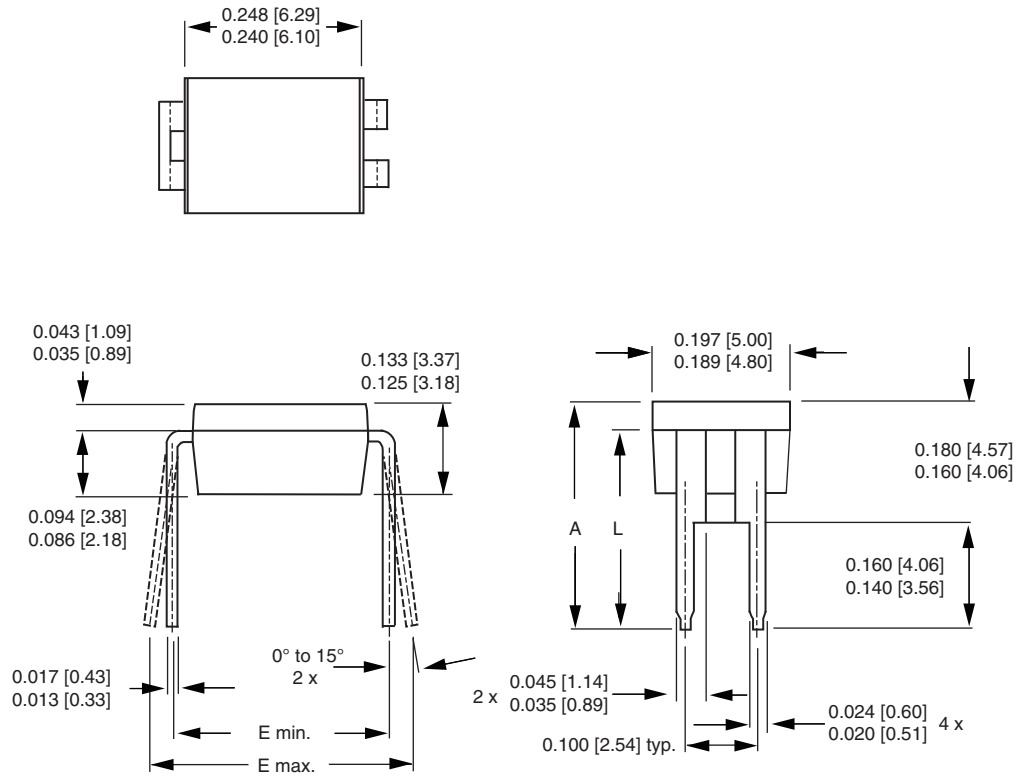

**Fig. 12 - Unclamped Inductive Test Circuit**

**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**



**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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