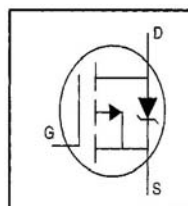


International IOR Rectifier HEXFET® Power MOSFET

PD-95415

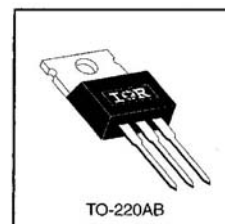
IRF9Z24PbF



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

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

$$I_D = -11A$$



- Dynamic dv/dt Rating
- Repetitive Avalanche Rated
- P-Channel
- 175°C Operating Temperature
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements

- Lead-Free

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 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.

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, $V_{GS} @ -10 V$	-7.7	
I_{DM}	Pulsed Drain Current ①	-44	
$P_D @ T_C = 25^\circ C$	Power Dissipation	60	W
	Linear Derating Factor	0.40	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy ②	240	mJ
I_{AR}	Avalanche Current ①	-11	A
E_{AR}	Repetitive Avalanche Energy ①	6.0	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-4.5	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 screw	10 lbf•in (1.1 N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	2.5	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	—	62	

IRF9Z24PbF

International
IR Rectifier

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°C , $I_D=-1mA$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.28	Ω	$V_{GS}=-10V$, $I_D=-6.6A$ 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	1.4	—	—	S	$V_{DS}=-25V$, $I_D=-6.6A$ ④
I_{DSS}	Drain-to-Source Leakage Current	—	—	-100	μA	$V_{DS}=-60V$, $V_{GS}=0V$
		—	—	-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

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	-11	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	-44		
V_{SD}	Diode Forward Voltage	—	—	-6.3	V	$T_J=25^\circ\text{C}$, $I_S=-11A$, $V_{GS}=0V$ 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	μC	$di/dt=100A/\mu s$ 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)

② $V_{DD}=-25V$, starting $T_J=25^\circ\text{C}$, $L=2.3mH$, $R_G=25\Omega$, $I_{AS}=-11A$ (See Figure 12)

