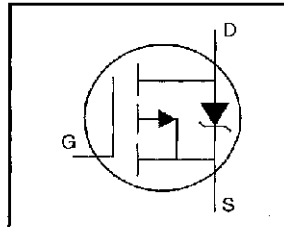


# IRF9610SPbF

## HEXFET® Power MOSFET

- Surface Mount
- Available in Tape & Reel
- Dynamic dv/dt Rating
- P-Channel
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Lead-Free

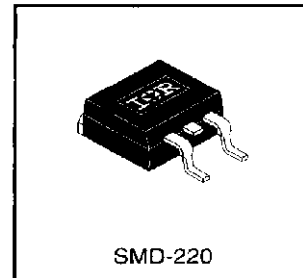


$V_{DSS} = -200V$   
 $R_{DS(on)} = 3.0\Omega$   
 $I_D = -1.8A$

### Description

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

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

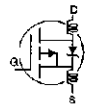
	Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ -10 V$	-1.8	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ -10 V$	-1.0	
$I_{DM}$	Pulsed Drain Current ①	-7.0	
$P_D @ T_C = 25^\circ C$	Power Dissipation	20	W
$P_D @ T_A = 25^\circ C$	Power Dissipation (PCB Mount)**	3.0	
	Linear Derating Factor	0.16	W/°C
	Linear Derating Factor (PCB Mount)**	0.025	
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$I_{LM}$	Inductive Current, Clamp	-7.0	A
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

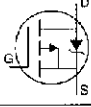
	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	6.4	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB mount)**	—	—	40	
$R_{\theta JA}$	Junction-to-Ambient	—	—	62	

\*\* 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	—	-0.23	—	V/°C	Reference to 25°C, I <sub>D</sub> =-1mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance	—	—	3.0	Ω	V <sub>GS</sub> =-10V, I <sub>D</sub> =-0.90A 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	0.90	—	—	S	V <sub>DS</sub> =-50V, I <sub>D</sub> =-0.90A 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	—	—	11	nC	I <sub>D</sub> =-3.5A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	7.0		V <sub>DS</sub> =-160V
Q <sub>gd</sub>	Gate-to-Drain ("Miller") Charge	—	—	4.0		V <sub>GS</sub> =-10V See Fig. 6 and 12 ④
t <sub>d(on)</sub>	Turn-On Delay Time	—	8.0	—	ns	V <sub>DD</sub> =-100V
t <sub>r</sub>	Rise Time	—	15	—		I <sub>D</sub> =-0.90A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	10	—		R <sub>G</sub> =50Ω
t <sub>f</sub>	Fall Time	—	8.0	—		R <sub>D</sub> =110Ω See Figure 10 ④
L <sub>D</sub>	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6 mm (0.25in.) from package and center of die contact
L <sub>S</sub>	Internal Source Inductance	—	7.5	—		
C <sub>iss</sub>	Input Capacitance	—	170	—	pF	V <sub>GS</sub> =0V
C <sub>oss</sub>	Output Capacitance	—	50	—		V <sub>DS</sub> =-25V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	15	—		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 (Body Diode)	—	—	-1.8	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	-7.0		
V <sub>SD</sub>	Diode Forward Voltage	—	—	-5.8	V	T <sub>J</sub> =25°C, I <sub>S</sub> =-1.8A, V <sub>GS</sub> =0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	240	360	ns	T <sub>J</sub> =25°C, I <sub>F</sub> =-1.8A
Q <sub>rr</sub>	Reverse Recovery Charge	—	1.7	2.6	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)
- ② Not Applicable
- ③ I<sub>SP</sub>≤-1.8A, di/dt≤70A/μs, V<sub>DD</sub>≤V<sub>(BR)DSS</sub>, T<sub>J</sub>≤150°C
- ④ Pulse width ≤ 300 μs; duty cycle ≤2%.

