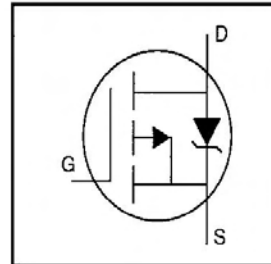


# IRFI9Z24GPbF

## HEXFET® Power MOSFET

- Isolated Package
- High Voltage Isolation= 2.5KVRMS ⑤
- Sink to Lead Creepage Dist.= 4.8mm
- P-Channel
- 175°C Operating Temperature
- Dynamic dv/dt Rating
- Low Thermal Resistance
- Lead-Free



$$V_{DSS} = -60V$$

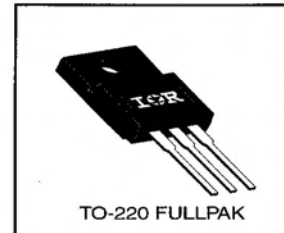
$$R_{DS(on)} = 0.28\Omega$$

$$I_D = -8.5A$$

### 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 TO-220 Fullpak eliminates the need for additional insulating hardware in commercial-industrial applications. The moulding compound used provides a high isolation capability and a low thermal resistance between the tab and external heatsink. This isolation is equivalent to using a 100 micron mica barrier with standard TO-220 product. The Fullpak is mounted to a heatsink using a single clip or by a single screw fixing.



### Absolute Maximum Ratings

	Parameter	Max.	Units
$I_D$ @ $T_C = 25^\circ C$	Continuous Drain Current, $V_{GS}$ @ -10 V	-8.5	A
$I_D$ @ $T_C = 100^\circ C$	Continuous Drain Current, $V_{GS}$ @ -10 V	-6.0	
$I_{DM}$	Pulsed Drain Current ①	-34	
$P_D$ @ $T_C = 25^\circ C$	Power Dissipation	37	W
	Linear Derating Factor	0.24	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 20$	V
$E_{AS}$	Single Pulse Avalanche Energy ②	200	mJ
$I_{AR}$	Avalanche Current ①	-8.5	A
$E_{AR}$	Repetitive Avalanche Energy ①	3.7	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	V/ns
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting Torque, 6-32 or M3 screw	10 lbf•in (1.1 N•m)	

### Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	4.1	°C/W
$R_{\theta JA}$	Junction-to-Ambient	—	—	65	

# IRFI9Z24GPbF

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	-60	—	—	V	$V_{GS}=0V$ , $I_D=-250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	-0.056	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D=-1mA$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.28	$\Omega$	$V_{GS}=-10V$ , $I_D=-5.1A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	—	-4.0	V	$V_{DS}=V_{GS}$ , $I_D=-250\mu A$
$g_{fs}$	Forward Transconductance	3.2	—	—	S	$V_{DS}=-25V$ , $I_D=-5.1A$ ④
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	-100	$\mu A$	$V_{DS}=-60V$ , $V_{GS}=0V$
		—	—	-500		$V_{DS}=-48V$ , $V_{GS}=0V$ , $T_J=150^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	-100	nA	$V_{GS}=-20V$
	Gate-to-Source Reverse Leakage	—	—	100		$V_{GS}=20V$
$Q_g$	Total Gate Charge	—	—	19	nC	$I_D=-11A$
$Q_{gs}$	Gate-to-Source Charge	—	—	5.4		$V_{DS}=-48V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	—	11		$V_{GS}=-10V$ See Fig. 6 and 13 ④
$t_{d(on)}$	Turn-On Delay Time	—	13	—	ns	$V_{DD}=-30V$
$t_r$	Rise Time	—	68	—		$I_D=-11A$
$t_{d(off)}$	Turn-Off Delay Time	—	15	—		$R_G=18\Omega$
$t_f$	Fall Time	—	29	—		$R_D=2.5\Omega$ See Figure 10 ④
$L_D$	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6 mm (0.25in.) from package and center of die contact
$L_S$	Internal Source Inductance	—	7.5	—		
$C_{iss}$	Input Capacitance	—	570	—	pF	$V_{GS}=0V$
$C_{oss}$	Output Capacitance	—	360	—		$V_{DS}=-25V$
$C_{rss}$	Reverse Transfer Capacitance	—	65	—		$f=1.0MHz$ See Figure 5
$C$	Drain to Sink Capacitance	—	12	—	pF	$f=1.0MHz$

## Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	-8.5	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	-34		
$V_{SD}$	Diode Forward Voltage	—	—	-6.3	V	$T_J=25^\circ\text{C}$ , $I_S=-8.5A$ , $V_{GS}=0V$ ④
$t_{rr}$	Reverse Recovery Time	—	100	200	ns	$T_J=25^\circ\text{C}$ , $I_F=-11A$
$Q_{rr}$	Reverse Recovery Charge	—	0.32	0.64	$\mu C$	$di/dt=100A/\mu s$ ④
$t_{on}$	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ )				

### Notes:

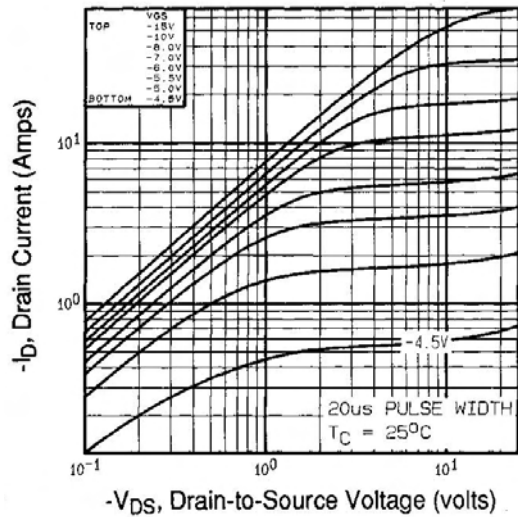
① Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)

③  $I_{SD} \leq -11A$ ,  $di/dt \leq 140A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$

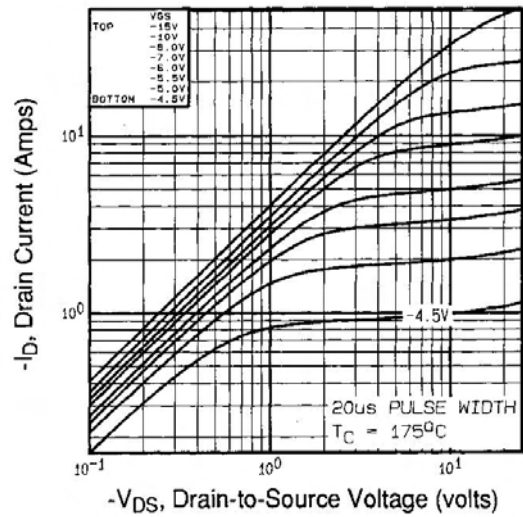
⑤  $t=60s$ ,  $f=60Hz$

②  $V_{DD}=-25V$ , starting  $T_J=25^\circ\text{C}$ ,  $L=3.2mH$ ,  $R_G=25\Omega$ ,  $I_{AS}=-8.5A$  (See Figure 12)

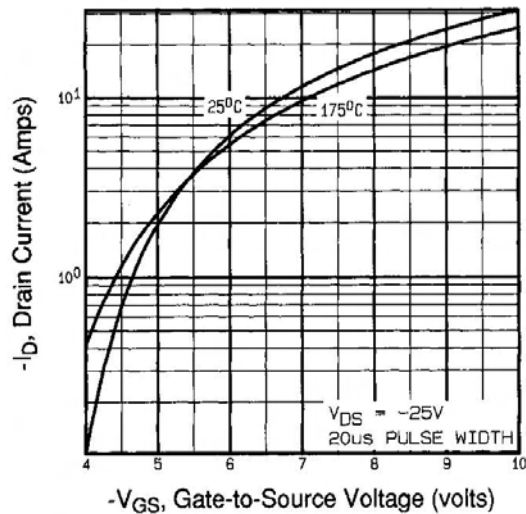
④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .



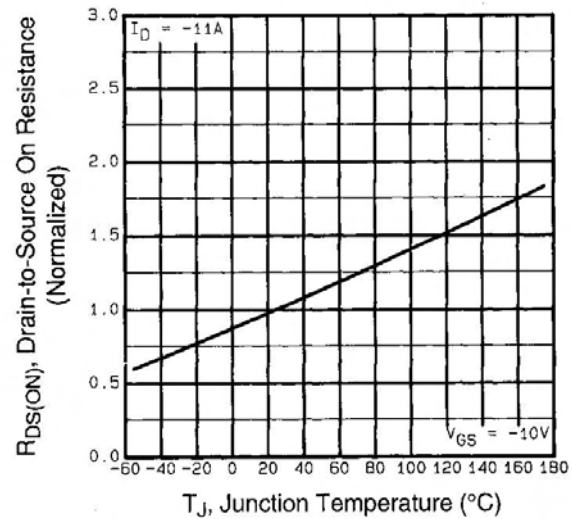
**Fig 1.** Typical Output Characteristics,  
 $T_C = 25^\circ\text{C}$