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

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

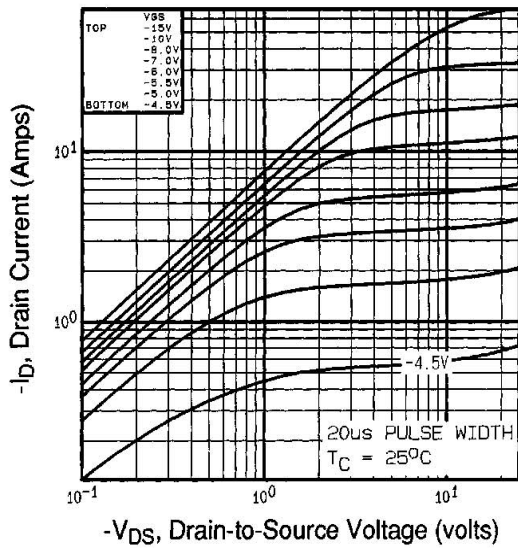


Fig 1. Typical Output Characteristics,
 $T_C = 25^\circ\text{C}$

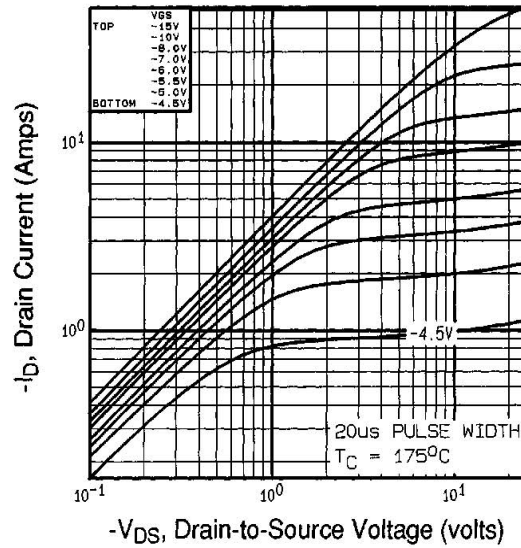


Fig 2. Typical Output Characteristics,
 $T_C = 175^\circ\text{C}$

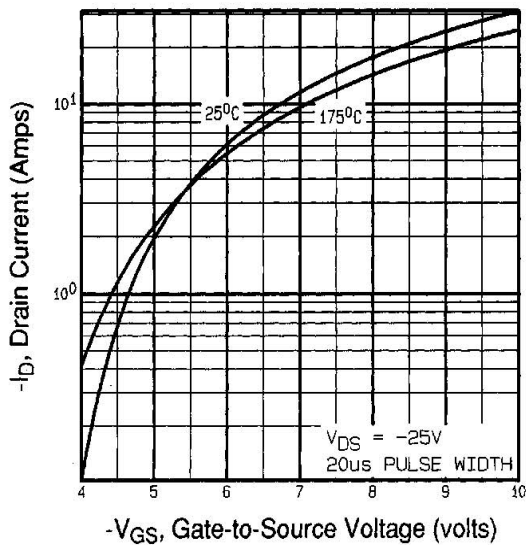


Fig 3. Typical Transfer Characteristics

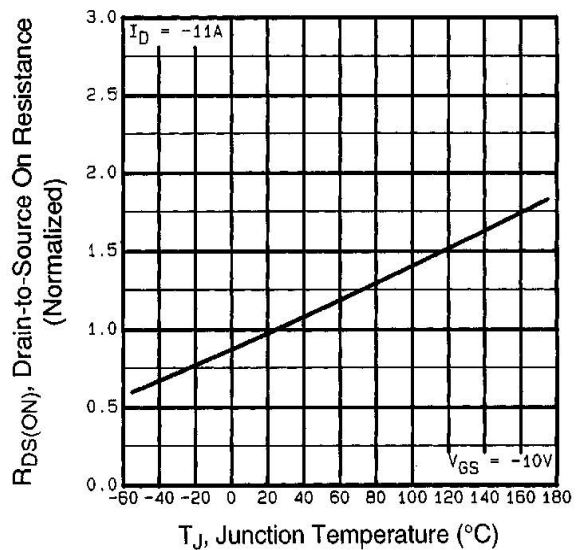