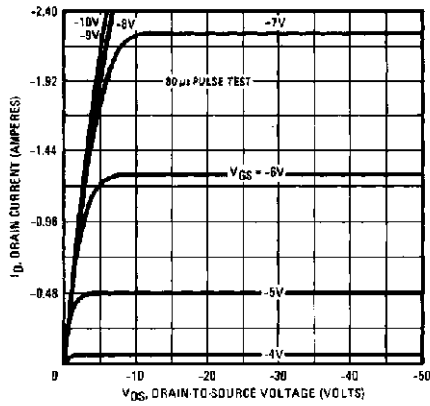


Fig. 1 — Typical Output Characteristics

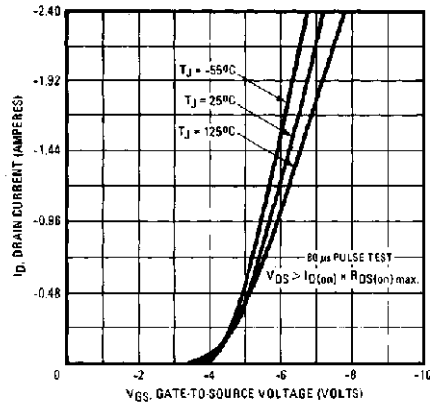


Fig. 2 — Typical Transfer Characteristics

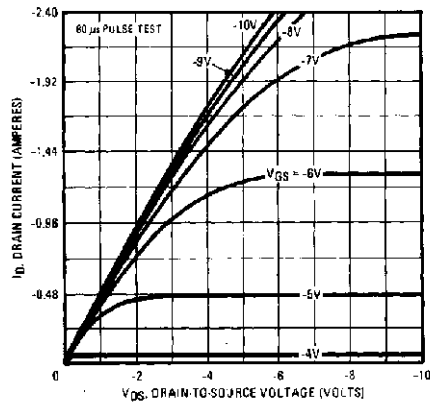


Fig. 3 — Typical Saturation Characteristics

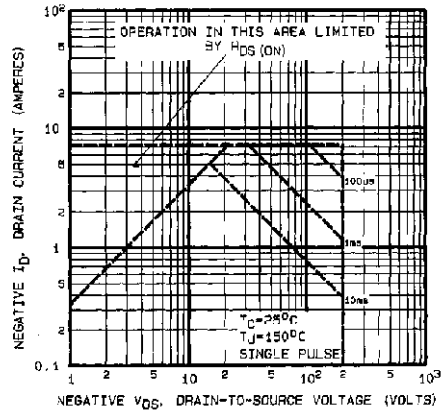


Fig. 4 — Maximum Safe Operating Area

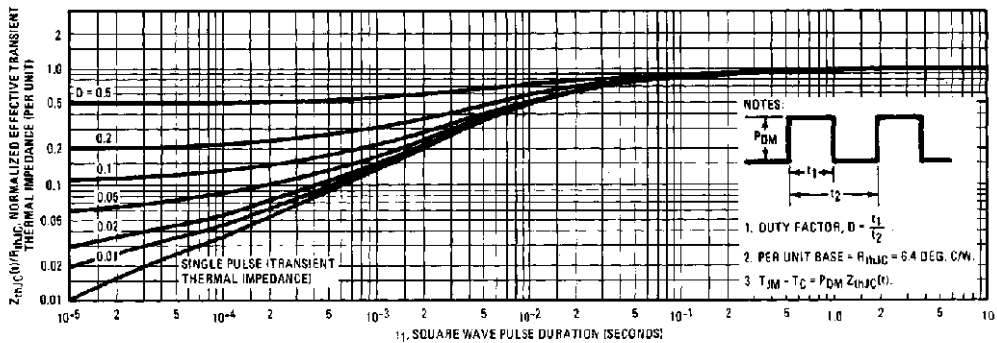


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

# IRF9610SPbF

International  
IR Rectifier

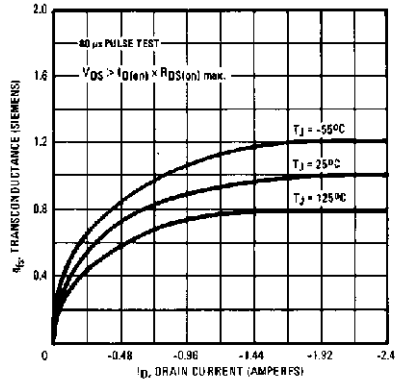


