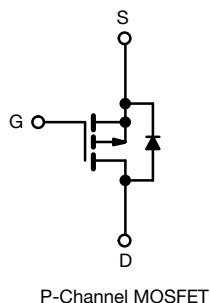
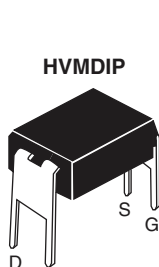


## Power MOSFET



P-Channel MOSFET

### FEATURES

- For automatic insertion
- Compact, end stackable
- Fast switching
- Low drive current
- Easy paralleled
- Excellent temperature stability
- P-channel versatility
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### DESCRIPTION

The HVMDIP technology is the key to Vishay's advanced line of power MOSFET transistors. The efficient geometry and unique processing of the HVMDIP design achieves very low on-state resistance combined with high transconductance and extreme device ruggedness.

The p-channel HVMDIPs are designed for application which require the convenience of reverse polarity operation. They retain all of the features of the more common n-channel HVMDIPs such as voltage control, very fast switching, ease of paralleling, and excellent temperature stability.

P-channels HVMDIPs are intended for use in power stages where complementary symmetry with n-channel devices offers circuit simplification. They are also very useful in drive stages because of the circuit versatility offered by the reverse polarity connection. Applications include motor control, audio amplifiers, switched mode converters, control circuits and pulse amplifiers.

### PRODUCT SUMMARY

|                           |                  |      |
|---------------------------|------------------|------|
| $V_{DS}$ (V)              | - 50             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = -10$ V | 0.50 |
| $Q_g$ (Max.) (nC)         | 11               |      |
| $Q_{gs}$ (nC)             | 3.8              |      |
| $Q_{gd}$ (nC)             | 4.1              |      |
| Configuration             | Single           |      |

### ORDERING INFORMATION

|                |             |
|----------------|-------------|
| Package        | HVMDIP      |
| Lead (Pb)-free | IRFD9010PbF |

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

| PARAMETER                                        | SYMBOL                              | LIMIT                     | UNIT                |
|--------------------------------------------------|-------------------------------------|---------------------------|---------------------|
| Drain-source voltage                             | $V_{DS}$                            | - 50                      | V                   |
| Gate-source voltage                              | $V_{GS}$                            | $\pm 20$                  |                     |
| Continuous drain current                         | $V_{GS}$ at -10 V                   | $T_C = 25^\circ\text{C}$  | A                   |
|                                                  |                                     | $T_C = 100^\circ\text{C}$ |                     |
| Pulsed drain current <sup>a</sup>                | $I_{DM}$                            | - 8.8                     |                     |
| Linear derating factor                           |                                     | 0.01                      | W/ $^\circ\text{C}$ |
| Inductive current, clamped                       | $L = 100$ $\mu\text{H}$ see fig. 14 | $I_{LM}$                  | A                   |
| Inductive current, unclamped (avalanche current) | see fig. 15                         | $I_L$                     |                     |
| Maximum power dissipation                        | $T_C = 25^\circ\text{C}$            | $P_D$                     | W                   |
| Operating junction and storage temperature range | $T_J, T_{stg}$                      | - 55 to + 150             | $^\circ\text{C}$    |
| Soldering recommendations (peak temperature)     | For 10 s                            | 300 <sup>d</sup>          |                     |

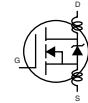
#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = -25$  V, starting  $T_J = 25^\circ\text{C}$ ,  $L = 52$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = -2.0$  A (see fig. 12)
- $I_{SD} \leq -4.0$  A,  $dI/dt \leq 75$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175^\circ\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