Fig 4. Normalized On-Resistance
Vs. Temperature

IRF9Z24PbF

International
IR Rectifier

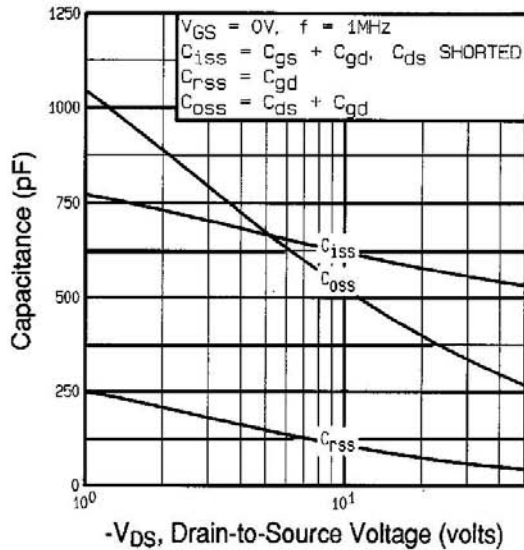


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

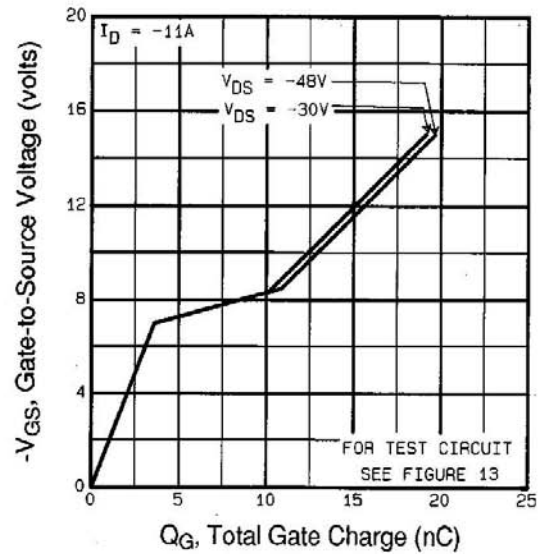


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

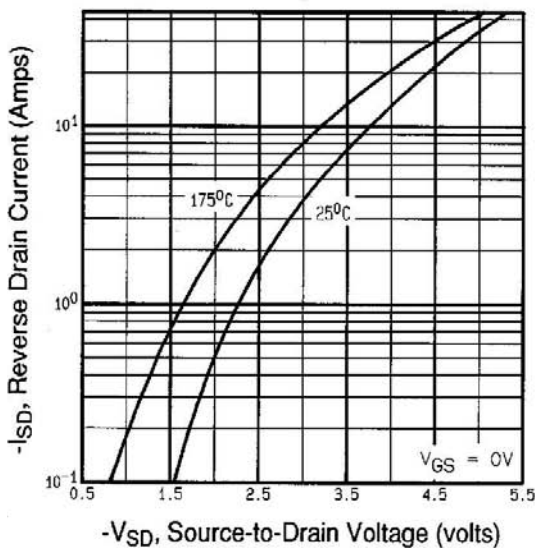


Fig 7. Typical Source-Drain Diode Forward Voltage

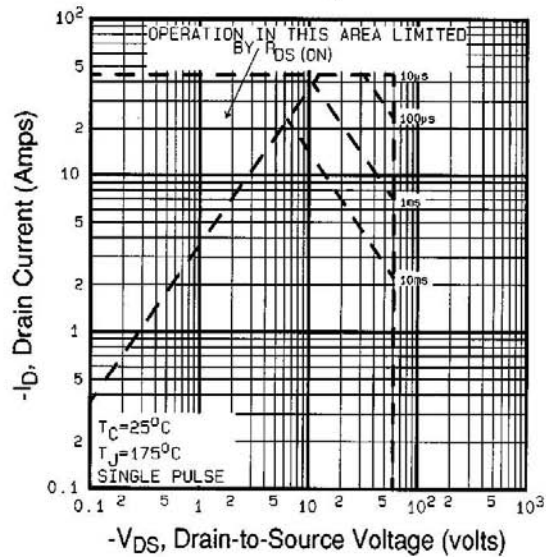


