

## Power MOSFET

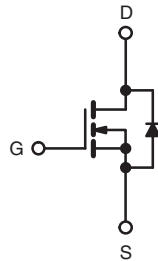
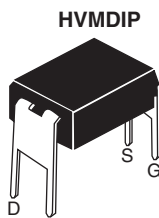
| PRODUCT SUMMARY           |                             |
|---------------------------|-----------------------------|
| $V_{DS}$ (V)              | 60                          |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ 0.20 |
| $Q_g$ (Max.) (nC)         | 11                          |
| $Q_{gs}$ (nC)             | 3.1                         |
| $Q_{gd}$ (nC)             | 5.8                         |
| Configuration             | Single                      |

### FEATURES

- Dynamic  $dV/dt$  Rating
- For Automatic Insertion
- End Stackable
- 175 °C Operating Temperature
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC



Available  
**RoHS\***  
COMPLIANT



N-Channel MOSFET

### 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       | IRFD014PbF  |
|                      | SiHFD014-E3 |
| SnPb                 | IRFD014     |
|                      | SiHFD014    |

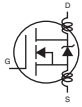

| ABSOLUTE MAXIMUM RATINGS ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                                  |                |                                   |                     |
|---------------------------------------------------------------------------------------|----------------------------------|----------------|-----------------------------------|---------------------|
| PARAMETER                                                                             |                                  | SYMBOL         | LIMIT                             | UNIT                |
| Drain-Source Voltage                                                                  |                                  | $V_{DS}$       | 60                                | V                   |
| Gate-Source Voltage                                                                   |                                  | $V_{GS}$       | $\pm 20$                          |                     |
| Continuous Drain Current                                                              | $V_{GS}$ at 10 V                 | $I_D$          | $T_A = 25\text{ }^\circ\text{C}$  | A                   |
|                                                                                       |                                  |                | $T_A = 100\text{ }^\circ\text{C}$ |                     |
| Pulsed Drain Current <sup>a</sup>                                                     |                                  | $I_{DM}$       | 14                                |                     |
| Linear Derating Factor                                                                |                                  |                | 0.0083                            | W/ $^\circ\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>                                            |                                  | $E_{AS}$       | 130                               | mJ                  |
| Maximum Power Dissipation                                                             | $T_A = 25\text{ }^\circ\text{C}$ | $P_D$          | 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  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 52\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 1.7\text{ A}$  (see fig. 12).
- $I_{SD} \leq 10\text{ A}$ ,  $dI/dt \leq 90\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