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



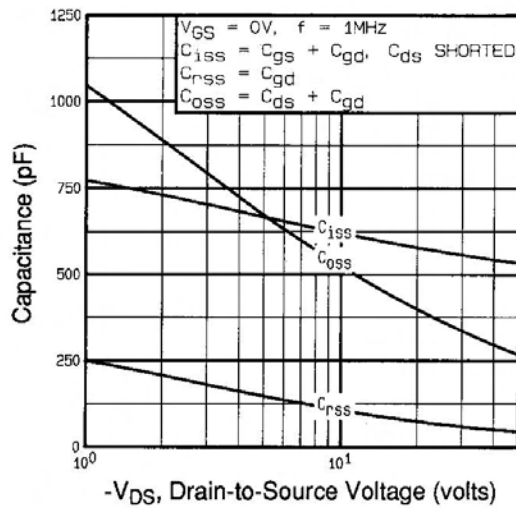
**Fig 3.** Typical Transfer Characteristics



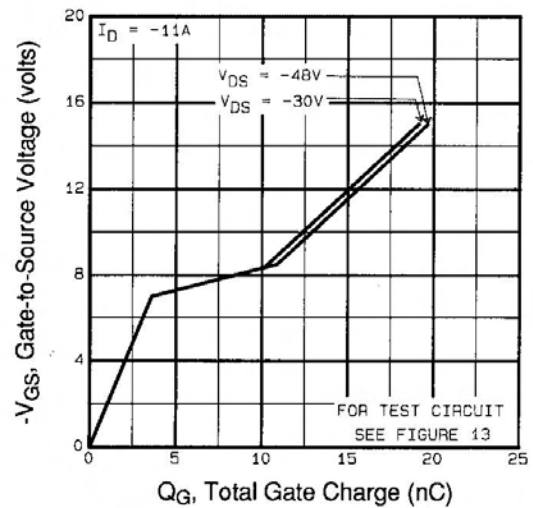
**Fig 4.** Normalized On-Resistance  
Vs. Temperature

# IRFI9Z24GPbF

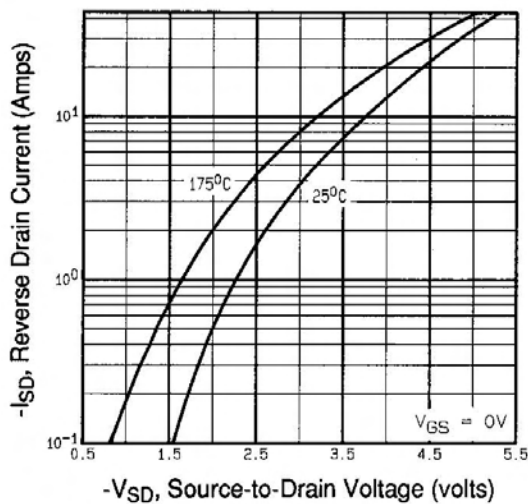
International  
Rectifier



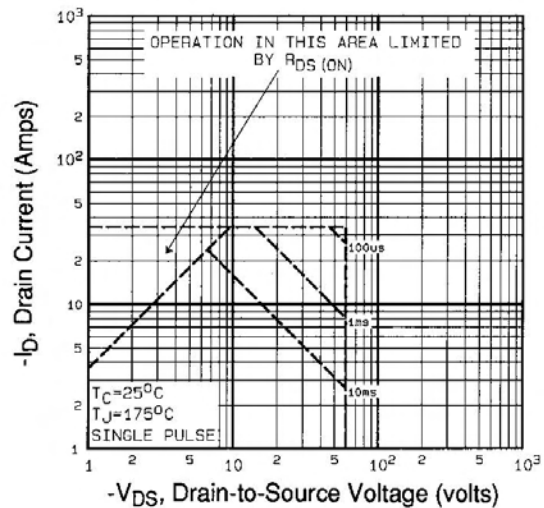
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



