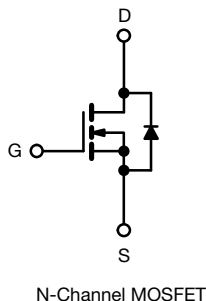


# Power MOSFET



N-Channel MOSFET

## FEATURES

- Dynamic dV/dt rating
- For automatic insertion
- End stackable
- Logic-level gate drive
- $R_{DS(on)}$  specified at  $V_{GS} = 4\text{ V}$  and  $5\text{ V}$
- $175\text{ }^{\circ}\text{C}$  operating temperature
- Fast switching
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



## PRODUCT SUMMARY

|                           |                         |      |
|---------------------------|-------------------------|------|
| $V_{DS}$ (V)              | 60                      |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 5.0\text{ V}$ | 0.10 |
| $Q_g$ (Max.) (nC)         | 18                      |      |
| $Q_{gs}$ (nC)             | 4.5                     |      |
| $Q_{gd}$ (nC)             | 12                      |      |
| 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-insertible 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 | IRLD024PbF |

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

| PARAMETER                                        | SYMBOL         | LIMIT                               | UNIT                  |
|--------------------------------------------------|----------------|-------------------------------------|-----------------------|
| Drain-source voltage                             | $V_{DS}$       | 60                                  | V                     |
| Gate-source voltage                              | $V_{GS}$       | $\pm 10$                            |                       |
| Continuous drain current                         | $I_D$          | $T_A = 25\text{ }^{\circ}\text{C}$  | A                     |
|                                                  |                | $T_A = 100\text{ }^{\circ}\text{C}$ |                       |
| Pulsed drain current <sup>a</sup>                | $I_{DM}$       | 20                                  |                       |
| Linear derating factor                           |                | 0.0083                              | W/ $^{\circ}\text{C}$ |
| Single pulse avalanche energy <sup>b</sup>       | $E_{AS}$       | 91                                  | mJ                    |
| Maximum power dissipation                        | $P_D$          | 1.3                                 | W                     |
| Peak diode recovery dV/dt <sup>c</sup>           | dV/dt          | 4.5                                 | V/ns                  |
| Operating junction and storage temperature range | $T_J, T_{stg}$ | - 55 to + 175                       | $^{\circ}\text{C}$    |
| Soldering recommendations (peak temperature)     | For 10 s       | 300 <sup>d</sup>                    |                       |

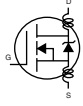
### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 25\text{ V}$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 16\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 2.5\text{ A}$  (see fig. 12)
- $I_{SD} \leq 17\text{ A}$ ,  $dI/dt \leq 140\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^{\circ}\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