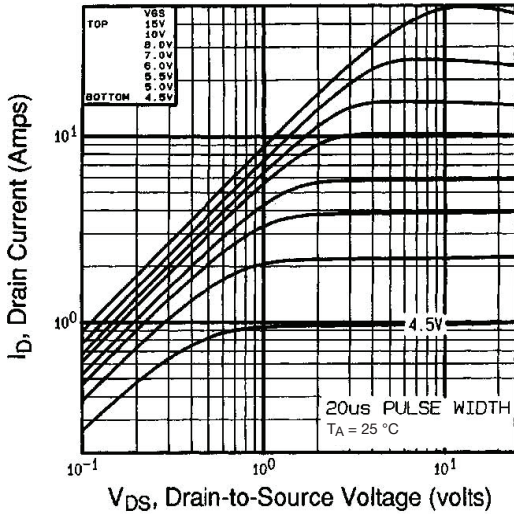
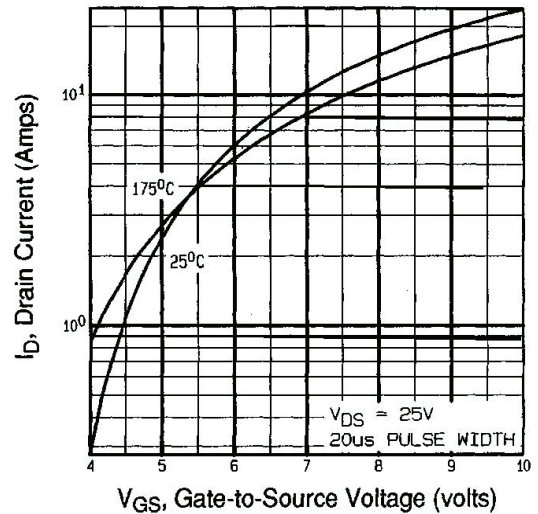
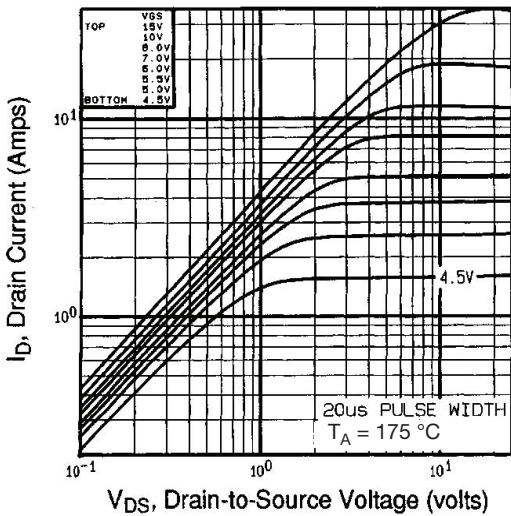
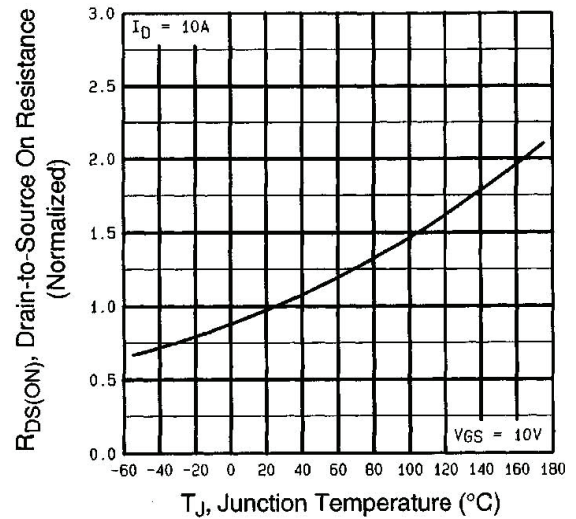
\* Pb containing terminations are not RoHS compliant, exemptions may apply

