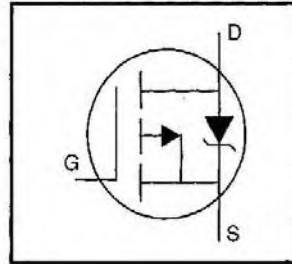


# IRF9640SPbF

## HEXFET® Power MOSFET

- Surface Mount
- Available in Tape & Reel
- Dynamic dv/dt Rating
- Repetitive Avalanche Rated
- P-Channel
- Fast Switching
- Ease of Paralleling
- Lead-Free



$$V_{DSS} = -200V$$

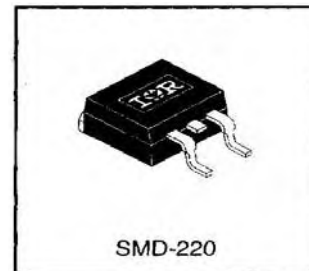
$$R_{DS(on)} = 0.50\Omega$$

$$I_D = -11A$$

### Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The SMD-220 is a surface mount power package capable of accommodating die sizes up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The SMD-220 is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0W in a typical surface mount application.



### Absolute Maximum Ratings

|                             | Parameter                                  | Max.                  | Units |
|-----------------------------|--|-----------------------|-------|
| $I_D$ @ $T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10 V$ | -11                   | A     |
| $I_D$ @ $T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10 V$ | -6.8                  |       |
| $I_{DM}$                    | Pulsed Drain Current ①                     | -44                   |       |
| $P_D$ @ $T_C = 25^\circ C$  | Power Dissipation                          | 125                   | W     |
| $P_D$ @ $T_A = 25^\circ C$  | Power Dissipation (PCB Mount)**            | 3.0                   |       |
|                             | Linear Derating Factor                     | 1.0                   | W/°C  |
|                             | Linear Derating Factor (PCB Mount)**       | 0.025                 |       |
| $V_{GS}$                    | Gate-to-Source Voltage                     | $\pm 20$              | V     |
| $E_{AS}$                    | Single Pulse Avalanche Energy ②            | 700                   | mJ    |
| $I_{AR}$                    | Avalanche Current ①                        | -11                   | A     |
| $E_{AR}$                    | Repetitive Avalanche Energy ①              | 13                    | mJ    |
| dv/dt                       | Peak Diode Recovery dv/dt ③                | -5.0                  | V/ns  |
| $T_J, T_{STG}$              | Junction and Storage Temperature Range     | -55 to +150           | °C    |
|                             | Soldering Temperature, for 10 seconds      | 300 (1.6mm from case) |       |

### Thermal Resistance

|                 | Parameter                         | Min. | Typ. | Max. | Units |
|-----------------|-----------------------------------|------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                  | —    | —    | 1.0  | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)** | —    | —    | 40   |       |
| $R_{\theta JA}$ | Junction-to-Ambient               | —    | —    | 62   |       |

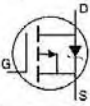
\*\* When mounted on 1" square PCB (FR-4 or G-10 Material).

For recommended footprint and soldering techniques refer to application note #AN-994.

## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

|  | Parameter                            | Min. | Typ.  | Max. | Units | Test Conditions  |
|--|--------------------------------------|------|-------|------|-------|--|
| V <sub>(BR)DSS</sub>                   | Drain-to-Source Breakdown Voltage    | -200 | —     | —    | V     | V <sub>GS</sub> =0V, I <sub>D</sub> =-250μA  |
| ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | -0.20 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> =-1mA  |
| R <sub>DS(on)</sub>                    | Static Drain-to-Source On-Resistance | —    | —     | 0.50 | Ω     | V <sub>GS</sub> =-10V, I <sub>D</sub> =-6.6A ④                                       |
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage               | -2.0 | —     | -4.0 | V     | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =-250μA                            |
| g <sub>fs</sub>                        | Forward Transconductance             | 4.1  | —     | —    | S     | V <sub>DS</sub> =-50V, I <sub>D</sub> =-6.6A ④                                       |
| I <sub>DSS</sub>                       | Drain-to-Source Leakage Current      | —    | —     | -100 | μA    | V <sub>DS</sub> =-200V, V <sub>GS</sub> =0V  |
|  |                                      | —    | —     | -500 |       | V <sub>DS</sub> =-160V, V <sub>GS</sub> =0V, T <sub>J</sub> =125°C                   |
| I <sub>GSS</sub>                       | Gate-to-Source Forward Leakage       | —    | —     | -100 | nA    | V <sub>GS</sub> =-20V  |
|  | Gate-to-Source Reverse Leakage       | —    | —     | 100  |       | V <sub>GS</sub> =20V   |
| Q <sub>g</sub>                         | Total Gate Charge                    | —    | —     | 44   | nC    | I <sub>D</sub> =-11A   |
| Q <sub>gs</sub>                        | Gate-to-Source Charge                | —    | —     | 7.1  |       | V <sub>DS</sub> =-160V   |
| Q <sub>gd</sub>                        | Gate-to-Drain ("Miller") Charge      | —    | —     | 27   |       | V <sub>GS</sub> =-10V See Fig. 6 and 13 ④  |
| t <sub>d(on)</sub>                     | Turn-On Delay Time                   | —    | 14    | —    | ns    | V <sub>DD</sub> =-100V   |
| t <sub>r</sub>                         | Rise Time                            | —    | 43    | —    |       | I <sub>D</sub> =-11A   |
| t <sub>d(off)</sub>                    | Turn-Off Delay Time                  | —    | 39    | —    |       | R <sub>G</sub> =9.1Ω   |
| t <sub>f</sub>                         | Fall Time                            | —    | 38    | —    |       | R <sub>D</sub> =8.6Ω See Figure 10 ④   |
| L <sub>D</sub>                         | Internal Drain Inductance            | —    | 4.5   | —    | nH    | Between lead,<br>6 mm (0.25in.)<br>from package<br>and center of<br>die contact      |
| L <sub>S</sub>                         | Internal Source Inductance           | —    | 7.5   | —    |       |  |
| C <sub>iss</sub>                       | Input Capacitance                    | —    | 1200  | —    | pF    | V <sub>GS</sub> =0V  |
| C <sub>oss</sub>                       | Output Capacitance                   | —    | 370   | —    |       | V <sub>DS</sub> =-25V  |
| C <sub>rss</sub>                       | Reverse Transfer Capacitance         | —    | 81    | —    |       | f=1.0MHz See Figure 5  |

## Source-Drain Ratings and Characteristics

|                 | Parameter                                 | Min.   | Typ. | Max. | Units | Test Conditions   |
|-----------------|---|--|------|------|-------|---|
| I <sub>S</sub>  | Continuous Source Current<br>(Body Diode) | —  | —    | -11  | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.               |
| I <sub>SM</sub> | Pulsed Source Current<br>(Body Diode) ①   | —  | —    | -44  |       |  |
| V <sub>SD</sub> | Diode Forward Voltage                     | —  | —    | -5.0 | V     | T <sub>J</sub> =25°C, I <sub>S</sub> =-11A, V <sub>GS</sub> =0V ④                     |
| t <sub>rr</sub> | Reverse Recovery Time                     | —  | 250  | 300  | ns    | T <sub>J</sub> =25°C, I <sub>F</sub> =-11A  |
| Q <sub>rr</sub> | Reverse Recovery Charge                   | —  | 2.9  | 3.6  | μC    | di/dt=100A/μs ④   |
| t <sub>on</sub> | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> +L <sub>D</sub> ) |      |      |       |   |

