

# International IR Rectifier

- Advanced Process Technology
- Dynamic  $dv/dt$  Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Ease of Paralleling
- Simple Drive Requirements

## Lead-Free Description

Fifth Generation HEXFET® Power MOSFETs from International Rectifier 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 HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

The D<sup>2</sup>Pak 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 D<sup>2</sup>Pak 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.

The through-hole version (IRF640NL) is available for low-profile application.

## Absolute Maximum Ratings

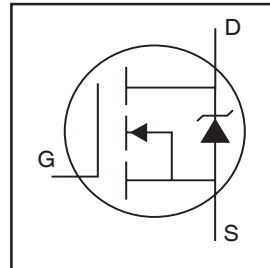
	Parameter	Max.	Units
$I_D$ @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V	18	A
$I_D$ @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V	13	
$I_{DM}$	Pulsed Drain Current ①	72	
$P_D$ @ $T_C = 25^\circ\text{C}$	Power Dissipation	150	W
	Linear Derating Factor	1.0	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$E_{AS}$	Single Pulse Avalanche Energy②	247	mJ
$I_{AR}$	Avalanche Current①	18	A
$E_{AR}$	Repetitive Avalanche Energy①	15	mJ
$dv/dt$	Peak Diode Recovery $dv/dt$ ⑥	8.1	V/ns
$T_J$	Operating Junction and	-55 to +175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (1.6mm from case )	
	Mounting torque, 6-32 or M3 screw④	10 lbf•in (1.1N•m)	

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PD - 95046

IRF640NPbF  
IRF640NSPbF  
IRF640NLPbF

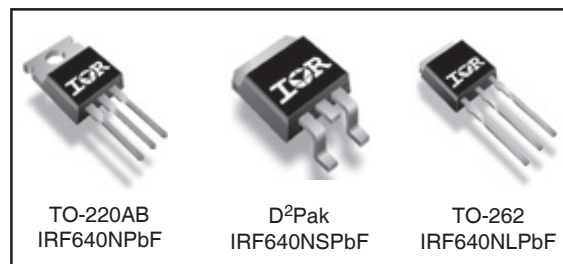
HEXFET® Power MOSFET



$$V_{DSS} = 200V$$

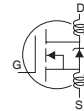
$$R_{DS(on)} = 0.15\Omega$$

$$I_D = 18A$$



**Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

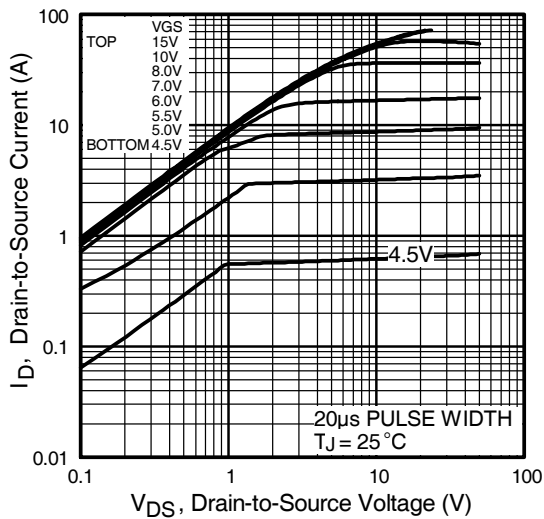
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	200	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.25	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.15	$\Omega$	$V_{GS} = 10V, I_D = 11A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$g_{fs}$	Forward Transconductance	6.8	—	—	S	$V_{DS} = 50V, I_D = 11A$ ③
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	25	$\mu A$	$V_{DS} = 200V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 160V, V_{GS} = 0V, T_J = 150^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -20V$
$Q_g$	Total Gate Charge	—	—	67	nC	$I_D = 11A$
$Q_{gs}$	Gate-to-Source Charge	—	—	11		$V_{DS} = 160V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	—	33		$V_{GS} = 10V$ , See Fig. 6 and 13
$t_{d(on)}$	Turn-On Delay Time	—	10	—	ns	$V_{DD} = 100V$
$t_r$	Rise Time	—	19	—		$I_D = 11A$
$t_{d(off)}$	Turn-Off Delay Time	—	23	—		$R_G = 2.5\Omega$
$t_f$	Fall Time	—	5.5	—		$R_D = 9.0\Omega$ , See Fig. 10 ③
$L_D$	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact
$L_S$	Internal Source Inductance	—	7.5	—		
$C_{iss}$	Input Capacitance	—	1160	—	pF	$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	185	—		$V_{DS} = 25V$
$C_{rss}$	Reverse Transfer Capacitance	—	53	—		$f = 1.0\text{MHz}$ , See Fig. 5