| 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          |
| <b>Static</b>                                                   |                     |                                                                                                                                                                 |                                                                             |      |       |           |               |
| Drain-Source Breakdown Voltage                                  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                                                                                                             |                                                                             | 60   | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient                                | $\Delta V_{DS}/T_J$ | Reference to $25\text{ °C}$ , $I_D = 1\text{ mA}$                                                                                                               |                                                                             | -    | 0.063 | -         | 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                                 | $I_{DSS}$           | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$                                                                                                                     |                                                                             | -    | -     | 25        | $\mu\text{A}$ |
|                                                                 |                     | $V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ °C}$                                                                                                |                                                                             | -    | -     | 250       |               |
| Drain-Source On-State Resistance                                | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                          | $I_D = 1.0\text{ A}^b$                                                      | -    | -     | 0.20      | $\Omega$      |
| Forward Transconductance                                        | $g_{fs}$            | $V_{DS} = 25\text{ V}, I_D = 1.0\text{ A}^b$                                                                                                                    |                                                                             | 0.96 | -     | -         | S             |
| <b>Dynamic</b>                                                  |                     |                                                                                                                                                                 |                                                                             |      |       |           |               |
| Input Capacitance                                               | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 25\text{ V},$<br>$f = 1.0\text{ MHz}$ , see fig. 5                                                                          |                                                                             | -    | 310   | -         | pF            |
| Output Capacitance                                              | $C_{oss}$           |                                                                                                                                                                 |                                                                             | -    | 160   | -         |               |
| Reverse Transfer Capacitance                                    | $C_{rss}$           |                                                                                                                                                                 |                                                                             | -    | 37    | -         |               |
| Total Gate Charge                                               | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                          | $I_D = 10\text{ A}, V_{DS} = 48\text{ V}$<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 11        | nC            |
| Gate-Source Charge                                              | $Q_{gs}$            |                                                                                                                                                                 |                                                                             | -    | -     | 3.1       |               |
| Gate-Drain Charge                                               | $Q_{gd}$            |                                                                                                                                                                 |                                                                             | -    | -     | 5.8       |               |
| Turn-On Delay Time                                              | $t_{d(on)}$         | $V_{DD} = 30\text{ V}, I_D = 10\text{ A}$<br>$R_g = 24\text{ }\Omega, R_D = 2.7\text{ }\Omega$ , see fig. 10 <sup>b</sup>                                       |                                                                             | -    | 10    | -         | ns            |
| Rise Time                                                       | $t_r$               |                                                                                                                                                                 |                                                                             | -    | 50    | -         |               |
| Turn-Off Delay Time                                             | $t_{d(off)}$        |                                                                                                                                                                 |                                                                             | -    | 13    | -         |               |
| 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  |                                                                             | -    | 4.0   | -         | nH            |
| Internal Source Inductance                                      | $L_S$               |                                                                                                                                                                 |                                                                             | -    | 6.0   | -         |               |
| <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    |                                                                             | -    | -     | 1.7       | A             |
| Pulsed Diode Forward Current <sup>a</sup>                       | $I_{SM}$            |                                                                                                                                                                 |                                                                             | -    | -     | 14        |               |
| Body Diode Voltage                                              | $V_{SD}$            | $T_J = 25\text{ °C}, I_S = 1.7\text{ A}, V_{GS} = 0\text{ V}^b$                                                                                                 |                                                                             | -    | -     | 1.6       | V             |
| Body Diode Reverse Recovery Time                                | $t_{rr}$            | $T_J = 25\text{ °C}, I_F = 10\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$                                                                                     |                                                                             | -    | 70    | 140       | ns            |
| Body Diode Reverse Recovery Charge                              | $Q_{rr}$            |                                                                                                                                                                 |                                                                             | -    | 0.20  | 0.40      | $\mu\text{C}$ |
| 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,  $T_A = 25\text{ }^\circ\text{C}$** 