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

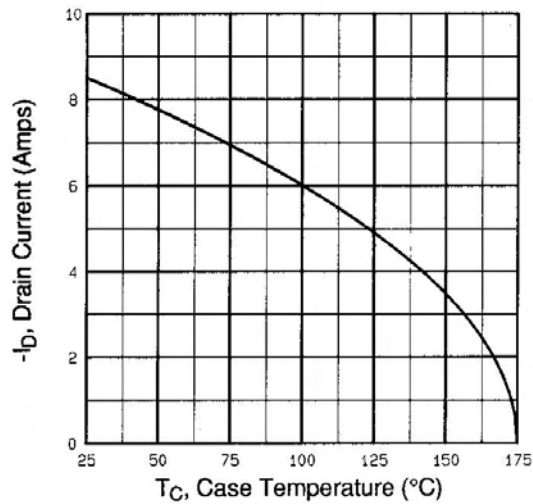


**Fig 7.** Typical Source-Drain Diode Forward Voltage

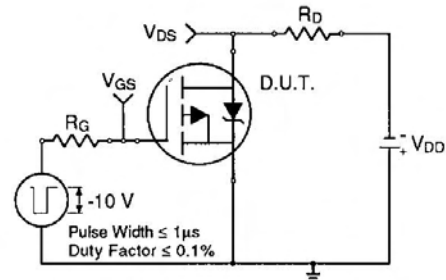


**Fig 8.** Maximum Safe Operating Area

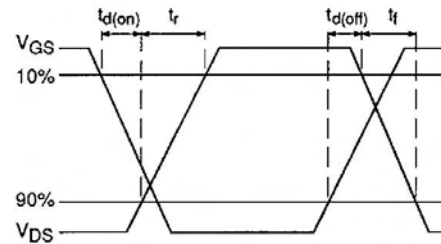




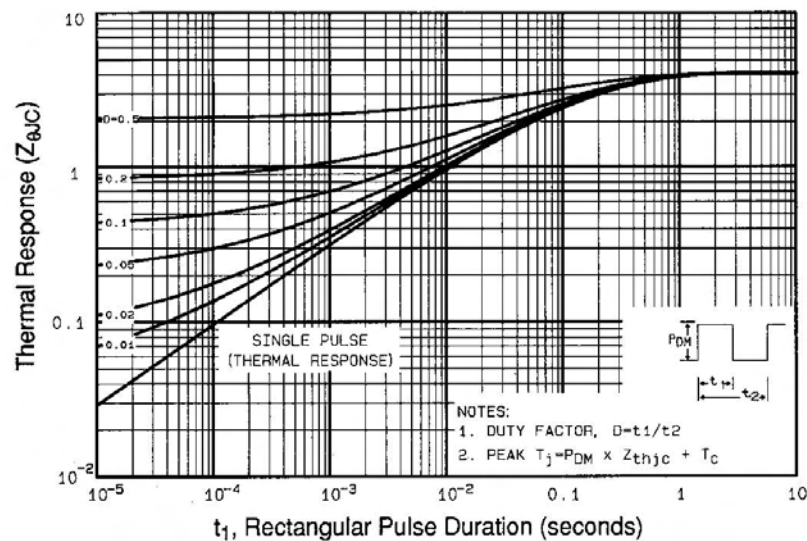
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



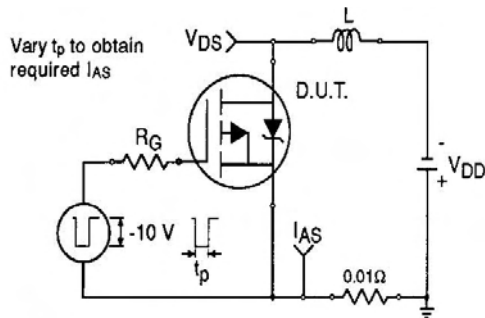
**Fig 10b.** Switching Time Waveforms



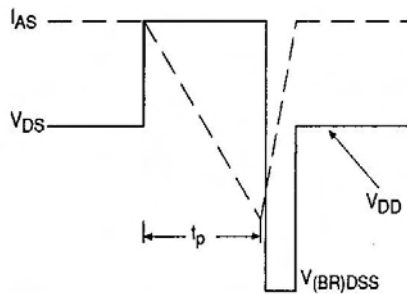
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRFI9Z24GPbF