Fig 8. Maximum Safe Operating Area

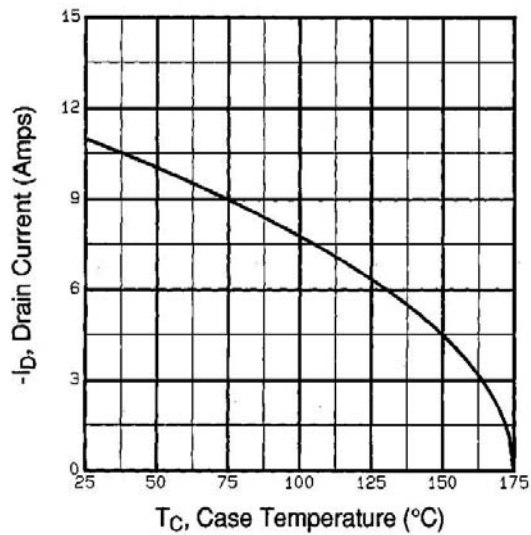


Fig 9. Maximum Drain Current Vs. Case Temperature

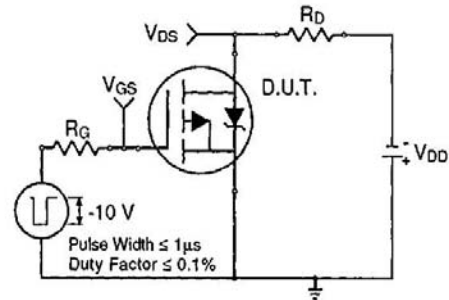


Fig 10a. Switching Time Test Circuit

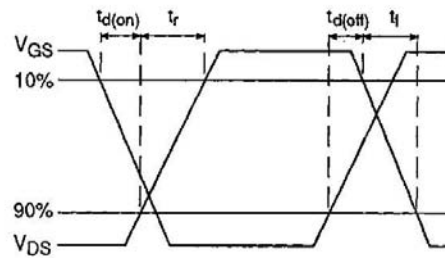


Fig 10b. Switching Time Waveforms

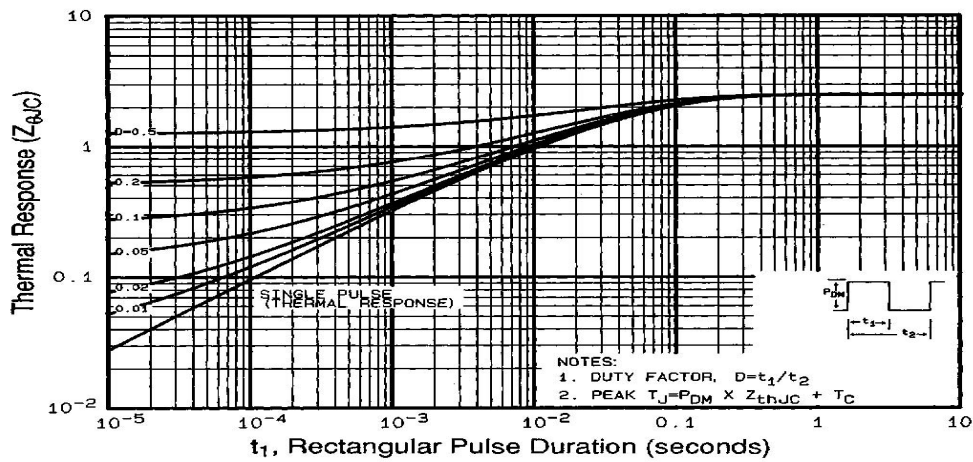


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRF9Z24PbF

International
IR Rectifier

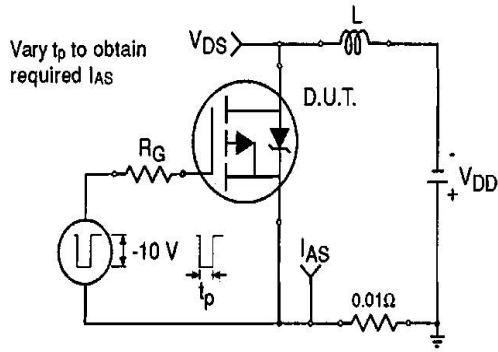