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

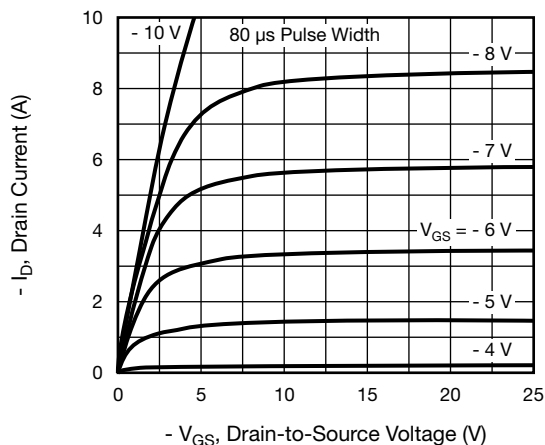
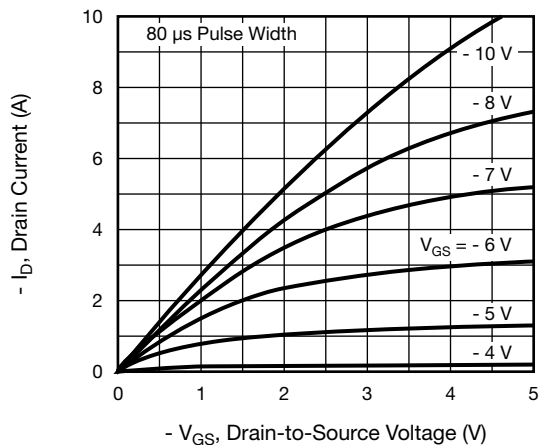
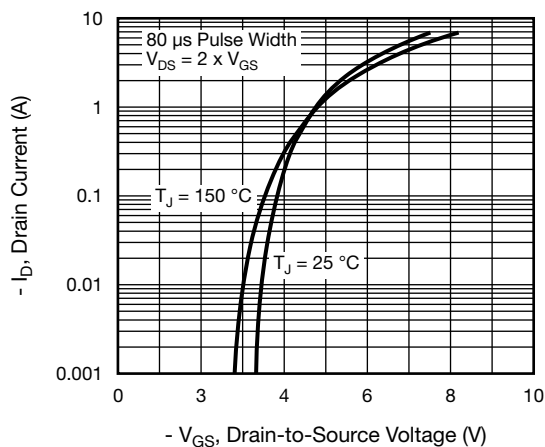
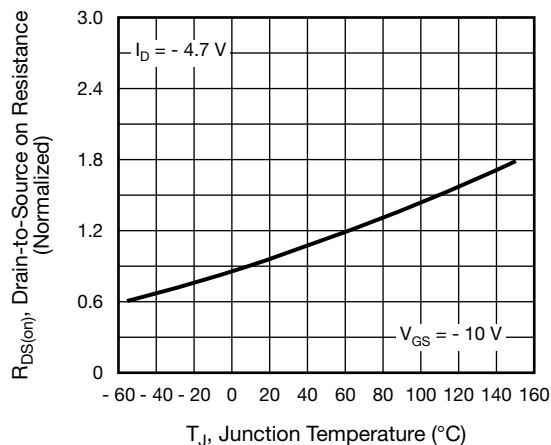
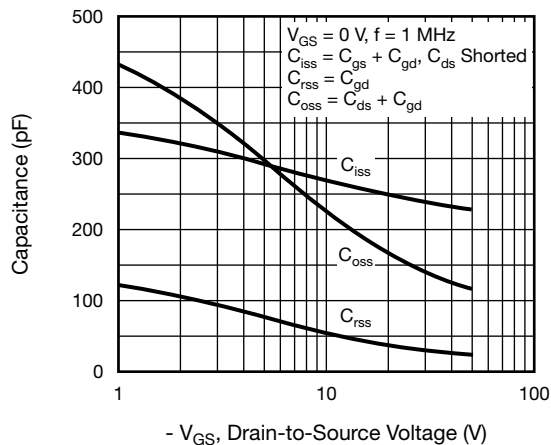
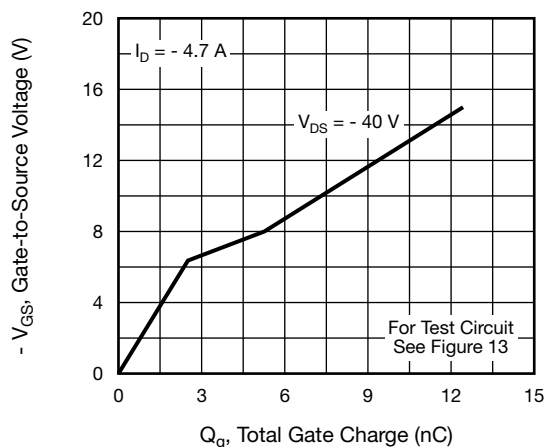
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