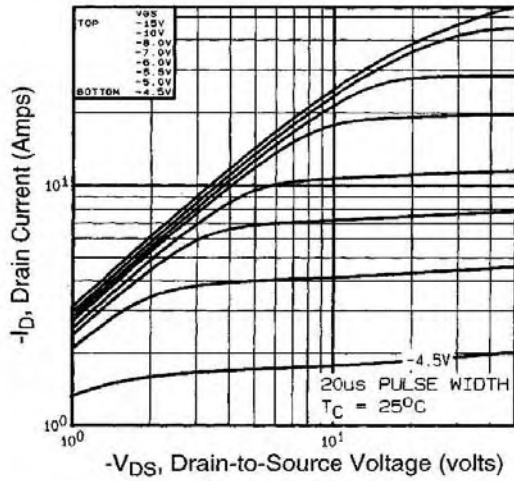
### Notes:

① Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)

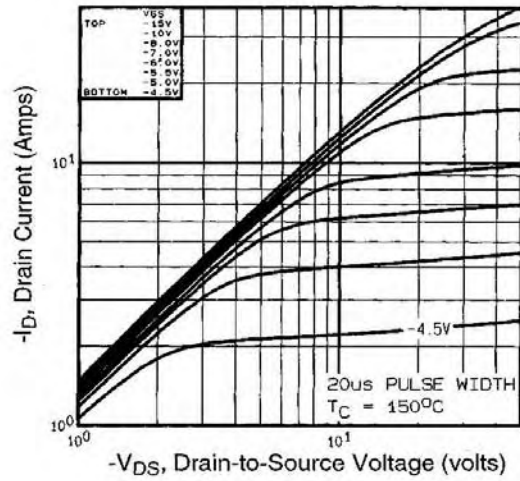
③ I<sub>SD</sub> ≤ -11A, di/dt ≤ 150A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ 150°C

② V<sub>DD</sub> = -50V, starting T<sub>J</sub> = 25°C, L = 8.7mH  
R<sub>G</sub> = 25Ω, I<sub>AS</sub> = -11A (See Figure 12)

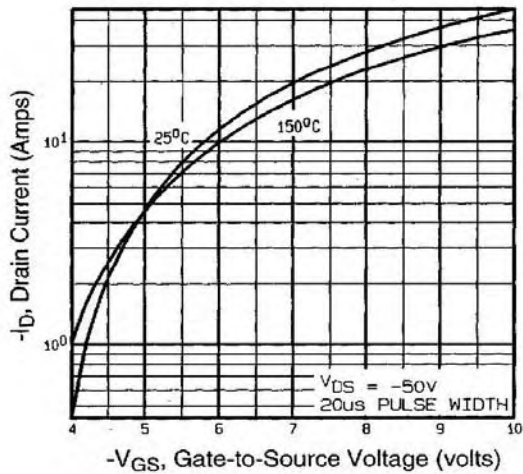
④ Pulse width ≤ 300 μs; duty cycle ≤ 2%.



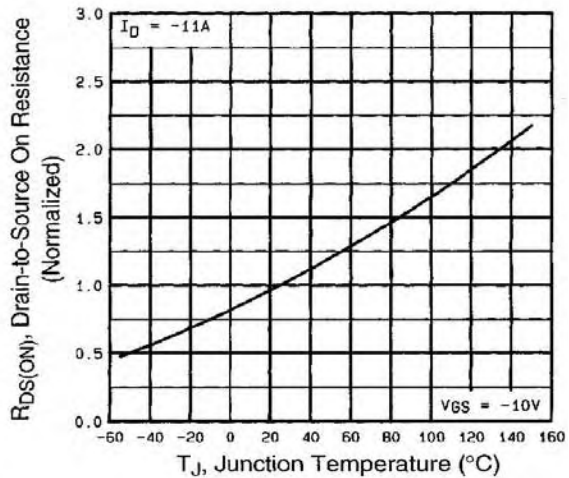
**Fig 1.** Typical Output Characteristics,  
 $T_C=25^\circ\text{C}$