Fig 12a. Unclamped Inductive Test Circuit

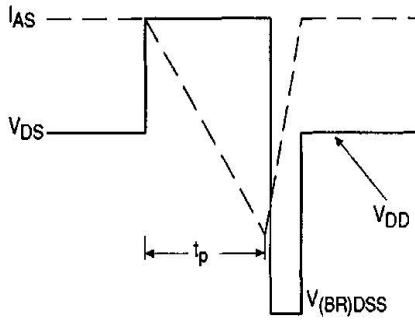


Fig 12b. Unclamped Inductive Waveforms

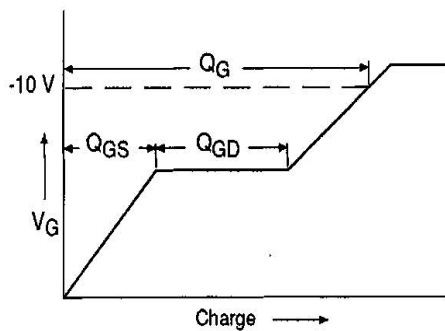


Fig 13a. Basic Gate Charge Waveform

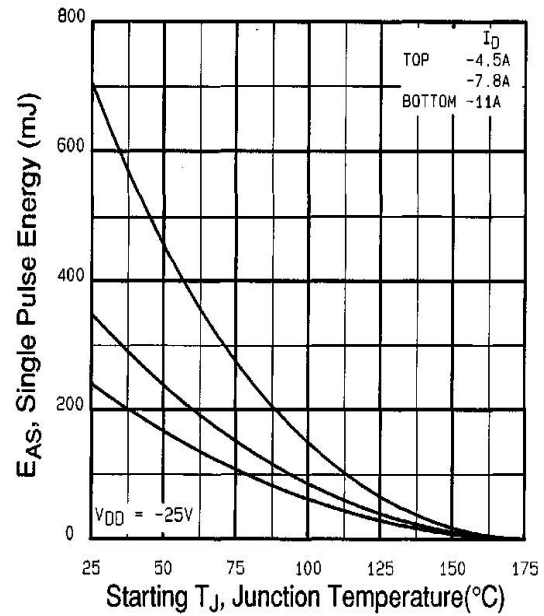


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

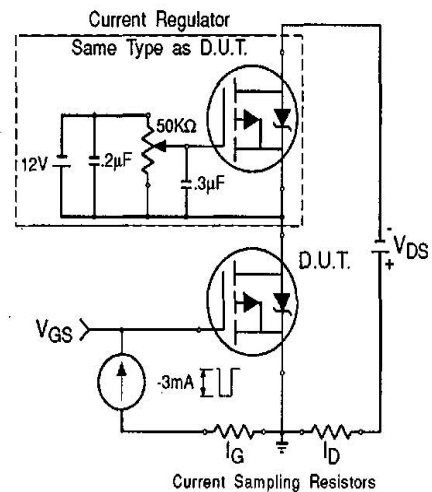
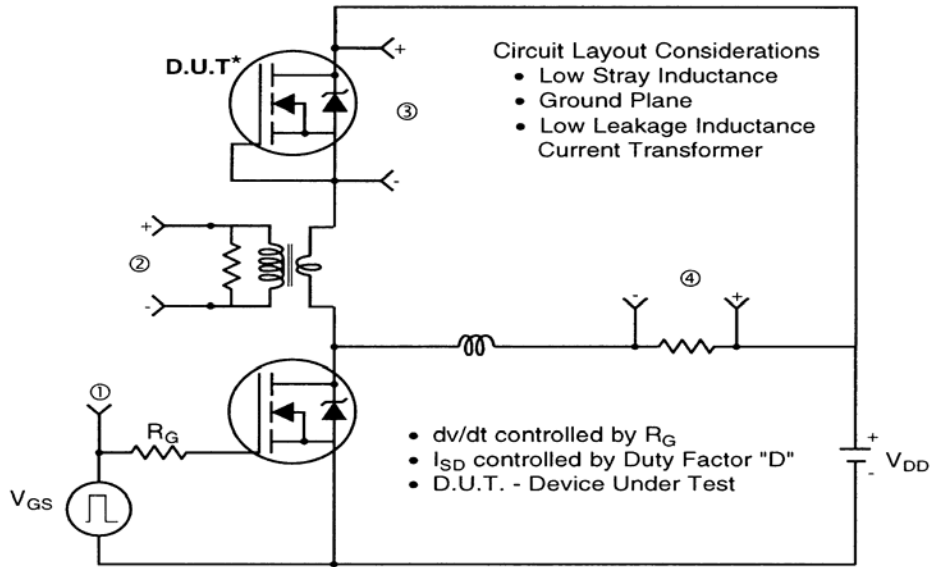
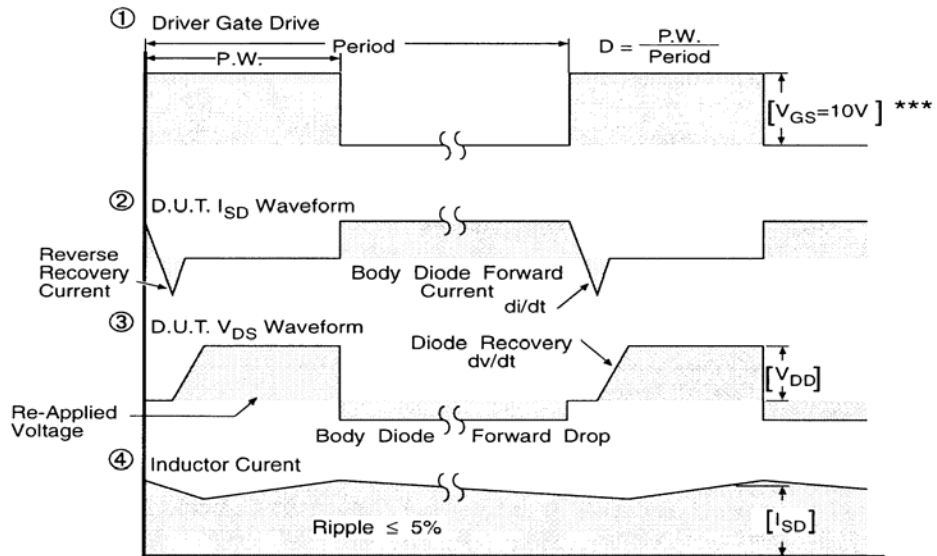


