

## Power MOSFET

**D<sup>2</sup>PAK (TO-263)**


N-Channel MOSFET

### PRODUCT SUMMARY

|                           |                       |      |
|---------------------------|-----------------------|------|
| $V_{DS}$ (V)              | 60                    |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 5\text{ V}$ | 0.20 |
| $Q_g$ max. (nC)           | 8.4                   |      |
| $Q_{gs}$ (nC)             | 3.5                   |      |
| $Q_{gd}$ (nC)             | 6.0                   |      |
| Configuration             | Single                |      |

### FEATURES

- Advanced process technology
- Surface-mount
- 175 °C operating temperature
- Fast switching
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS\***  
Available  
**HALOGEN**  
**FREE**  
Available

### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### DESCRIPTION

Third generation power MOSFETs from Vishay utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that power MOSFETs are well known for, provides the designer with an extremely efficient reliable device for use in a wide variety of applications.

The D<sup>2</sup>PAK (TO-263) is a surface-mount power package capable of accommodating die sizes up to HEX-4. It provides the highest power capability and lowest possible on-resistance in any existing surface-mount package. The D<sup>2</sup>PAK (TO-263) is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0 W in a typical surface-mount application.

### ORDERING INFORMATION

|                                 |                             |                              |                              |
|---------------------------------|-----------------------------|------------------------------|------------------------------|
| Package                         | D <sup>2</sup> PAK (TO-263) | D <sup>2</sup> PAK (TO-263)  | D <sup>2</sup> PAK (TO-263)  |
| Lead (Pb)-free and halogen-free | SiHLZ14S-GE3                | SiHLZ14STRL-GE3 <sup>a</sup> | SiHLZ14STRR-GE3 <sup>a</sup> |
| Lead (Pb)-free                  | IRLZ14SPbF                  | IRLZ14STRLPbF <sup>a</sup>   | IRLZ14STRRPbF <sup>a</sup>   |

### Note

a. See device orientation

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

| PARAMETER                                                 | SYMBOL         | LIMIT                 | UNIT |
|-----------------------------------------------------------|----------------|-----------------------|------|
| Drain-source voltage <sup>e</sup>                         | $V_{DS}$       | 60                    | V    |
| Gate-source voltage                                       | $V_{GS}$       | $\pm 10$              |      |
| Continuous drain current                                  | $I_D$          | $T_C = 25\text{ °C}$  | A    |
|                                                           |                | $T_C = 100\text{ °C}$ |      |
| Pulsed drain current <sup>a, e</sup>                      | $I_{DM}$       | 40                    |      |
| Linear derating factor                                    |                | 0.29                  | W/°C |
| Single pulse avalanche energy <sup>b, e</sup>             | $E_{AS}$       | 68                    | mJ   |
| Maximum power dissipation                                 | $P_D$          | $T_C = 25\text{ °C}$  | W    |
|                                                           |                | $T_A = 25\text{ °C}$  |      |
| Peak diode recovery $dv/dt$ <sup>c, e</sup>               | $dv/dt$        | 4.5                   | V/ns |
| Operating junction and storage temperature range          | $T_J, T_{stg}$ | -55 to +175           | °C   |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s       | 300                   |      |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 25\text{ V}$ , starting  $T_J = 25\text{ °C}$ ,  $L = 790\text{ }\mu\text{H}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 10\text{ A}$  (see fig. 12)
- $I_{SD} \leq 10\text{ A}$ ,  $di/dt \leq 90\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ °C}$
- 1.6 mm from case
- Uses IRLZ14, SiHLZ14 data and test conditions

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                            | SYMBOL            | TYP. | MAX. | UNIT |
|------------------------------------------------------|-------------------|------|------|------|
| Maximum junction-to-ambient (PCB mount) <sup>a</sup> | R <sub>thJA</sub> | -    | 40   | °C/W |
| Maximum junction-to- case (drain)                    | R <sub>thJC</sub> | -    | 3.5  |      |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material)