**Fig 2.** Typical Output Characteristics,  
 $T_C=150^\circ\text{C}$

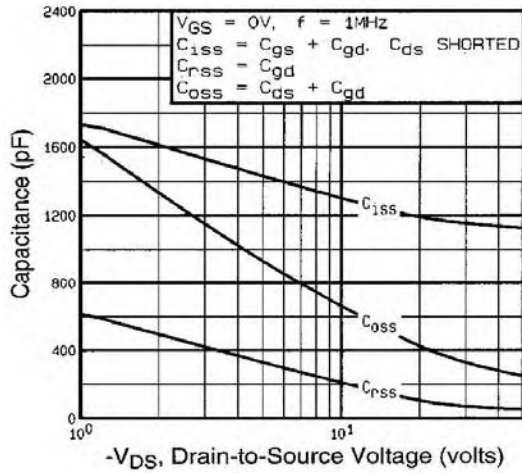


**Fig 3.** Typical Transfer Characteristics

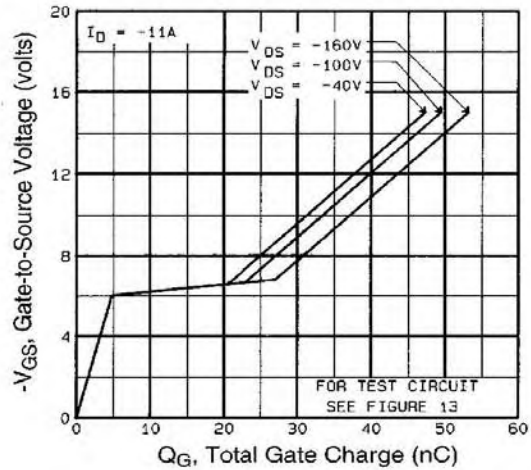


**Fig 4.** Normalized On-Resistance  
 Vs. Temperature

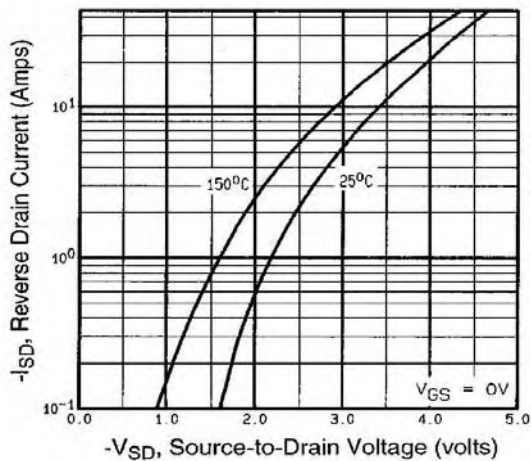




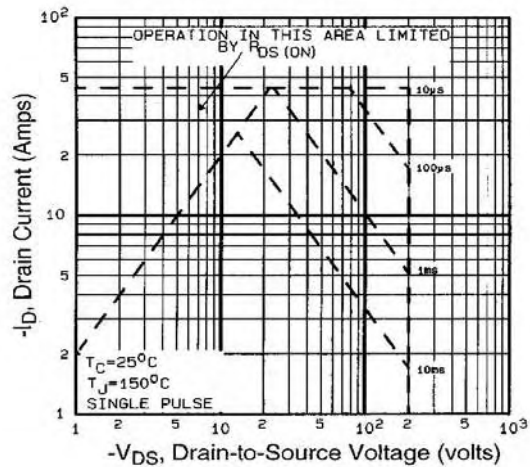
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



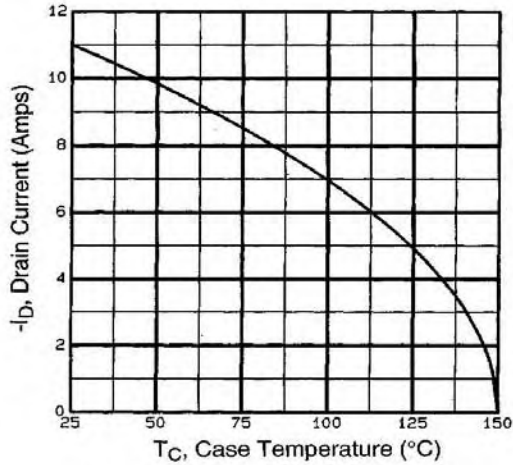
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