Fig. 6 — Typical Transconductance Vs. Drain Current

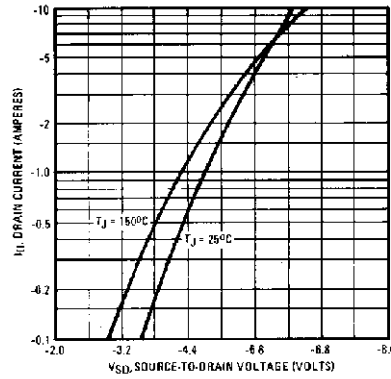


Fig. 7 — Typical Source-Drain Diode Forward Voltage

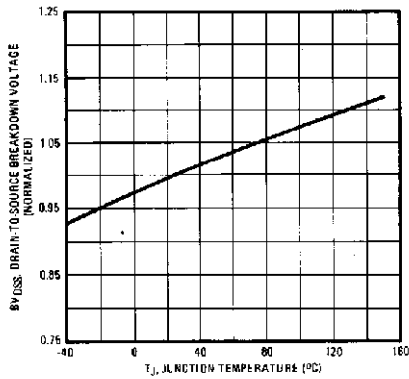


Fig. 8 — Breakdown Voltage Vs. Temperature

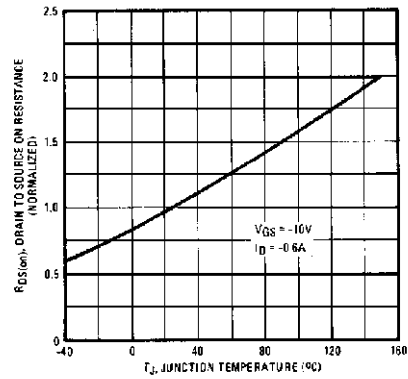


Fig. 9 — Normalized On-Resistance Vs. Temperature

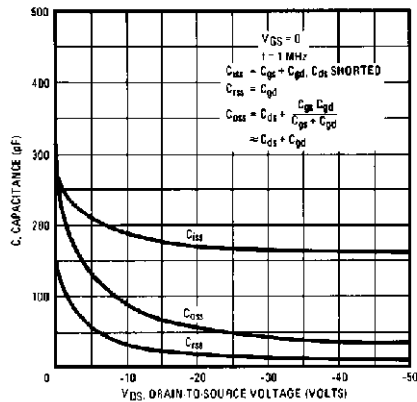


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

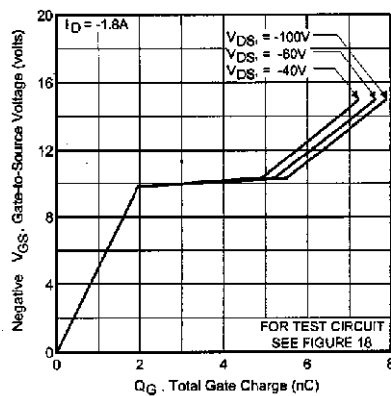
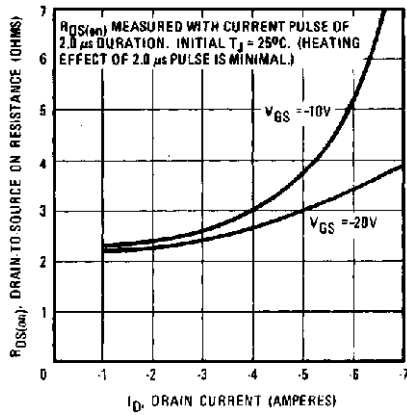
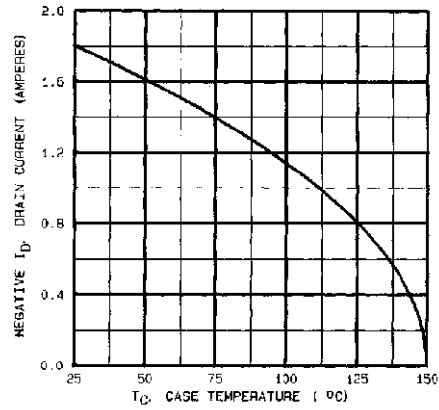