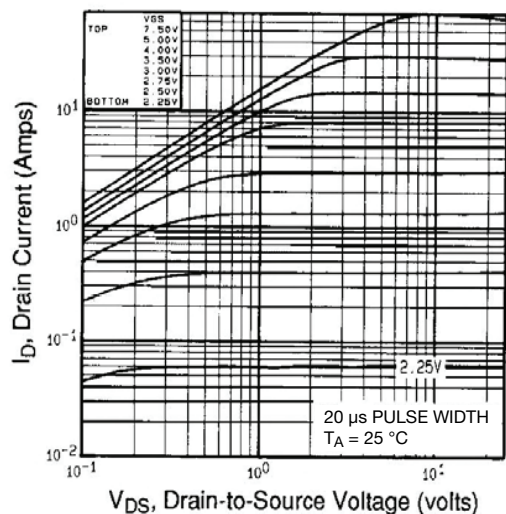
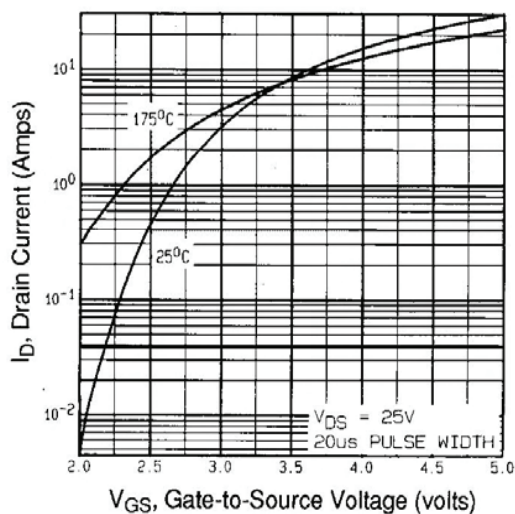
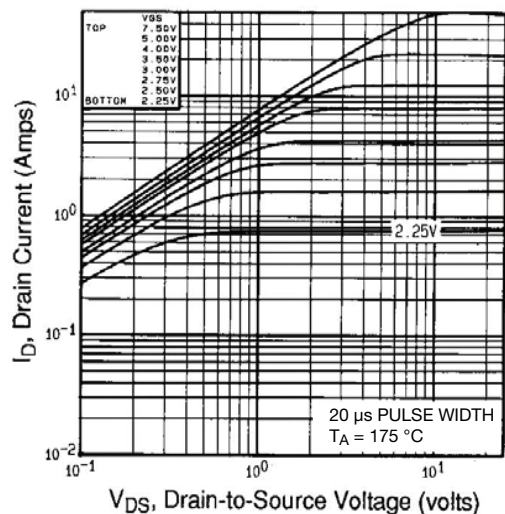
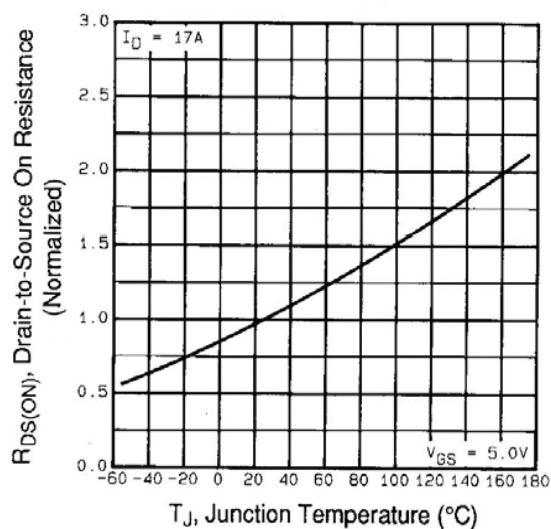
| PARAMETER                   | SYMBOL     | TYP. | MAX. | UNIT |
|-----------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient | $R_{thJA}$ | -    | 120  | °C/W |

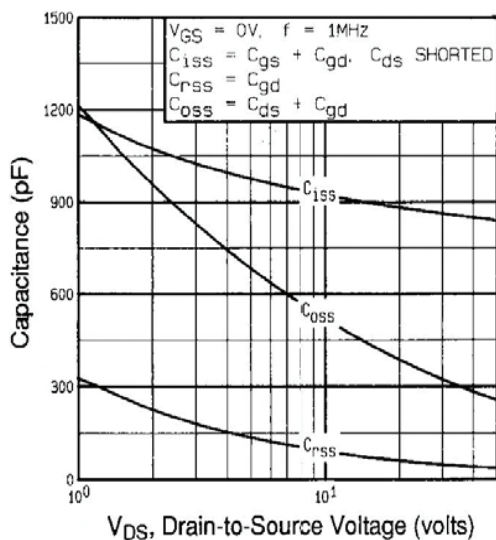
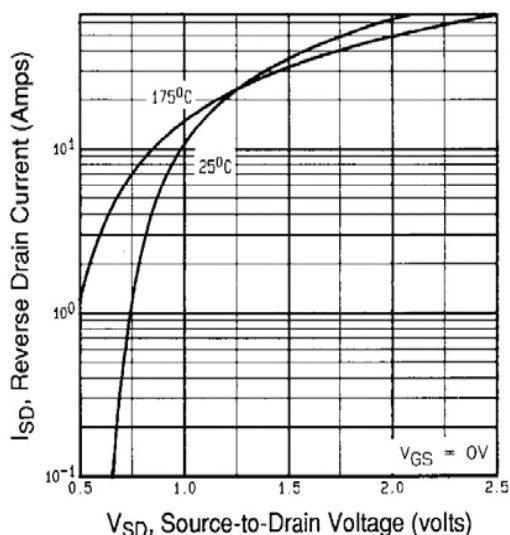
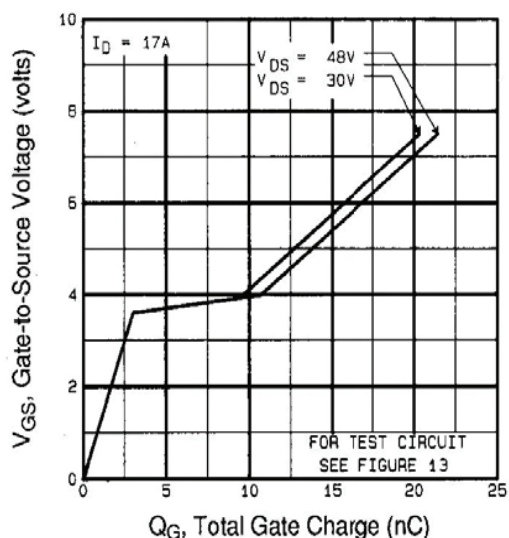
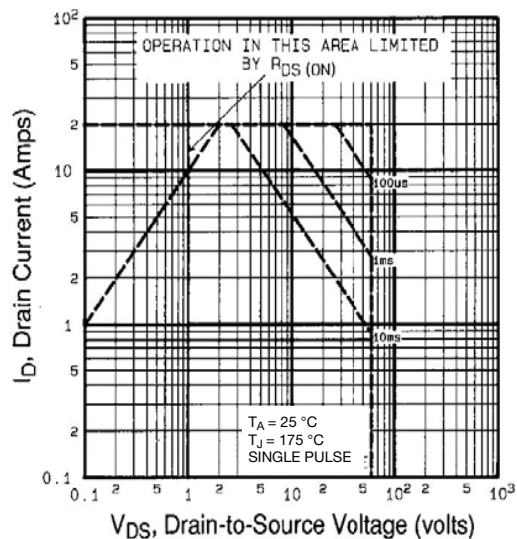
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