**SPECIFICATIONS** (T<sub>J</sub> = 25 °C, unless otherwise noted)

| PARAMETER                                      | SYMBOL                           | TEST CONDITIONS                                                                                                                                       | MIN. | TYP. | MAX.  | UNIT |
|------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-------|------|
| <b>Static</b>                                  |                                  |                                                                                                                                                       |      |      |       |      |
| Drain-source breakdown voltage                 | V <sub>DS</sub>                  | V <sub>GS</sub> = 0, 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                                                                                                             | -    | 0.07 | -     | 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 V, I <sub>D</sub> = 6.0 A <sup>b</sup>                                                                                            | -    | -    | 0.2   | Ω    |
|                                                |                                  | V <sub>GS</sub> = 4 V, I <sub>D</sub> = 5.0 A <sup>b</sup>                                                                                            | -    | -    | 0.28  |      |
| Forward transconductance                       | g <sub>fs</sub>                  | V <sub>DS</sub> = 25 V, I <sub>D</sub> = 6.0 A                                                                                                        | 3.5  | -    | -     | S    |
| <b>Dynamic</b>                                 |                                  |                                                                                                                                                       |      |      |       |      |
| 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                                                                          | -    | 400  | -     | pF   |
| Output capacitance                             | C <sub>oss</sub>                 |                                                                                                                                                       | -    | 170  | -     |      |
| Reverse transfer capacitance                   | C <sub>rss</sub>                 |                                                                                                                                                       | -    | 42   | -     |      |
| Total gate charge                              | Q <sub>g</sub>                   | V <sub>GS</sub> = 5 V, I <sub>D</sub> = 10 A, V <sub>DS</sub> = 48 V,<br>see fig. 6 and 13 <sup>b</sup>                                               | -    | -    | 8.4   | nC   |
| Gate-source charge                             | Q <sub>gs</sub>                  |                                                                                                                                                       | -    | -    | 3.5   |      |
| Gate-drain charge                              | Q <sub>gd</sub>                  |                                                                                                                                                       | -    | -    | 6.0   |      |
| Turn-on delay time                             | t <sub>d(on)</sub>               | V <sub>DD</sub> = 30 V, I <sub>D</sub> = 10 A,<br>R <sub>g</sub> = 12 Ω, R <sub>D</sub> = 2.8 Ω, see fig. 10 <sup>b</sup>                             | -    | 9.3  | -     | ns   |
| Rise time                                      | t <sub>r</sub>                   |                                                                                                                                                       | -    | 110  | -     |      |
| Turn-off delay time                            | t <sub>d(off)</sub>              |                                                                                                                                                       | -    | 17   | -     |      |
| Fall time                                      | t <sub>f</sub>                   |                                                                                                                                                       | -    | 26   | -     |      |
| Internal source inductance                     | L <sub>S</sub>                   | Between lead, and center of die contact                                                                                                               | -    | 7.5  | -     | nH   |
| <b>Drain-Source Body Diode Characteristics</b> |                                  |                                                                                                                                                       |      |      |       |      |
| Continuous source-drain diode current          | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode  | -    | -    | 10    | A    |
| Pulsed diode forward current <sup>a</sup>      | I <sub>SM</sub>                  |                                                                                                                                                       | -    | -    | 40    |      |
| Body diode voltage                             | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 10 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                     | -    | -    | 1.6   | V    |
| Body diode reverse recovery time               | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 10 A, di/dt = 100 A/μs <sup>b</sup>                                                                          | -    | 93   | 130   | ns   |
| Body diode reverse recovery charge             | Q <sub>rr</sub>                  |                                                                                                                                                       | -    | 340  | 650   | nC   |
| 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 ≤ 300 μs; duty cycle ≤ 2 %