**Fig. 3 - Typical Transfer Characteristics**

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

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

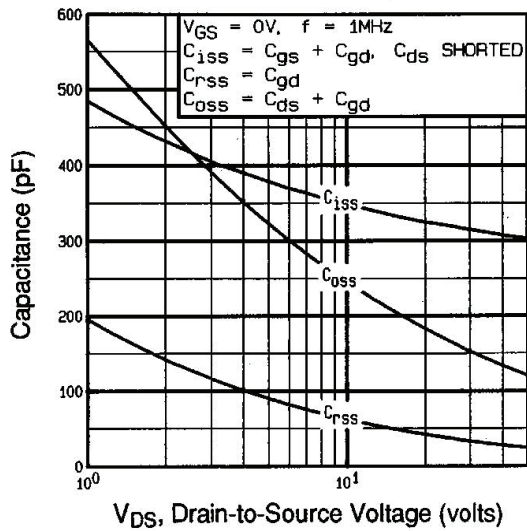


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

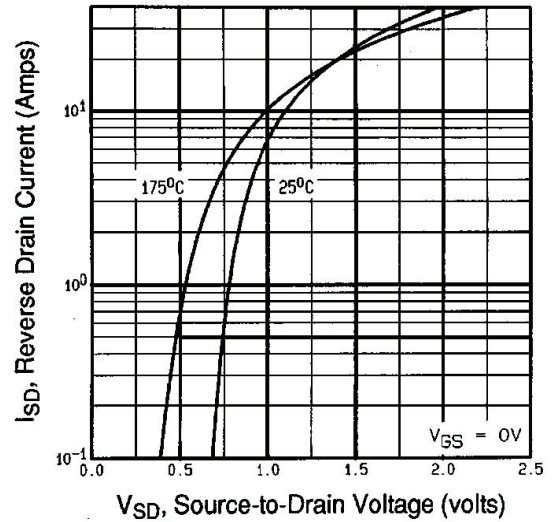


Fig. 7 - Typical Source-Drain Diode Forward Voltage

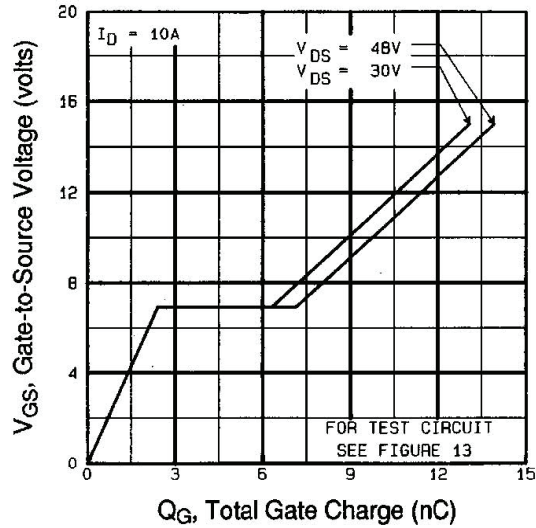


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

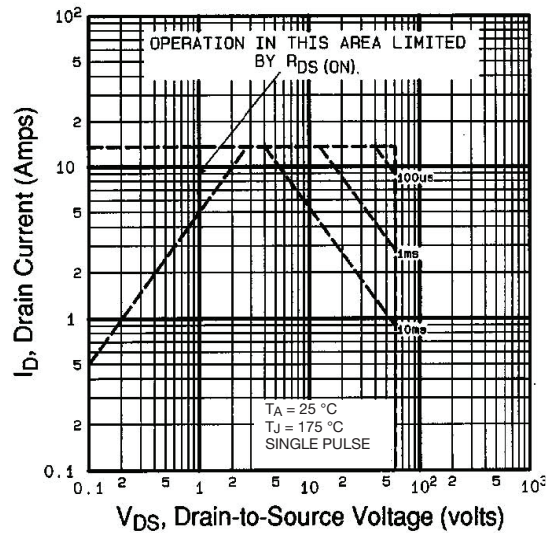


Fig. 8 - Maximum Safe Operating Area

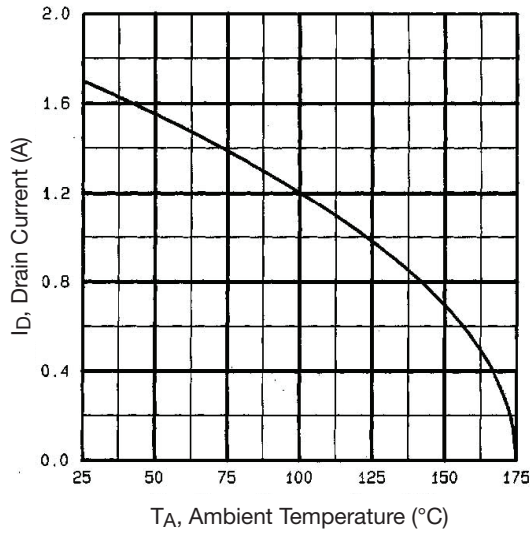


Fig. 9 - Maximum Drain Current vs. Ambient Temperature

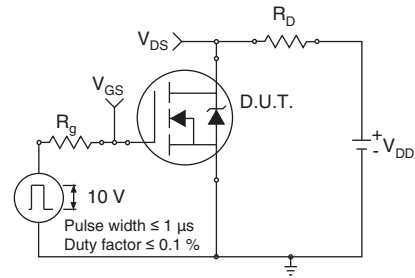