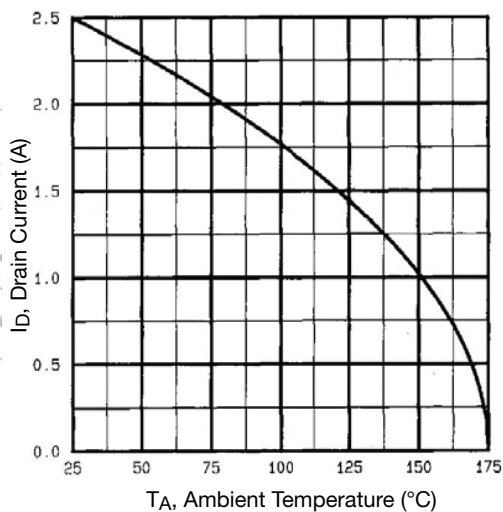
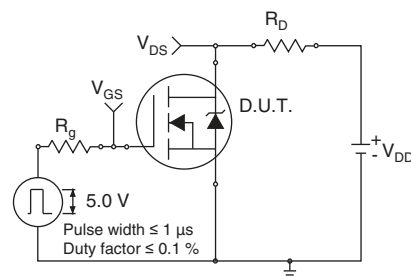
| PARAMETER                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                                     |                                                                                 | MIN. | TYP.  | MAX.  | UNIT |
|-------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|------|-------|-------|------|
| Static                                    |                                  |                                                                                                                                                                     |                                                                                 |      |       |       |      |
| Drain-Source Breakdown Voltage            | V <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                                                                                                                           |                                                                                 | -    | 0.060 | -     | 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                                                                                                         |                                                                                 | 1.0  | -     | 2.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 10 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> = 5.0 V                                                                                                                                             | I <sub>D</sub> = 1.5A <sup>b</sup>                                              | -    | -     | 0.10  | Ω    |
|                                           |                                  | V <sub>GS</sub> = 4.0 V                                                                                                                                             | I <sub>D</sub> = 1.3 A <sup>b</sup>                                             | -    | -     | 0.14  |      |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 25 V, I <sub>D</sub> = 1.5 A <sup>b</sup>                                                                                                         |                                                                                 | 3.7  | -     | -     | 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                                                                                          |                                                                                 | -    | 870   | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                                     |                                                                                 | -    | 360   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                                     |                                                                                 | -    | 53    | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 5.0 V                                                                                                                                             | I <sub>D</sub> = 17 A, V <sub>DS</sub> = 48 V<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 18    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                                     |                                                                                 | -    | -     | 4.5   |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                                     |                                                                                 | -    | -     | 12    |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 30 V, I <sub>D</sub> = 17 A<br>R <sub>g</sub> = 9.0 Ω, R <sub>D</sub> = 1.7 Ω, see fig. 10 <sup>b</sup>                                           |                                                                                 | -    | 11    | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                                     |                                                                                 | -    | 110   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                                     |                                                                                 | -    | 23    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                                     |                                                                                 | -    | 41    | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                 | -    | 4.0   | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                                                                     |                                                                                 | -    | 6.0   | -     |      |
| 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>   |                                                                                 | -    | -     | 2.5   | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                                     |                                                                                 | -    | -     | 20    |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 2.5 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                                  |                                                                                 | -    | -     | 1.5   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 17 A, dI/dt = 100 A/μs <sup>b</sup>                                                                                        |                                                                                 | -    | 110   | 260   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                                     |                                                                                 | -    | 0.49  | 1.5   | 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> )                                                                   |                                                                                 |      |       |       |      |