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

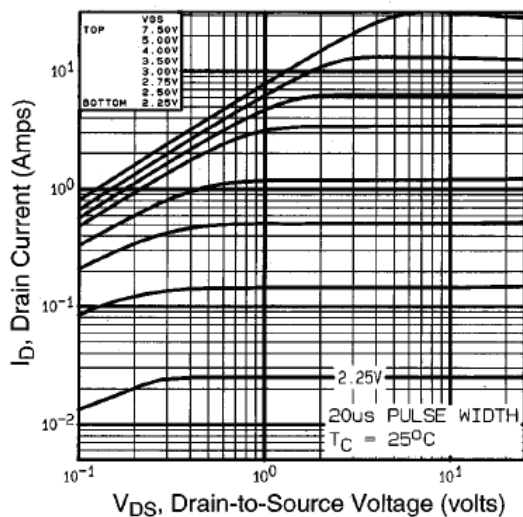


Fig. 1 - Typical Output Characteristics

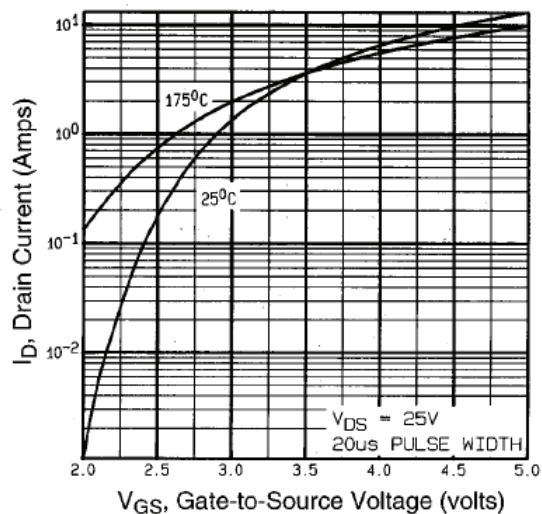


Fig. 3 - Typical Transfer Characteristics