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

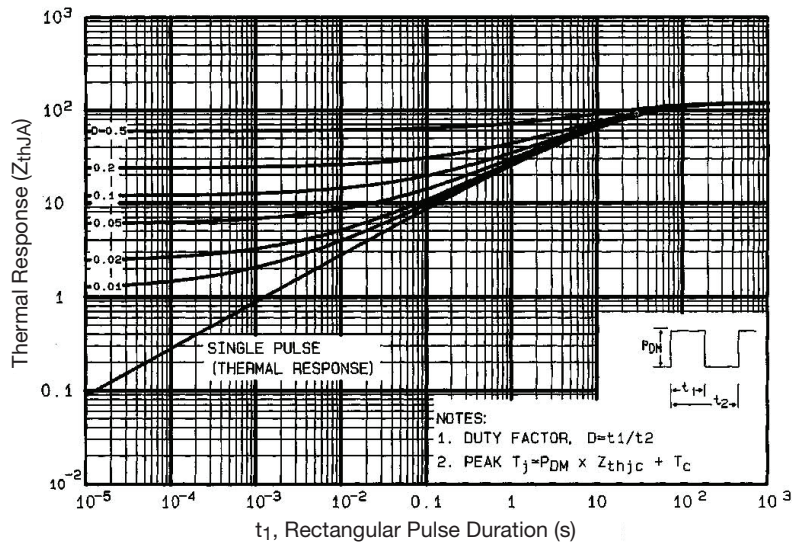


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

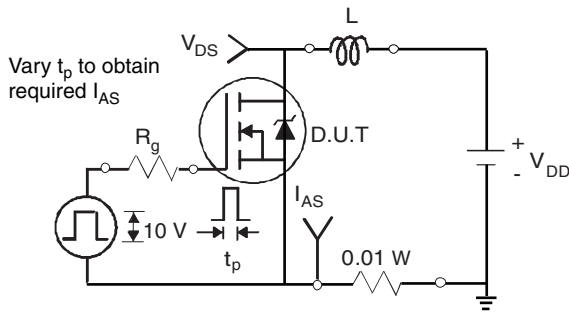


Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms

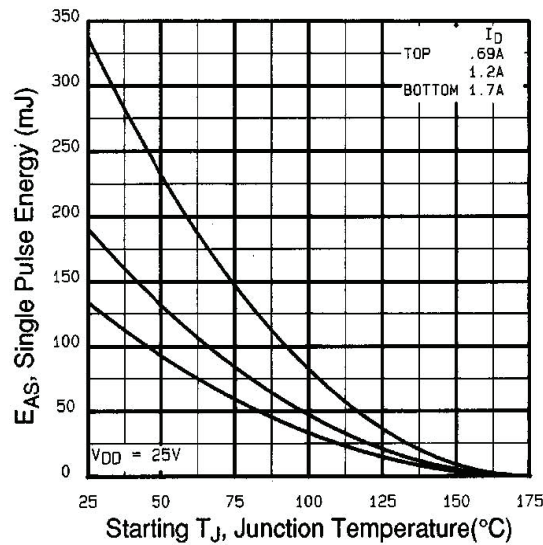


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

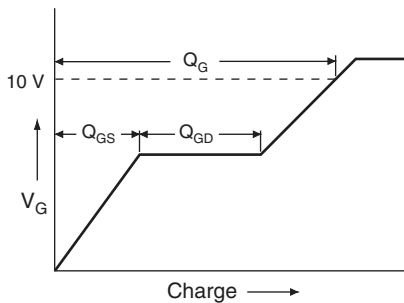


Fig. 13a - Basic Gate Charge Waveform

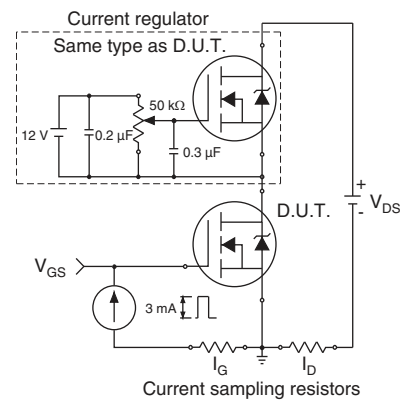


Fig. 13b - Gate Charge Test Circuit



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

**Fig. 14 - For N-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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