**Source-Drain Ratings and Characteristics**

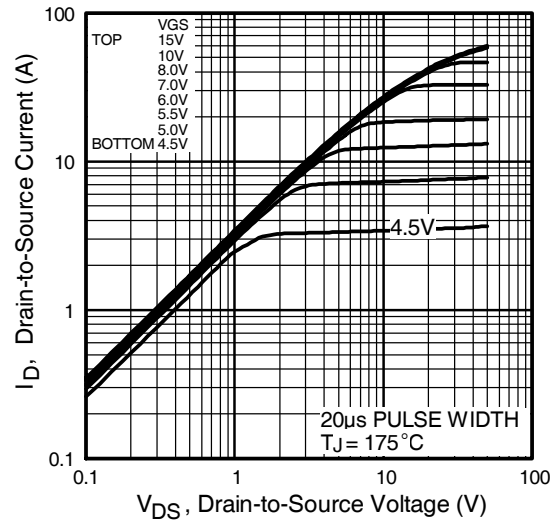
	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	18	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode)①	—	—	72		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}, I_S = 11A, V_{GS} = 0V$ ③
$t_{rr}$	Reverse Recovery Time	—	167	251	ns	$T_J = 25^\circ\text{C}, I_F = 11A$
$Q_{rr}$	Reverse Recovery Charge	—	929	1394	nC	$di/dt = 100A/\mu s$ ③
$t_{on}$	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ )				

**Thermal Resistance**

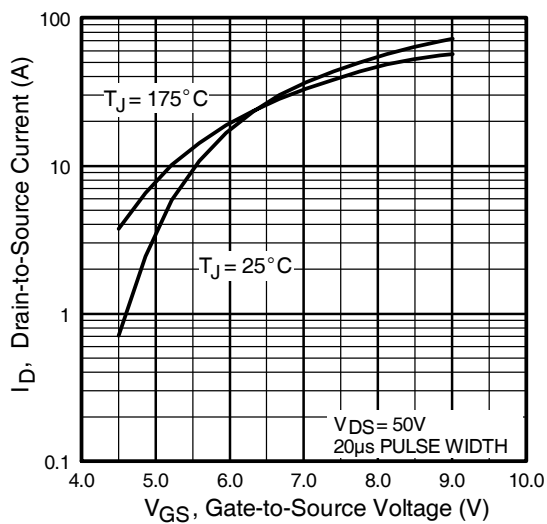
	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	1.0	$^\circ\text{C/W}$
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface ④	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient④	—	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB mount)⑤	—	40	



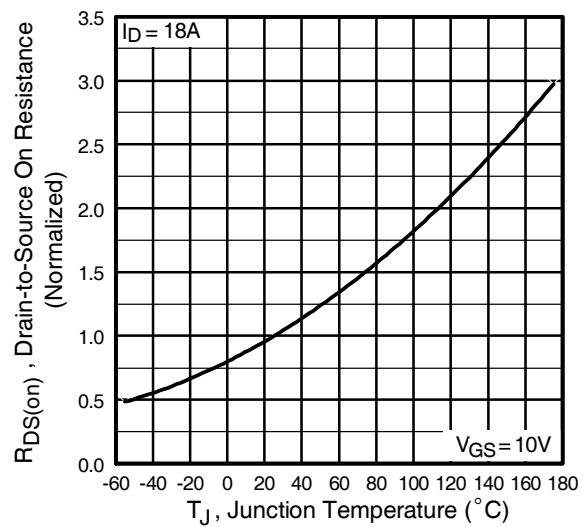
**Fig 1.** Typical Output Characteristics