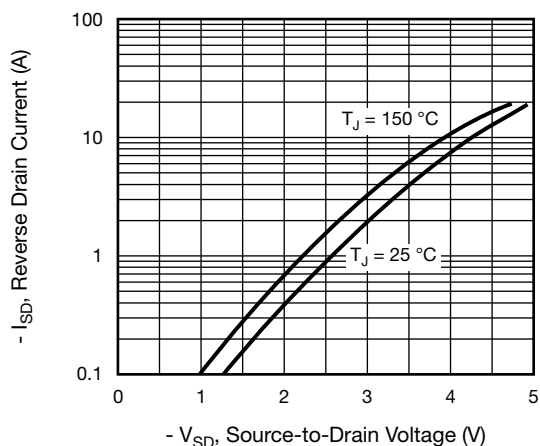
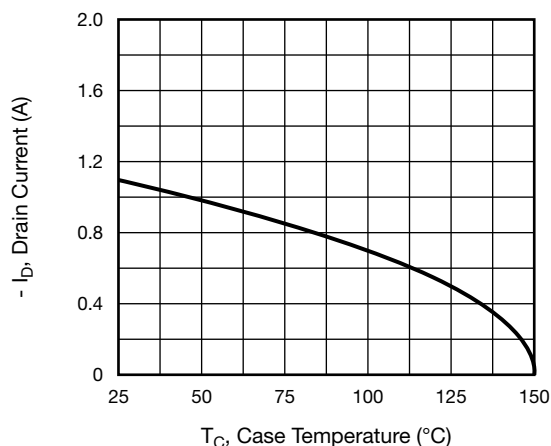
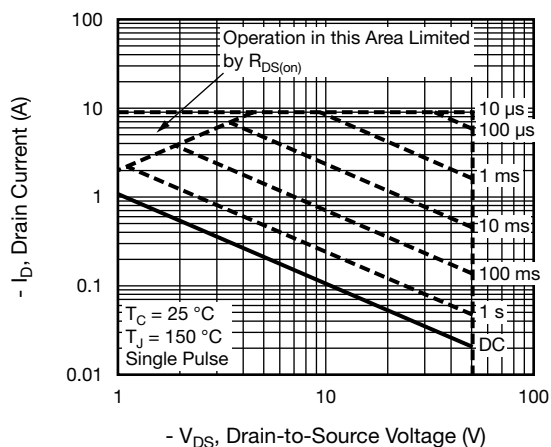
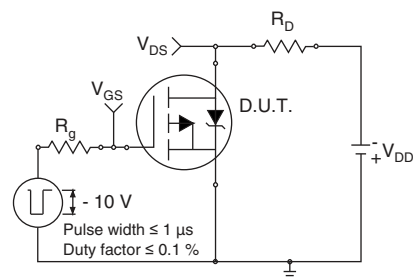
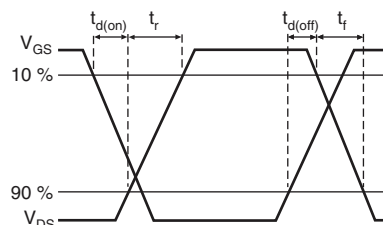
| PARAMETER                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                                     |                                                                                    | MIN.  | TYP.    | MAX.      | UNIT                |
|-------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------|---------|-----------|---------------------|
| Static                                    |                     |                                                                                                                                                                     |                                                                                    |       |         |           |                     |
| Drain-Source Breakdown Voltage            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = - 250\text{ }\mu\text{A}$                                                                                                            |                                                                                    | - 50  | -       | -         | V                   |
| $V_{DS}$ Temperature Coefficient          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = - 1\text{ mA}$                                                                                                     |                                                                                    | -     | - 0.091 | -         | V/ $^\circ\text{C}$ |
| 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                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                                          |                                                                                    | -     | -       | $\pm 500$ | nA                  |
| Zero Gate Voltage Drain Current           | $I_{DSS}$           | $V_{DS} = - 50\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                                    |                                                                                    | -     | -       | - 250     | $\mu\text{A}$       |
|                                           |                     | $V_{DS} = - 40\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                                |                                                                                    | -     | -       | - 1000    |                     |
| On-State Drain Current                    | $I_{D(on)}$         | $V_{GS} = 10\text{ V}$                                                                                                                                              | $V_{DS} > I_{D(on)} \times R_{DS(on)}$ max.                                        | - 1.1 | -       | -         | A                   |
| Drain-Source On-State Resistance          | $R_{DS(on)}$        | $V_{GS} = - 10\text{ V}$                                                                                                                                            | $I_D = - 0.58\text{ A}^b$                                                          | -     | 0.35    | 0.50      | $\Omega$            |
| Forward Transconductance                  | $g_{fs}$            | $V_{DS} = - 20\text{ V}$ , $I_D = - 2.4\text{ A}$                                                                                                                   |                                                                                    | 1.7   | 2.5     | -         | S                   |
| Dynamic                                   |                     |                                                                                                                                                                     |                                                                                    |       |         |           |                     |
| Input Capacitance                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = - 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5                                                                          |                                                                                    | -     | 240     | -         | pF                  |
| Output Capacitance                        | $C_{oss}$           |                                                                                                                                                                     |                                                                                    | -     | 160     | -         |                     |
| Reverse Transfer Capacitance              | $C_{rss}$           |                                                                                                                                                                     |                                                                                    | -     | 30      | -         |                     |