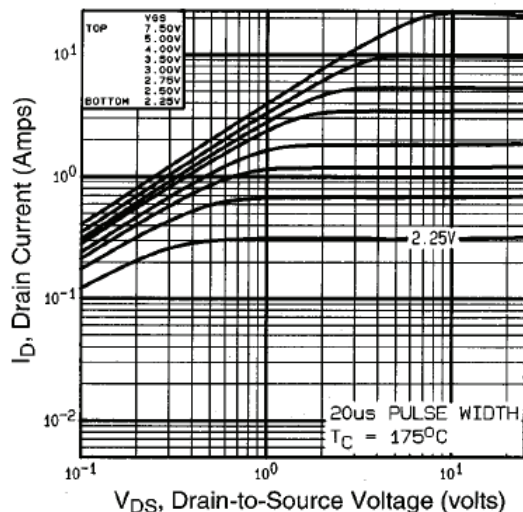


Fig. 2 - Typical Output Characteristics

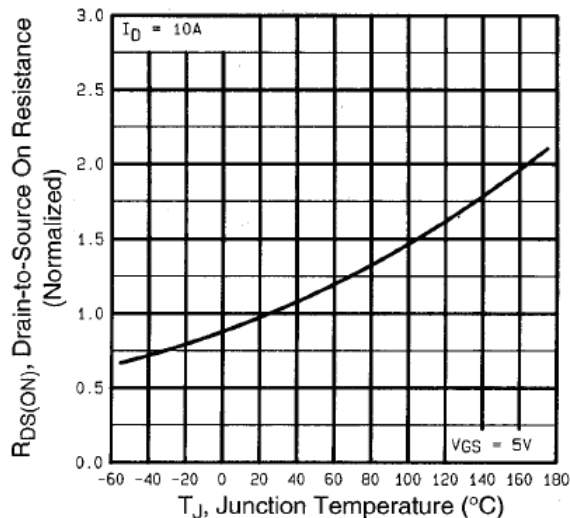
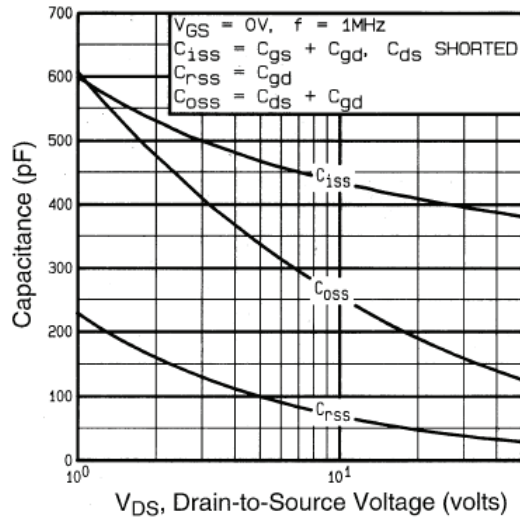
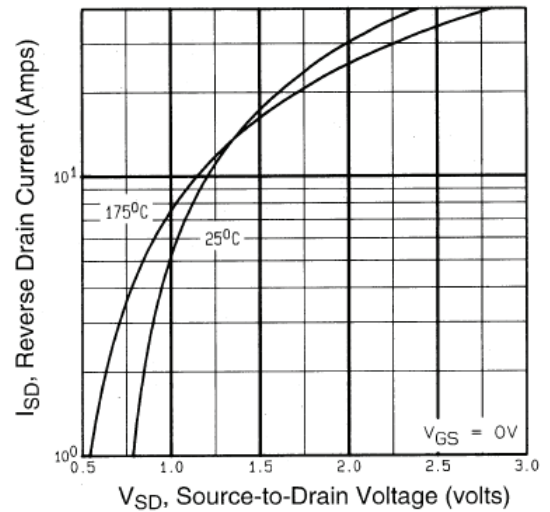
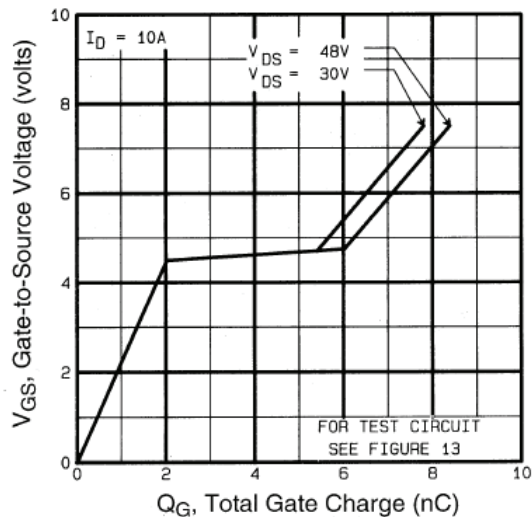