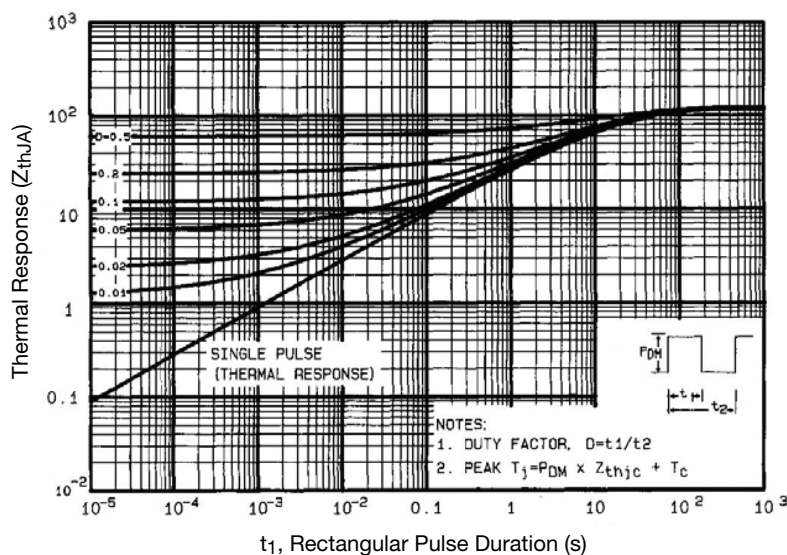
**Notes**

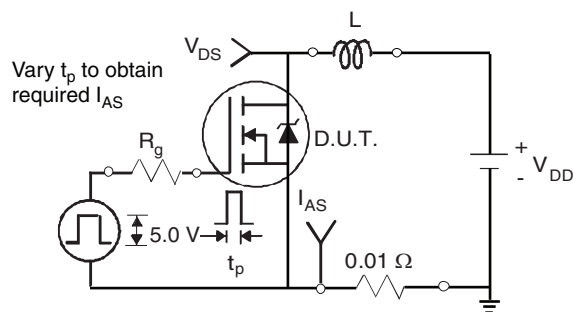
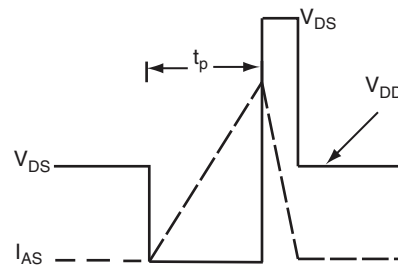
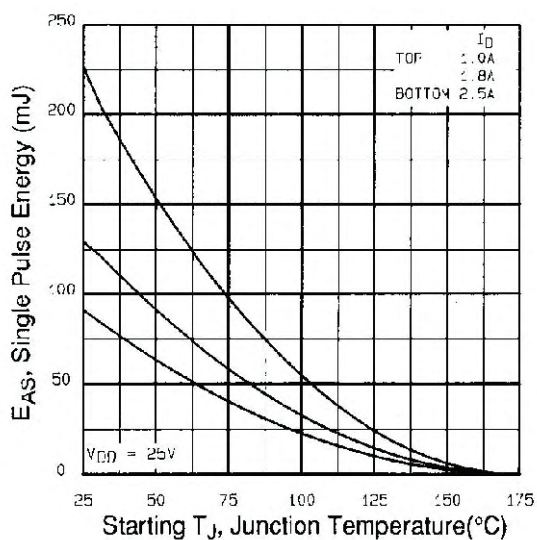
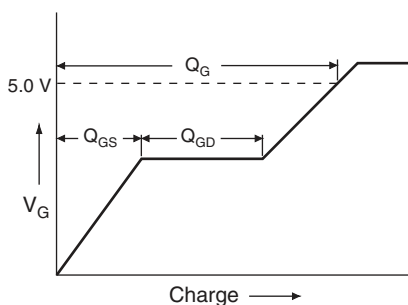
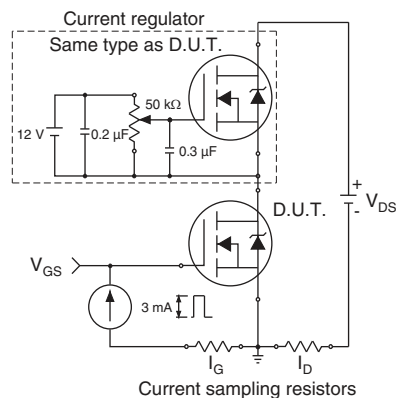
- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