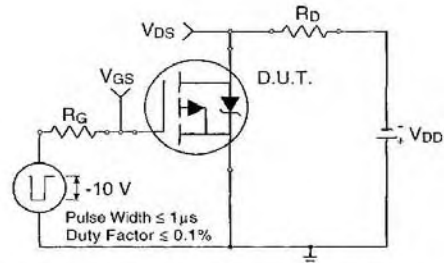
**Fig 7.** Typical Source-Drain Diode Forward Voltage



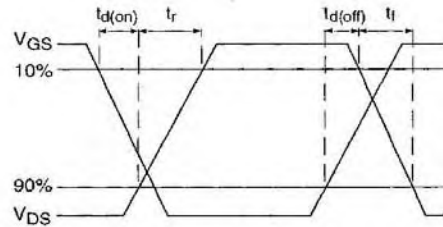
**Fig 8.** Maximum Safe Operating Area



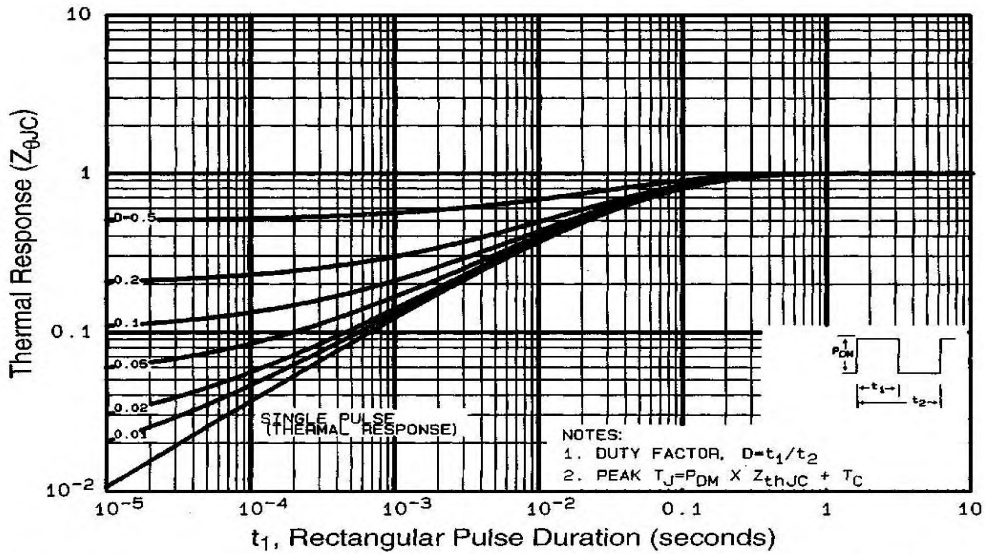
**Fig 9.** Maximum Drain Current Vs. Case Temperature



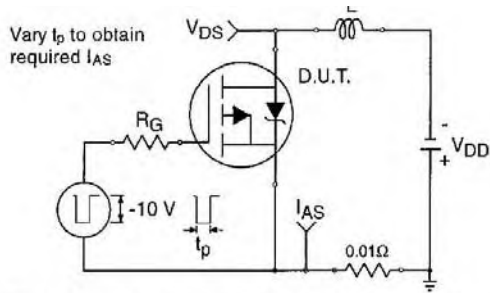
**Fig 10a.** Switching Time Test Circuit