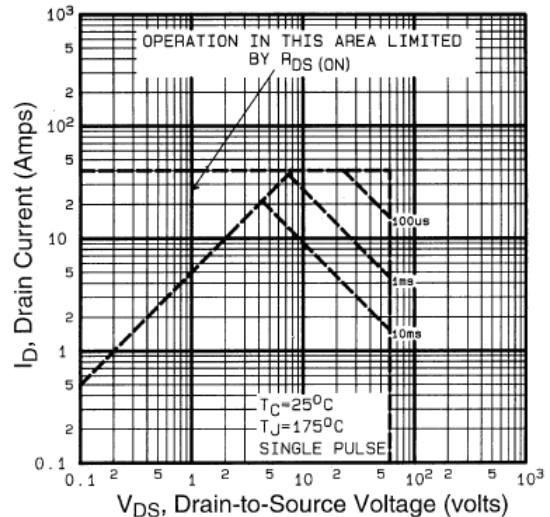
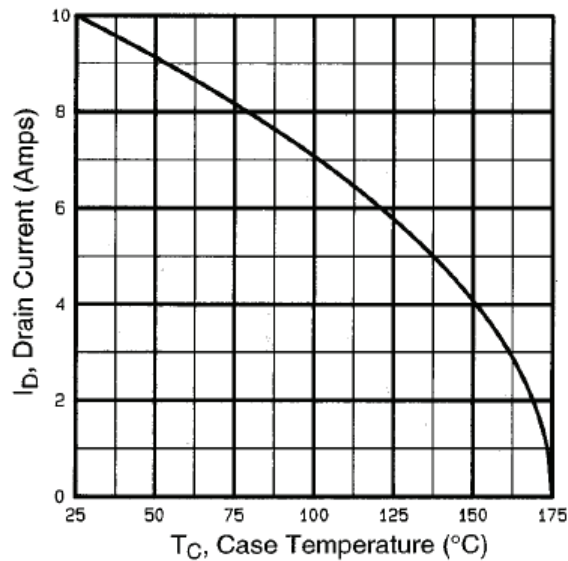
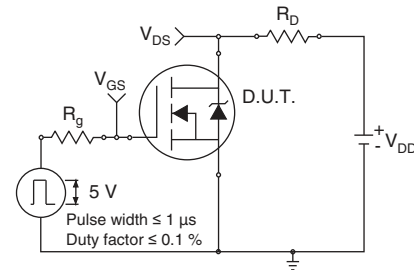
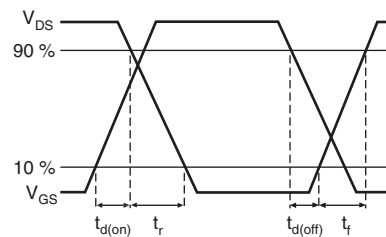
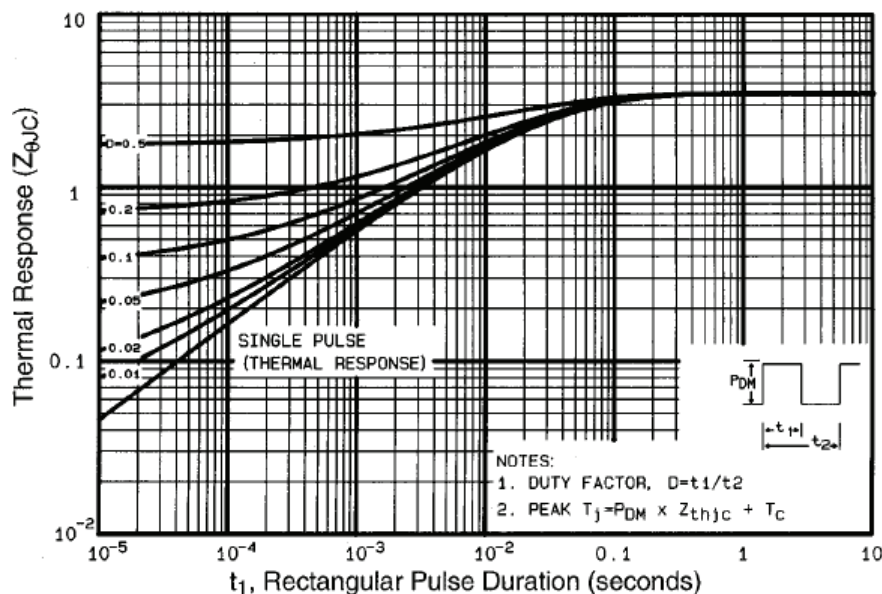
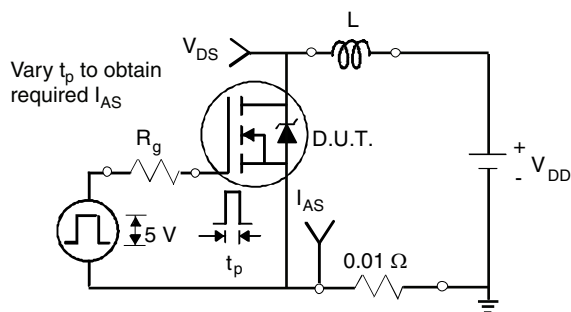