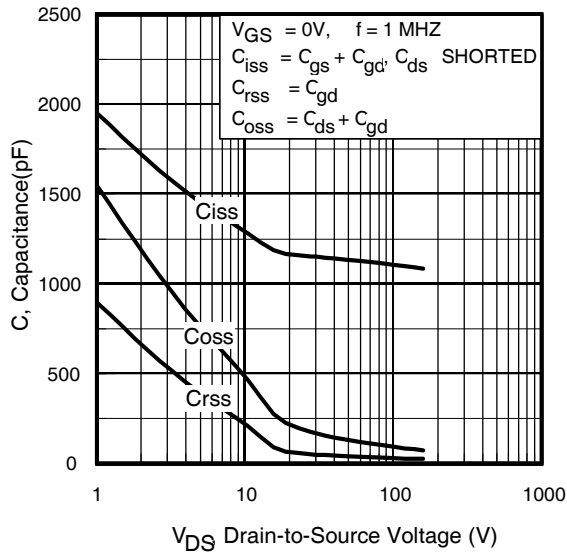
**Fig 2.** Typical Output Characteristics



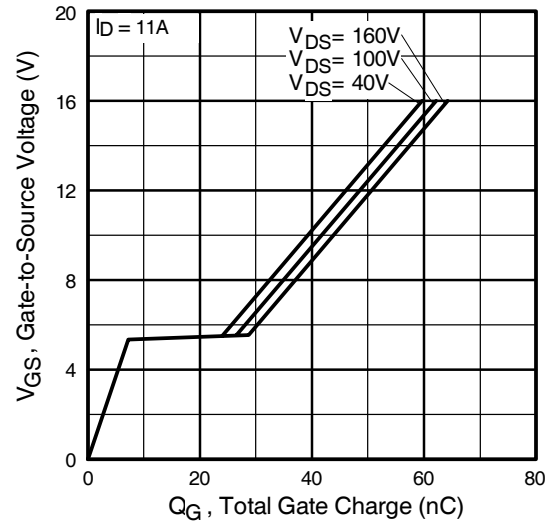
**Fig 3.** Typical Transfer Characteristics



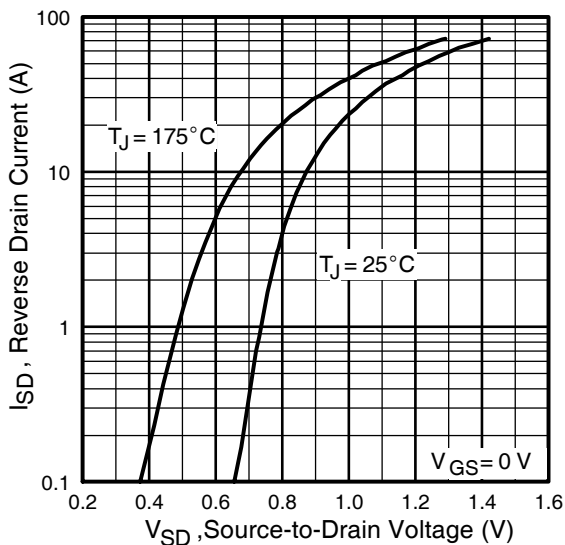
**Fig 4.** Normalized On-Resistance Vs. Temperature



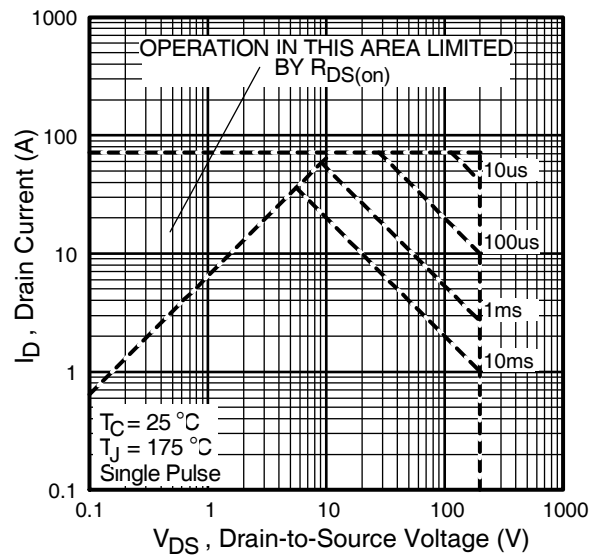
**Fig 5.** Typical Capacitance Vs.  
Drain-to-Source Voltage