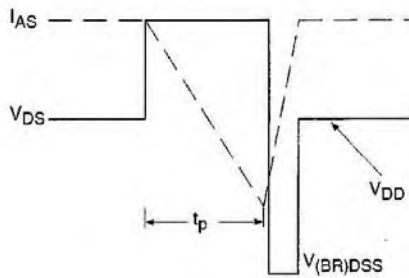
**Fig 10b.** Switching Time Waveforms



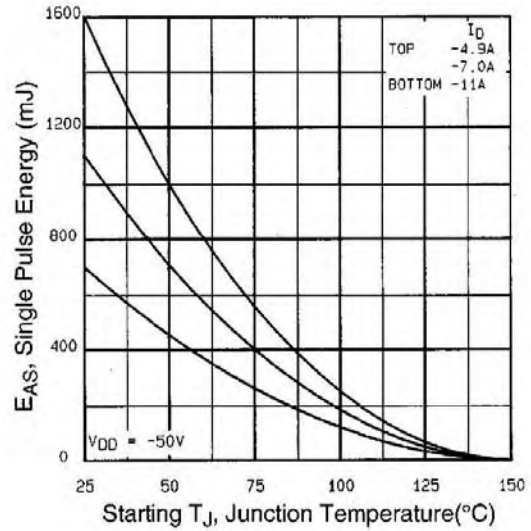
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



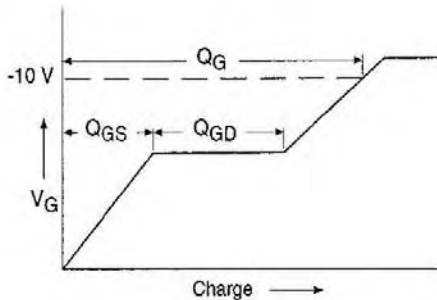
**Fig 12a.** Unclamped Inductive Test Circuit



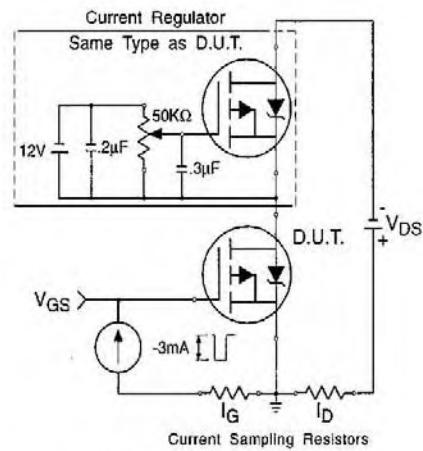
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