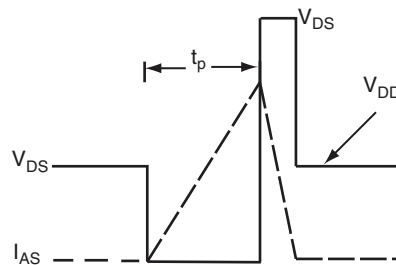
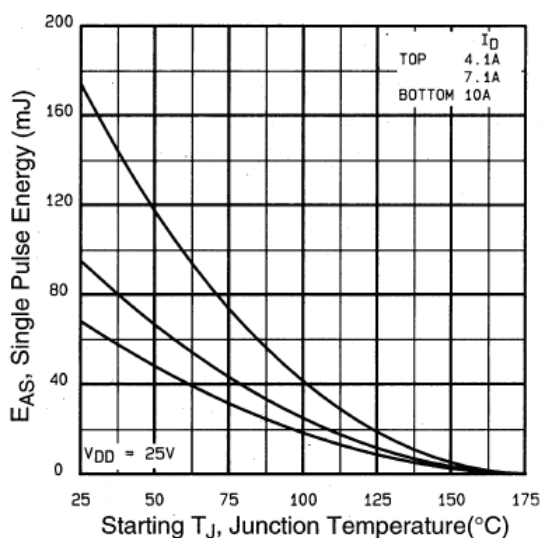
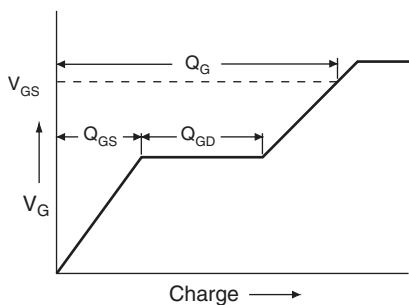
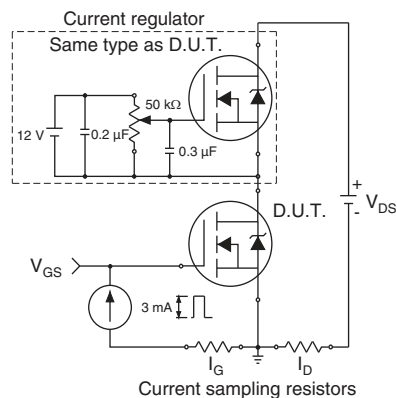
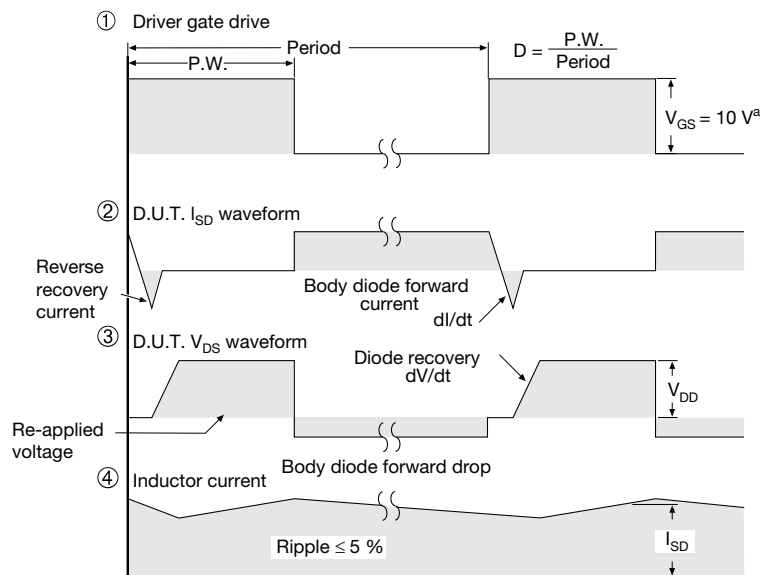
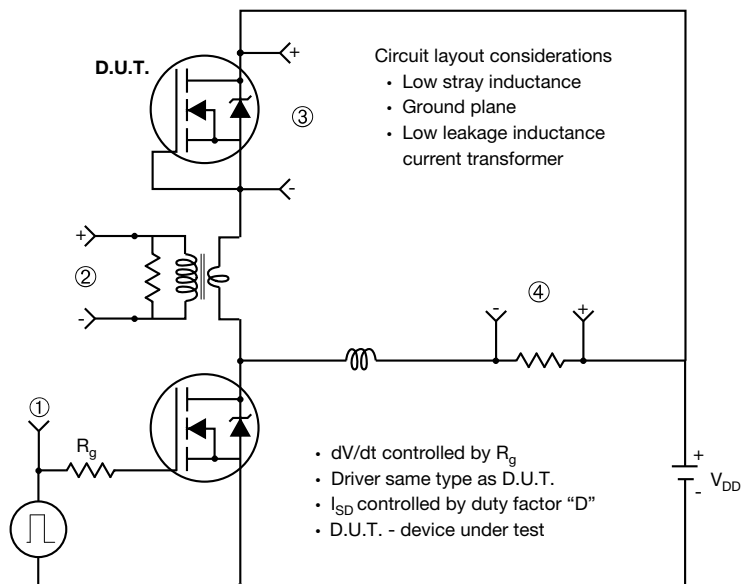