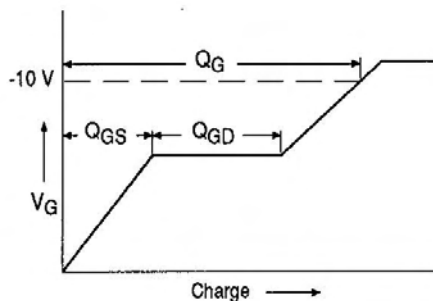
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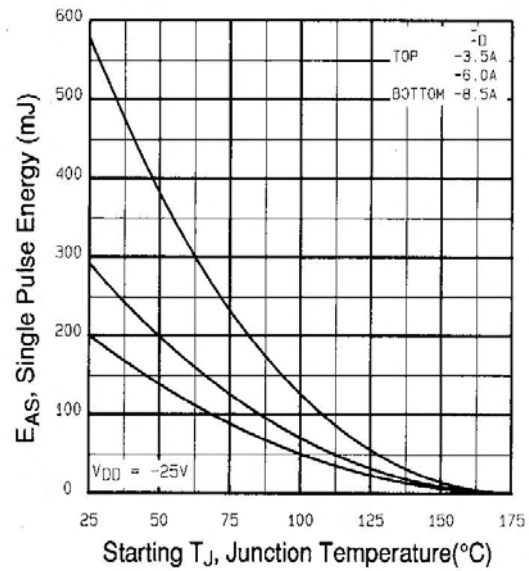
**Fig 12a.** Unclamped Inductive Test Circuit



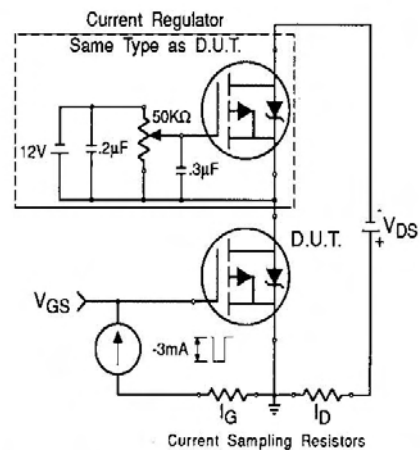
**Fig 12b.** Unclamped Inductive Waveforms