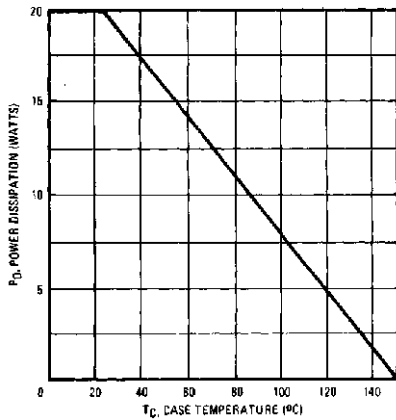
Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage



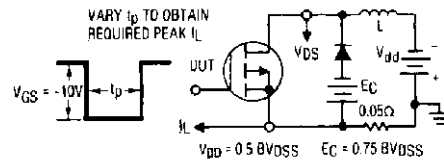
**Fig. 12 — Typical On-Resistance Vs. Drain Current**



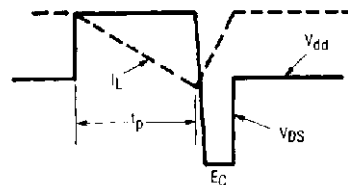
**Fig. 13 — Maximum Drain Current Vs. Case Temperature**



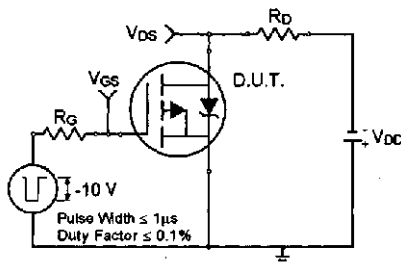
**Fig. 14 — Power Vs. Temperature Derating Curve**



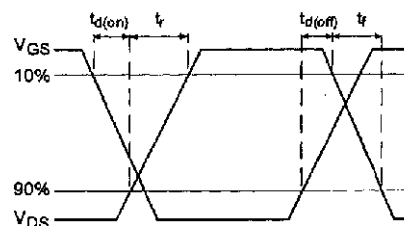
**Fig. 15 — Clamped Inductive Test Circuit**