| Total Gate Charge                         | $Q_g$               | $V_{GS} = - 10\text{ V}$                                                                                                                                            | $I_D = - 4.7\text{ A}$ , $V_{DS} = 0.8\text{ V}$<br>see fig. 6 and 13 <sup>b</sup> | -     | 7.2     | 11        | nC                  |
| Gate-Source Charge                        | $Q_{gs}$            |                                                                                                                                                                     |                                                                                    | -     | 2.5     | 3.8       |                     |
| Gate-Drain Charge                         | $Q_{gd}$            |                                                                                                                                                                     |                                                                                    | -     | 2.7     | 4.1       |                     |
| Turn-On Delay Time                        | $t_{d(on)}$         | $V_{DD} = - 25\text{ V}$ , $I_D = - 4.7\text{ A}$<br>$R_g = 24\text{ }\Omega$ , $R_D = 5.6\text{ }\Omega$ ,<br>see fig. 10 <sup>b</sup>                             |                                                                                    | -     | 6.1     | 9.2       | ns                  |
| Rise Time                                 | $t_r$               |                                                                                                                                                                     |                                                                                    | -     | 47      | 71        |                     |
| Turn-Off Delay Time                       | $t_{d(off)}$        |                                                                                                                                                                     |                                                                                    | -     | 13      | 20        |                     |
| Fall Time                                 | $t_f$               |                                                                                                                                                                     |                                                                                    | -     | 39      | 59        |                     |
| Internal Drain Inductance                 | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                    | -     | 4.0     | -         | nH                  |
| Internal Source Inductance                | $L_S$               |                                                                                                                                                                     |                                                                                    | -     | 6.0     | -         |                     |
| Drain-Source Body Diode Characteristics   |                     |                                                                                                                                                                     |                                                                                    |       |         |           |                     |
| Continuous Source-Drain Diode Current     | $I_S$               | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode<br>   |                                                                                    | -     | -       | - 1.1     | A                   |
| Pulsed Diode Forward Current <sup>a</sup> | $I_{SM}$            |                                                                                                                                                                     |                                                                                    | -     | -       | - 8.8     |                     |
| Body Diode Voltage                        | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = - 0.7\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                                                 |                                                                                    | -     | -       | - 5.5     | V                   |
| Body Diode Reverse Recovery Time          | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = - 4.7\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^b$                                                                    |                                                                                    | 33    | 75      | 160       | ns                  |
| Body Diode Reverse Recovery Charge        | $Q_{rr}$            |                                                                                                                                                                     |                                                                                    | 0.090 | 0.22    | 0.52      | $\mu\text{C}$       |
| Forward Turn-On Time                      | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                                     |                                                                                    |       |         |           |                     |