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

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

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 2 - Typical Output Characteristics,  $T_A = 175\text{ °C}$** 

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

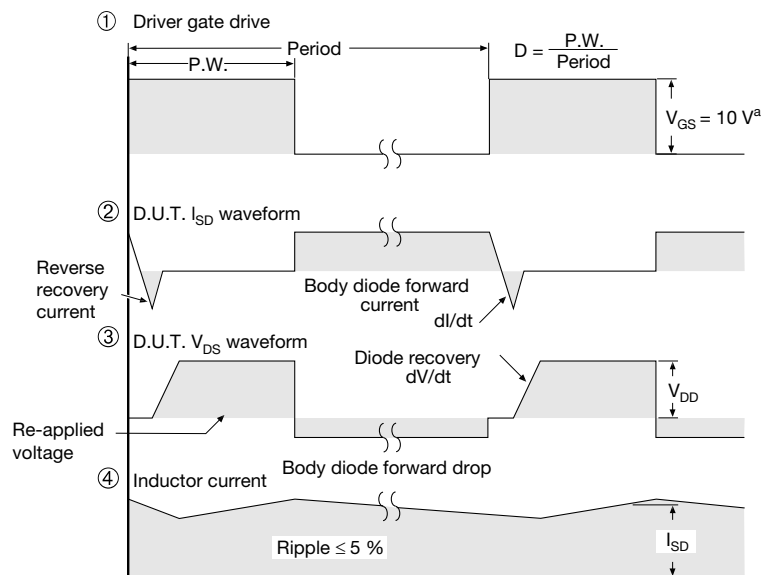
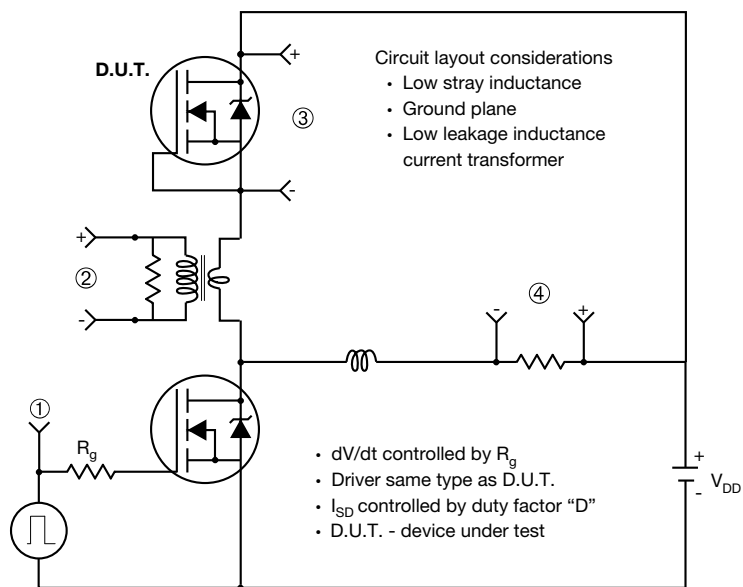

**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

**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. Ambient Temperature**

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

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

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


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

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

**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

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

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

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

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



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