**Fig. 16 — Clamped Inductive Waveforms**



**Fig. 17a — Switching Time Test Circuit**



**Fig. 17b — Switching Time Waveforms**

# IRF9610SPbF

International  
**IR** Rectifier

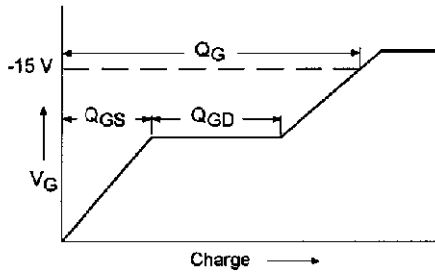


Fig. 18a — Basic Gate Charge Waveform

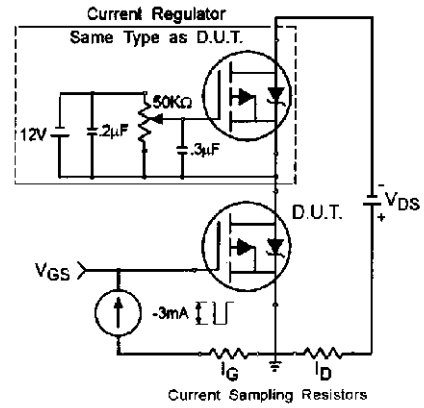
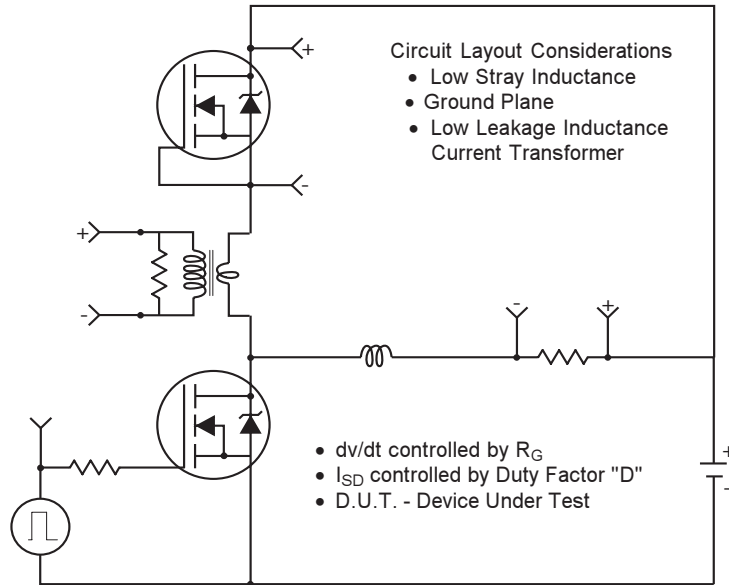


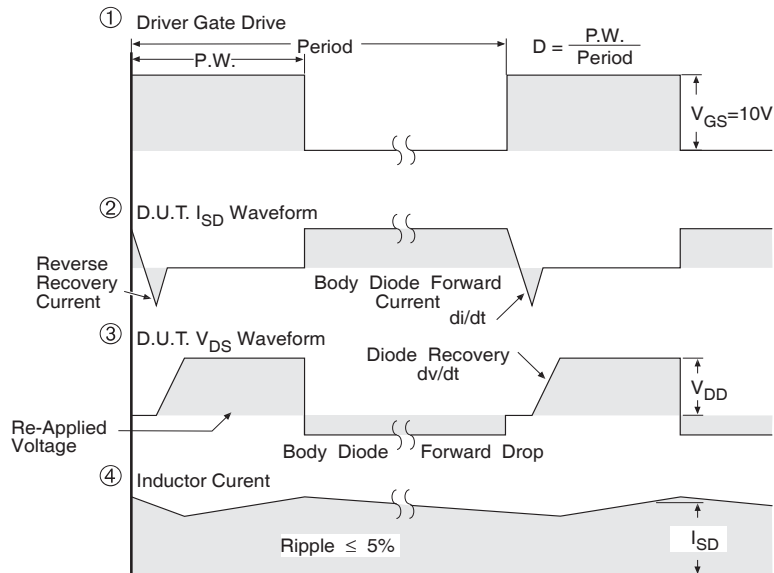
Fig. 18b — Gate Charge Test Circuit

## 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

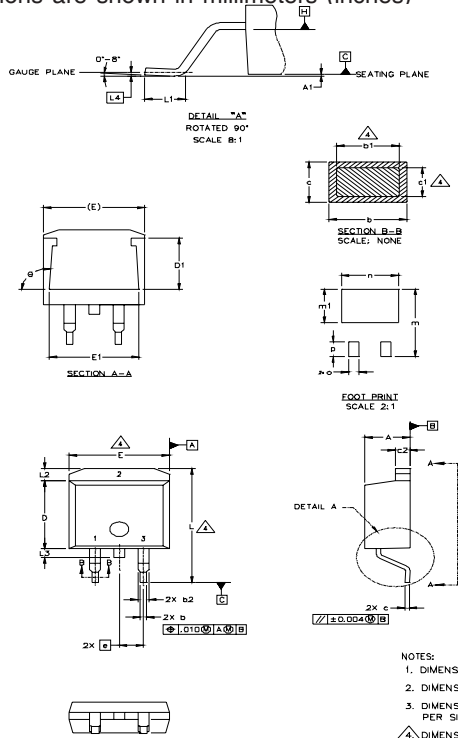
**Fig. 14** For N and P Channel HEXFETS

# IRF9610SPbF

International  
**IR** Rectifier

## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	4
A1		0.127	.005	.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	
b2	1.14	1.40	.045	.055	4
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	3
c2	1.14	1.40	.045	.055	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
E	9.65	10.67	.380	.420	
E1	6.22		.245		
e	2.54	BSC	.100	BSC	
L	14.61	15.88	.575	.625	
L1	1.78	2.79	.070	.110	
L2		1.65		.065	
L3	1.27	1.78	.050	.070	
L4	0.25	BSC	.010	BSC	
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
θ	90°	93°	90°	93°	