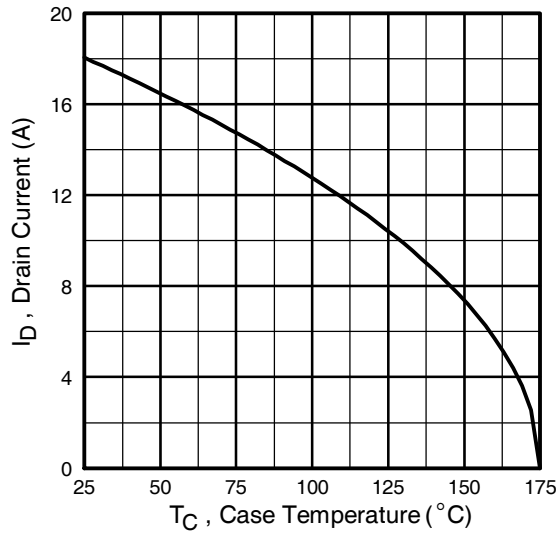
**Fig 6.** Typical Gate Charge Vs.  
Gate-to-Source Voltage



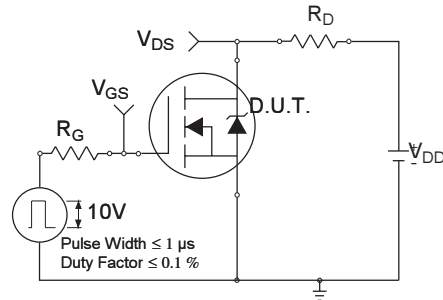
**Fig 7.** Typical Source-Drain Diode  
Forward Voltage



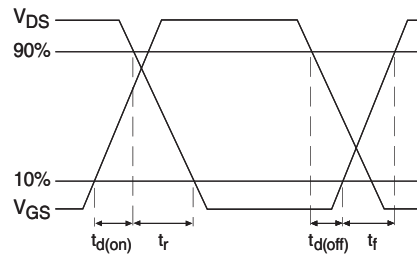
**Fig 8.** Maximum Safe Operating Area



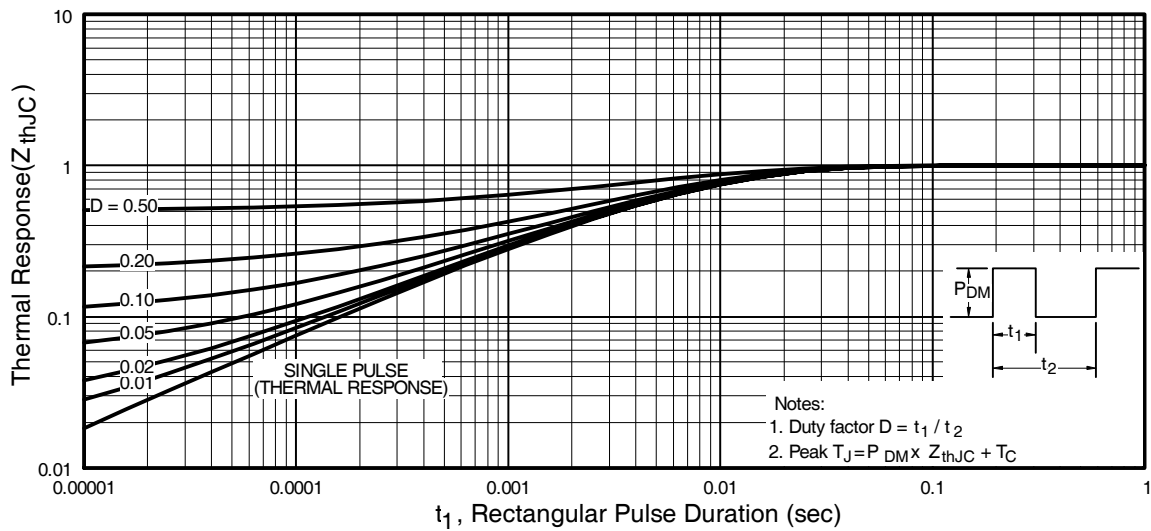
**Fig 9.** Maximum Drain Current Vs. Case Temperature