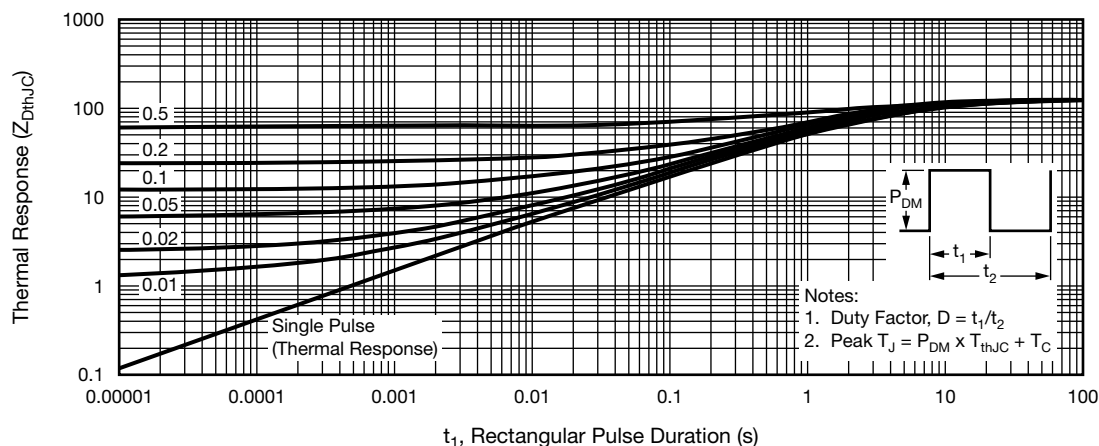
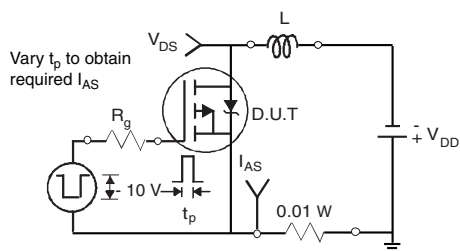
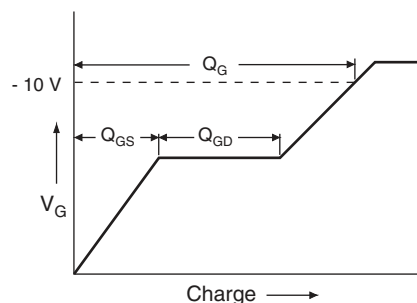
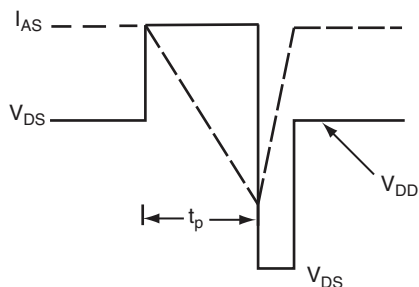
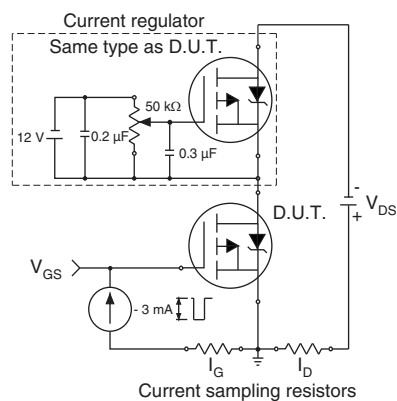
**Notes**