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

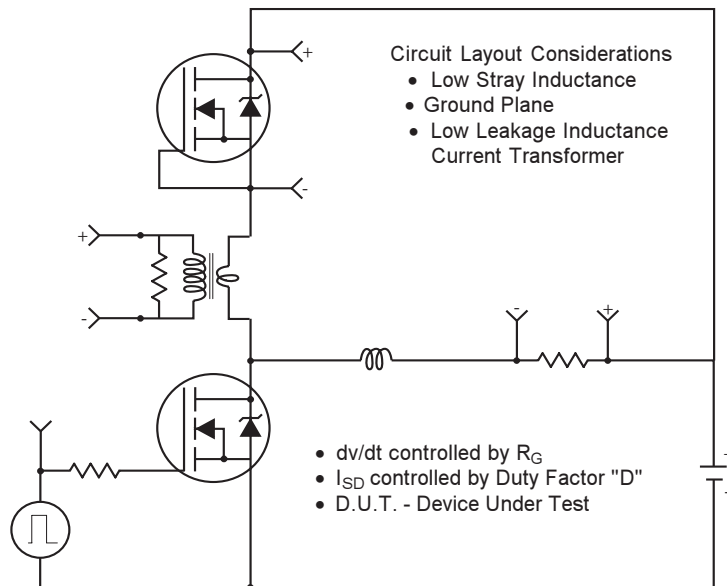


**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current



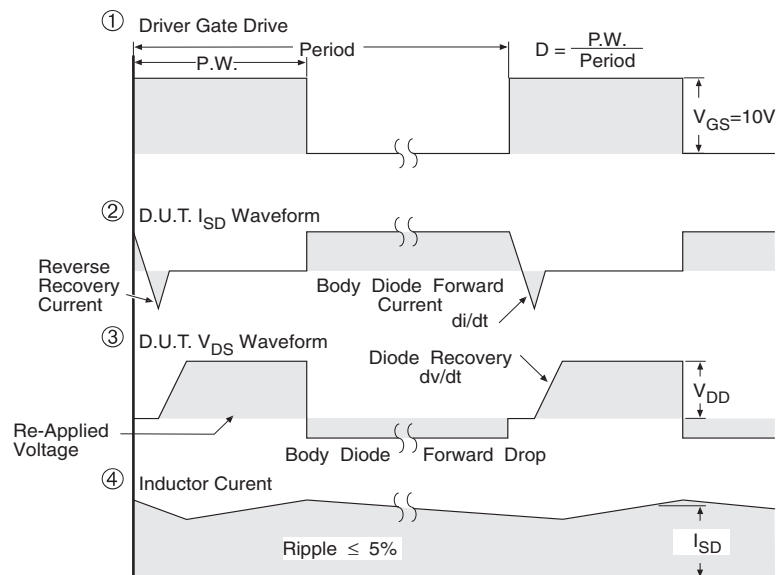
**Fig 13b.** Gate Charge Test Circuit

## 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

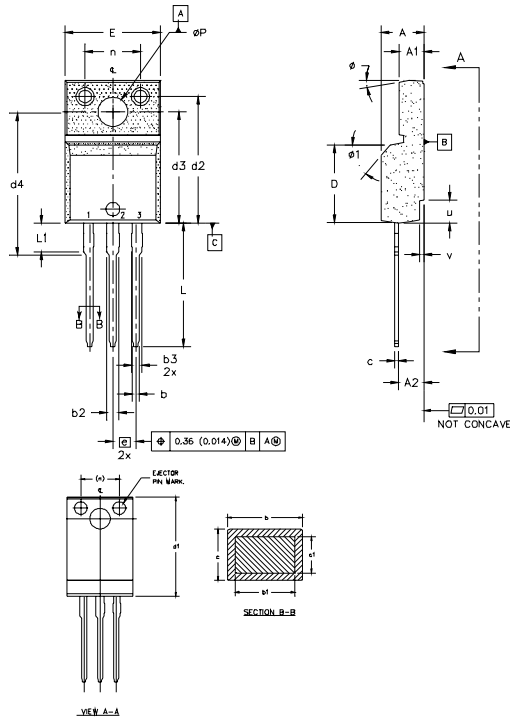
**Fig 14 For P Channel HEXFETS**

# IRFI9Z24GPbF

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## TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



### NOTES:

- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- 3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5.0 DIMENSION b1 APPLY TO BASE METAL ONLY.
- 6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
- 7.0 CONTROLLING DIMENSION : INCHES.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	0.180	0.190	5
A1	2.57	2.83	0.101	0.114	
A2	2.51	2.85	0.099	0.112	
b	0.622	0.89	0.024	0.035	
b1	0.622	0.838	0.024	0.033	
b2	1.229	1.400	0.048	0.055	
b3	1.229	1.400	0.048	0.055	
c	0.440	0.629	0.017	0.025	
c1	0.440	0.584	0.017	0.023	
D	8.65	9.80	0.341	0.386	
d1	15.80	16.12	0.622	0.635	
d2	13.97	14.22	0.550	0.560	
d3	12.30	12.92	0.484	0.509	
d4	8.64	9.91	0.340	0.390	4
E	10.36	10.63	0.408	0.419	
e	2.54 BSC		0.100 BSC		
L	13.20	13.73	0.520	0.541	
L1	3.10	3.50	0.122	0.138	3
n	6.05	6.15	0.238	0.242	
nP	3.05	3.45	0.120	0.136	6
u	2.40	2.50	0.094	0.098	
v	0.40	0.50	0.016	0.020	6
ø	3"	7"	3"	7"	
ø1		45"		45"	

LEAD ASSIGNMENTS	
HEXFET	
1. -	GATE
2. -	DRAIN
3. -	SOURCE
IGBTs, CoPACK	
1. -	GATE
2. -	COLLECTOR
3. -	EMITTER

### LEAD ASSIGNMENTS

#### HEXFET

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

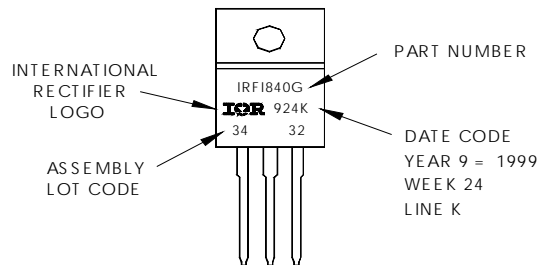
#### IGBTs, CoPACK

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

## TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI840G  
WITH ASSEMBLY  
LOT CODE 3432  
ASSEMBLED ON WW 24 1999  
IN THE ASSEMBLY LINE "K"

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



Data and specifications subject to change without notice.

International  
**IOR** Rectifier

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TAC Fax: (310) 252-7903  
12/04





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