### LEAD ASSIGNMENTS

HEXFET	IGBTs, CoPACK	DIODES
1.- GATE	1.- GATE	1.- ANODE *
2.- DRAIN	2.- COLLECTOR	2.- CATHODE
3.- SOURCE	3.- EMITTER	3.- ANODE

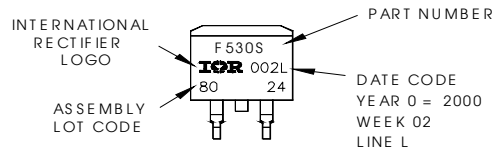
\* PART DEPENDENT.

- 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 [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.

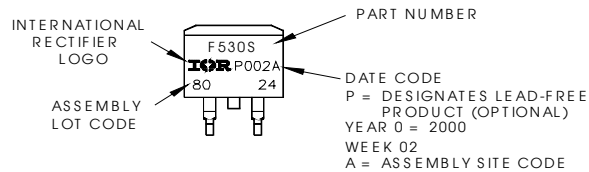
## D<sup>2</sup>Pak Part Marking Information (Lead-Free)

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE "L"

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

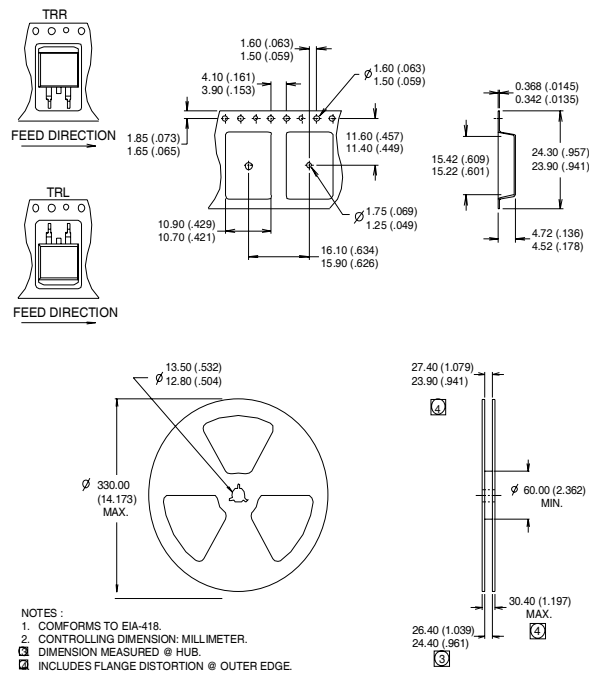


OR





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



Data and specifications subject to change without notice.

International  
**IR** Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105

TAC Fax: (310) 252-7903

09/04



## Notice

The products described herein were acquired by Vishay Intertechnology, Inc., as part of its acquisition of International Rectifier's Power Control Systems (PCS) business, which closed in April 2007. Specifications of the products displayed herein are pending review by Vishay and are subject to the terms and conditions shown below.

Specifications of the products displayed herein are subject to change without notice. Vishay Intertechnology, Inc., or anyone on its behalf, assumes no responsibility or liability for any errors or inaccuracies.

Information contained herein is intended to provide a product description only. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Vishay's terms and conditions of sale for such products, Vishay assumes no liability whatsoever, and disclaims any express or implied warranty, relating to sale and/or use of Vishay products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Vishay for any damages resulting from such improper use or sale.

International Rectifier®, IR®, the IR logo, HEXFET®, HEXSense®, HEXDIP®, DOL®, INTERO®, and POWIRTRAIN® are registered trademarks of International Rectifier Corporation in the U.S. and other countries. All other product names noted herein may be trademarks of their respective owners.