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

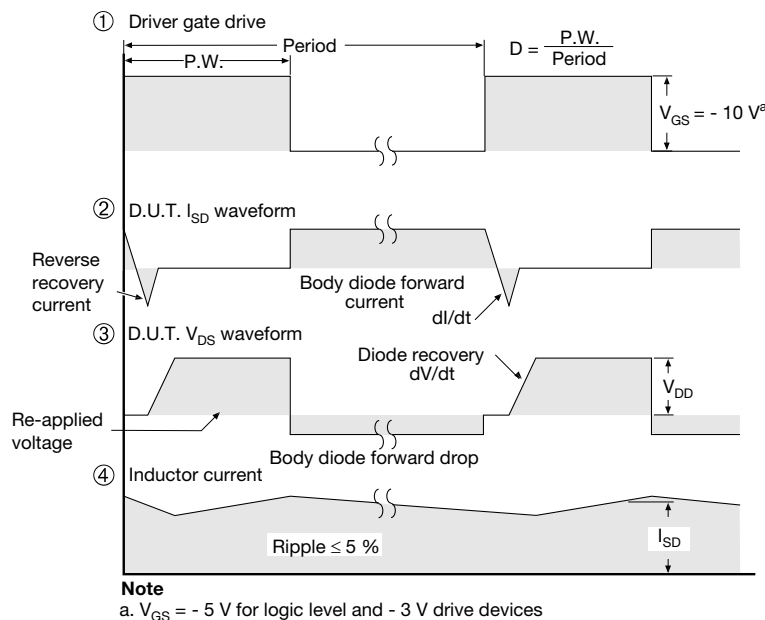
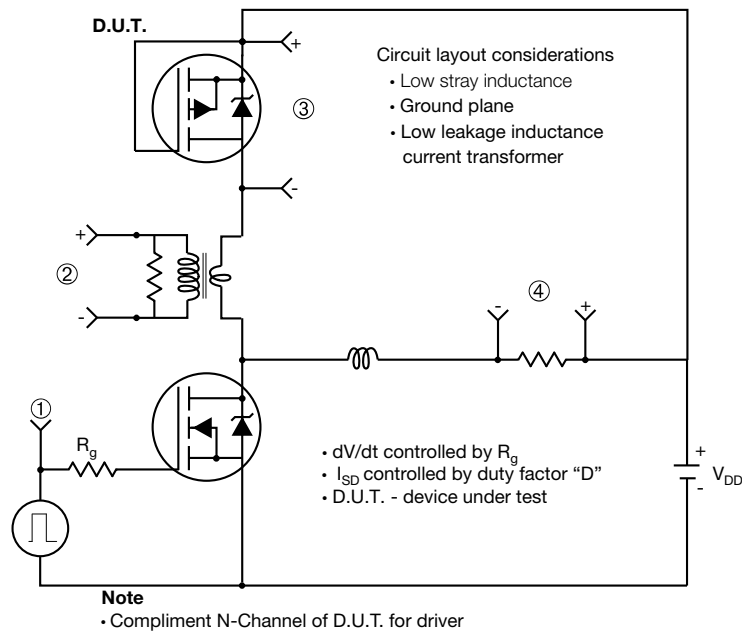
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

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

**Fig. 1 - Typical Output Characteristics**

**Fig. 2 - Typical Output Characteristics**

**Fig. 3 - Typical Transfer Characteristics**

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

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

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


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

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

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

**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. 13a - Basic Gate Charge Waveform**

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

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

## Peak Diode Recovery dV/dt Test Circuit



**Fig. 14 - For P-Channel**

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