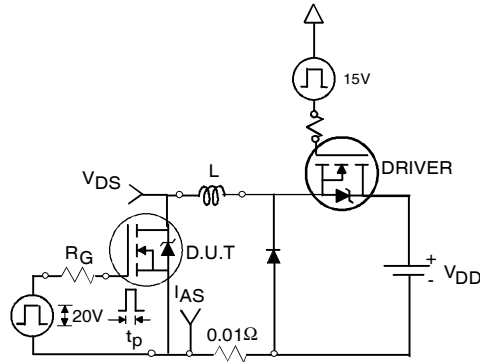
**Fig 10a.** Switching Time Test Circuit



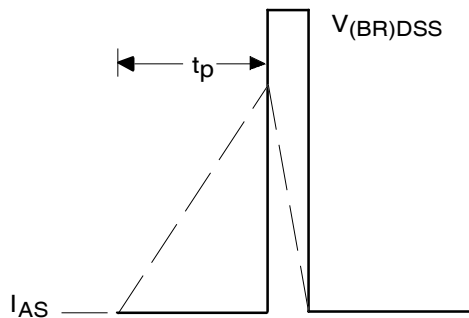
**Fig 10b.** Switching Time Waveforms



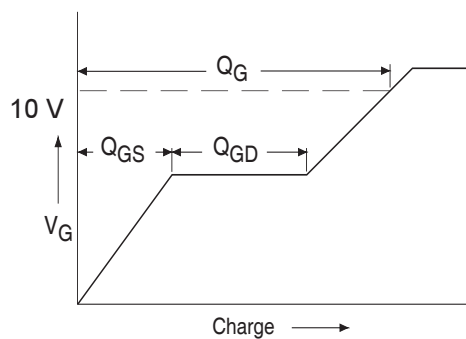
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



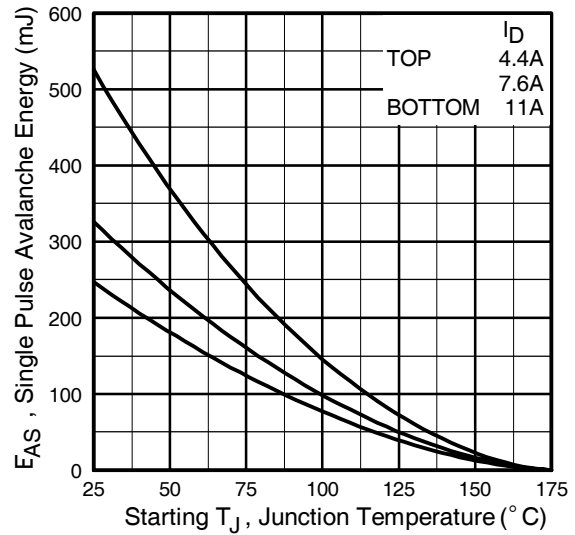
**Fig 12a.** Unclamped Inductive Test Circuit



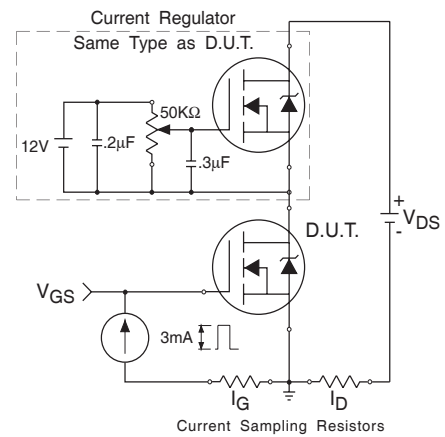
**Fig 12b.** Unclamped Inductive Waveforms



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



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



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

The diagram shows a Class D amplifier circuit. A square wave pulse generator (1) is connected to the gate of a MOSFET driver through a gate resistor  $R_G$ . The driver MOSFET's source is grounded, and its drain is connected to the gate of the D.U.T. MOSFET. A transformer (2) is connected between the driver MOSFET drain and the D.U.T. MOSFET gate. The D.U.T. MOSFET's source is grounded, and its drain is connected to a load network consisting of an inductor and a capacitor (4) in series, which is then connected to a positive supply voltage  $V_{DD}$ . The D.U.T. MOSFET's gate is also connected to  $V_{DD}$  through a pull-up resistor (3). The output of the D.U.T. is taken from its drain. The D.U.T. is represented by a circle containing a MOSFET symbol.