Fig. 4 - Normalized On-Resistance vs. Temperature


**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. Case Temperature**

**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. 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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|      | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
| DIM. | MIN.        | MAX.  | MIN.      | MAX.  |
| D1   | 6.86        | -     | 0.270     | -     |
| E    | 9.65        | 10.67 | 0.380     | 0.420 |
| E1   | 6.22        | -     | 0.245     | -     |
| e    | 2.54 BSC    |       | 0.100 BSC |       |
| H    | 14.61       | 15.88 | 0.575     | 0.625 |
| L    | 1.78        | 2.79  | 0.070     | 0.110 |
| L1   | -           | 1.65  | -         | 0.066 |
| L2   | -           | 1.78  | -         | 0.070 |
| L3   | 0.25 BSC    |       | 0.010 BSC |       |
| L4   | 4.78        | 5.28  | 0.188     | 0.208 |

## I<sup>2</sup>PAK (TO-262) (HIGH VOLTAGE)



|      | MILLIMETERS |      | INCHES |       |
|------|-------------|------|--------|-------|
| DIM. | MIN.        | MAX. | MIN.   | MAX.  |
| A    | 4.06        | 4.83 | 0.160  | 0.190 |
| A1   | 2.03        | 3.02 | 0.080  | 0.119 |
| b    | 0.51        | 0.99 | 0.020  | 0.039 |
| b1   | 0.51        | 0.89 | 0.020  | 0.035 |
| b2   | 1.14        | 1.78 | 0.045  | 0.070 |
| b3   | 1.14        | 1.73 | 0.045  | 0.068 |
| c    | 0.38        | 0.74 | 0.015  | 0.029 |
| c1   | 0.38        | 0.58 | 0.015  | 0.023 |
| c2   | 1.14        | 1.65 | 0.045  | 0.065 |

|      | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
| DIM. | MIN.        | MAX.  | MIN.      | MAX.  |
| D    | 8.38        | 9.65  | 0.330     | 0.380 |
| D1   | 6.86        | -     | 0.270     | -     |
| E    | 9.65        | 10.67 | 0.380     | 0.420 |
| E1   | 6.22        | -     | 0.245     | -     |
| e    | 2.54 BSC    |       | 0.100 BSC |       |
| L    | 13.46       | 14.10 | 0.530     | 0.555 |
| L1   | -           | 1.65  | -         | 0.065 |
| L2   | 3.56        | 3.71  | 0.140     | 0.146 |

ECN: S-82442-Rev. A, 27-Oct-08  
DWG: 5977

### Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outmost extremes of the plastic body.
3. Thermal pad contour optional within dimension E, L1, D1, and E1.
4. Dimension b1 and c1 apply to base metal only.

**RECOMMENDED MINIMUM PADS FOR D<sup>2</sup>PAK: 3-Lead**



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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