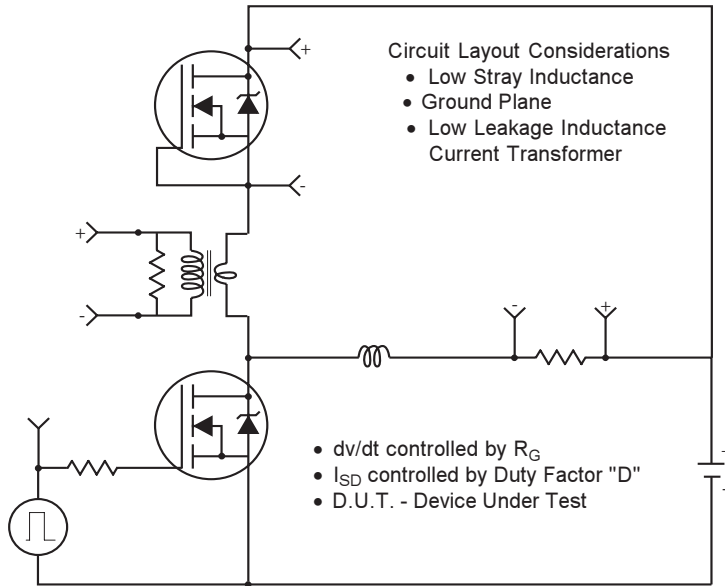


**Fig 13a.** Basic Gate Charge Waveform



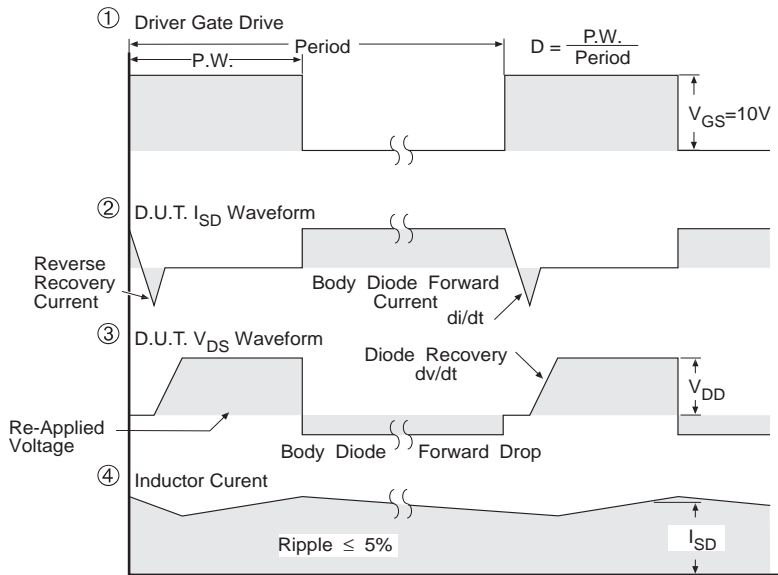
**Fig 13b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit



\* Reverse Polarity for P-Channel

\*\* Use P-Channel Driver for P-Channel Measurements



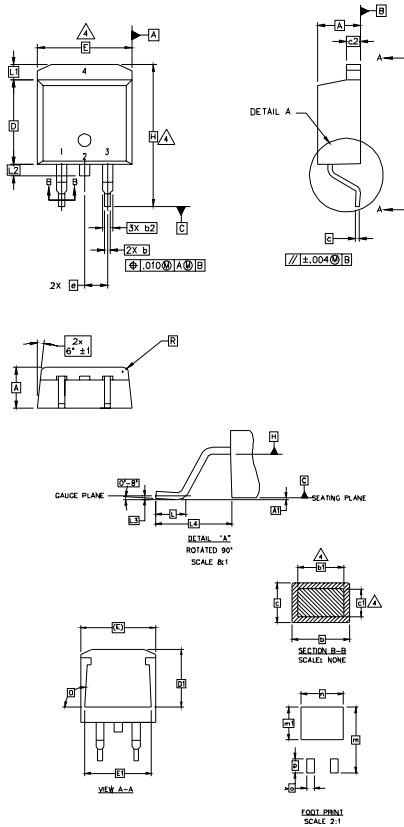
\*\*\*  $V_{GS} = 5.0V$  for Logic Level and 3V Drive Devices

**Fig 14** For P Channel HEXFETS

# IRF9640SPbF



## D<sup>2</sup>Pak Package Outline (Dimensions are shown in millimeters (inches))



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 | 4     |
| A1     | 0.00        | 0.254 | .000     | .010 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| c      | 0.38        | 0.74  | .015     | .029 |       |
| c1     | 0.38        | 0.58  | .015     | .023 |       |
| c2     | 1.14        | 1.65  | .045     | .065 |       |
| D      | 8.51        | 9.65  | .335     | .380 |       |
| D1     | 6.86        |       | .270     |      |       |
| E      | 9.65        | 10.67 | .380     | .420 | 3     |
| E1     | 6.22        |       | .245     |      |       |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| H      | 14.61       | 15.88 | .575     | .625 | 3     |
| L      | 1.78        | 2.79  | .070     | .110 |       |
| L1     |             | 1.65  |          | .065 |       |
| L2     | 1.27        | 1.78  | .050     | .070 |       |
| L3     | 0.25 BSC    |       | .010 BSC |      |       |
| L4     | 4.78        | 5.28  | .188     | .208 | 4     |
| m      | 17.78       |       | .700     |      |       |
| m1     | 8.89        |       | .350     |      |       |
| n      | 11.43       |       | .450     |      |       |
| o      | 2.08        |       | .082     |      |       |
| p      | 3.81        |       | .150     |      |       |
| R      | 0.51        | 0.71  | .020     | .028 |       |
| θ      | 90°         | 93°   | 90°      | 93°  |       |