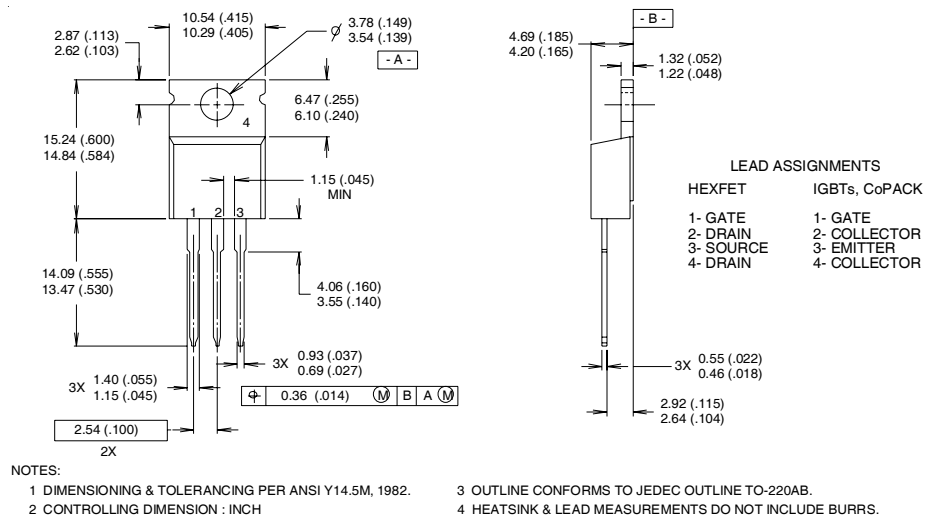
**Circuit Layout Considerations**

- Low Stray Inductance
- Ground Plane
- Low Leakage Inductance Current Transformer



## TO-220AB Package Outline

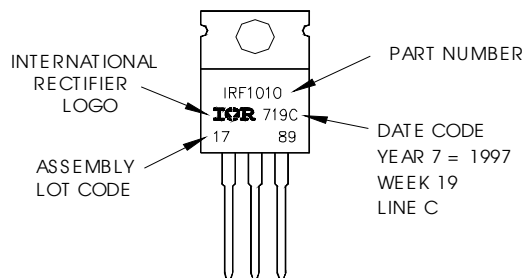
Dimensions are shown in millimeters (inches)



## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"

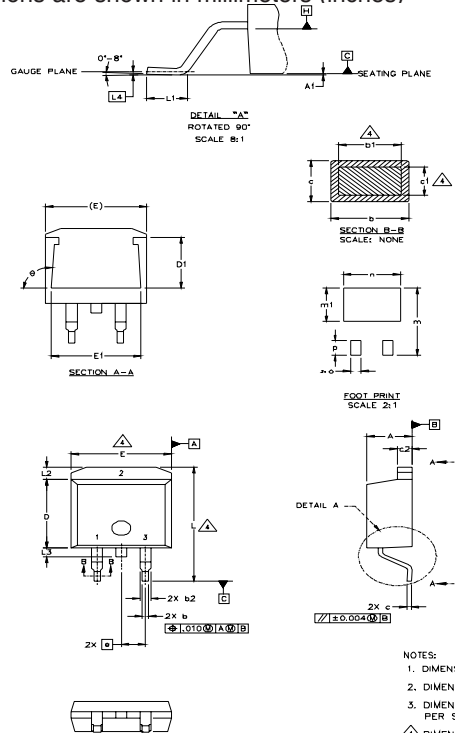
**Note:** "P" in assembly line position indicates "Lead-Free"





## 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	
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	
c2	1.14	1.40	.045	.055	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		3
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

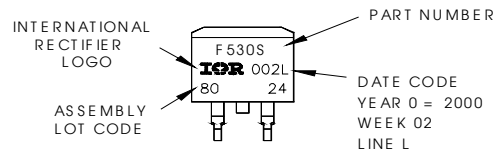
\* PART DEPENDENT.

- 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 [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.

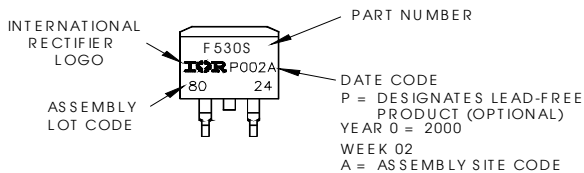
## D<sup>2</sup>Pak Part Marking Information (Lead-Free)

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

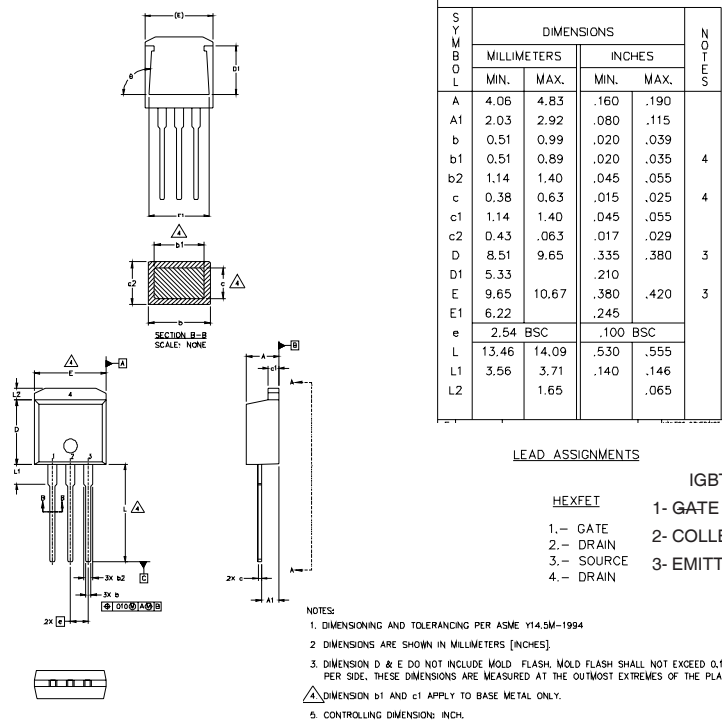
Note: "P" in assembly line  
position indicates "Lead-Free"



OR

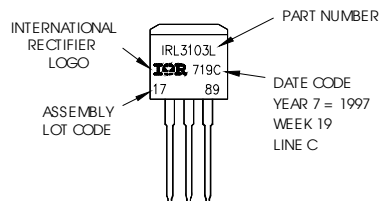


## TO-262 Package Outline

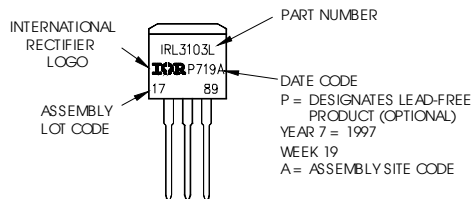


## TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"  
 Note: "P" in assembly line  
 position indicates "Lead-Free"

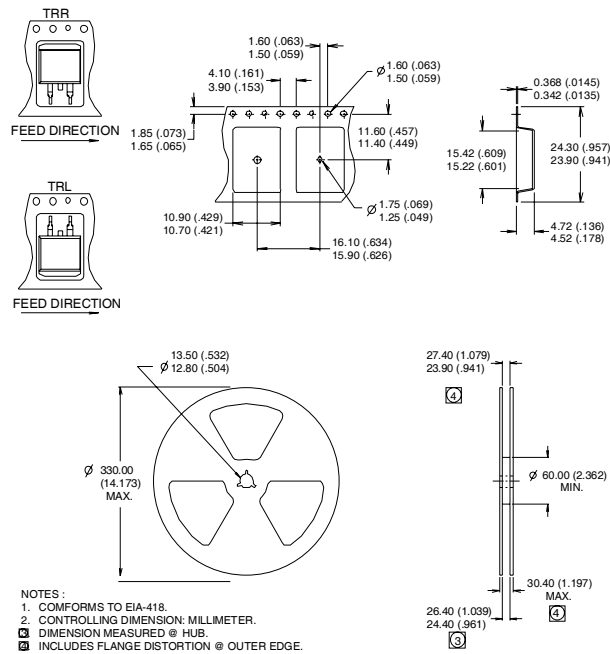


**OR**



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

Dimensions are shown in millimeters (inches)



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 4.2\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 11\text{A}$ .
- ③ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ④ This is only applied to TO-220AB package.
- ⑤ This is applied to D<sup>2</sup>Pak, when mounted on 1" square PCB (FR-4 or G-10 Material).  
For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑥  $I_{SD} \leq 11\text{A}$ ,  $di/dt \leq 344\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$

Data and specifications subject to change without notice.

International  
**IR** Rectifier

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