**LEAD ASSIGNMENTS**

**HEXFET**

- 1.- GATE
- 2, 4.- DRAIN
- 3.- SOURCE

**IGBTs, CoPACK**

- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

**DIODES**

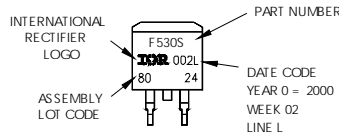
- 1.- ANODE \*
- 2, 4.- CATHODE
- 3.- ANODE

\* PART DEPENDENT.

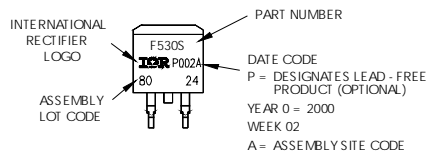
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON VV02, 2000  
IN THE ASSEMBLY LINE "L"

Note: "P" in assembly line position  
indicates "Lead - Free"



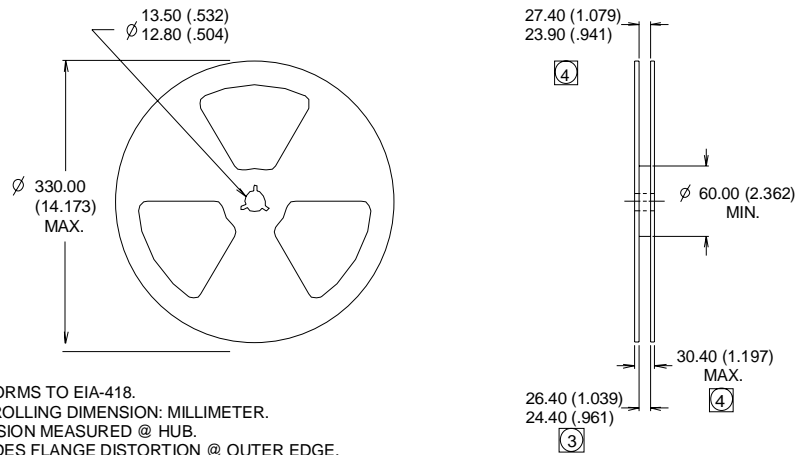
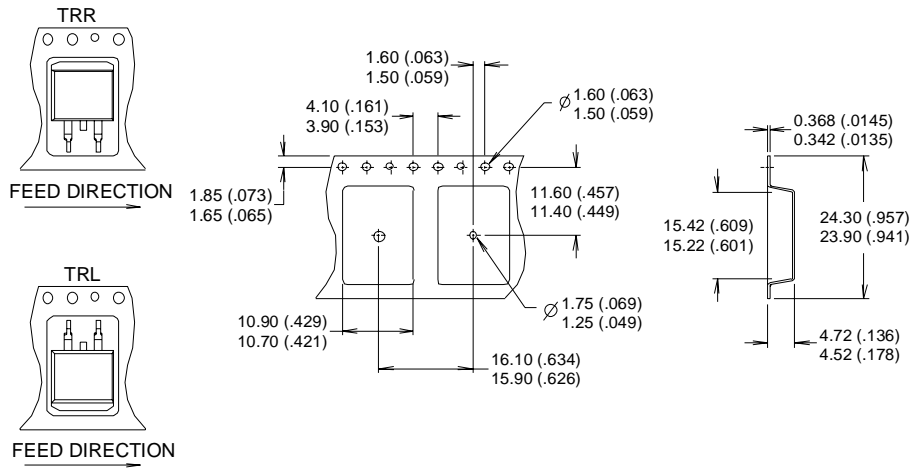
OR





## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



- NOTES:
1. COMFORMS TO EIA-418.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION MEASURED @ HUB.
  4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Data and specifications subject to change without notice.