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



* Reverse Polarity of D.U.T for P-Channel



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

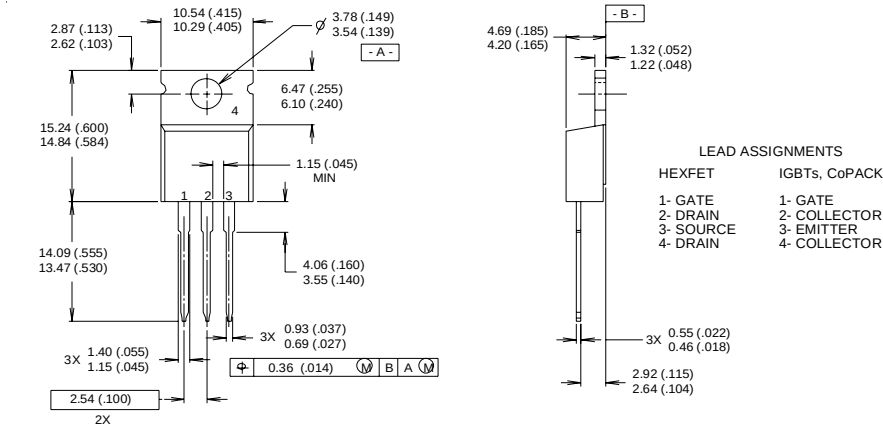
Fig 14. For P-Channel HEXFETS

IRF9Z24PbF

International
IR Rectifier

TO-220AB Package Outline

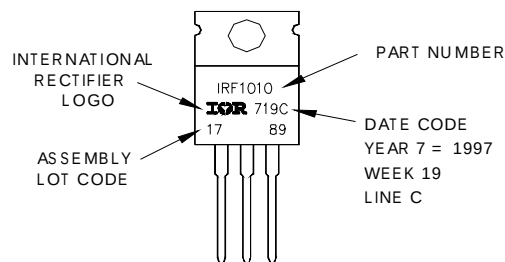
Dimensions are shown in millimeters (inches)



- NOTES:
- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
 - 2 CONTROLLING DIMENSION : INCH
 - 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
 - 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

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"



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

Visit us at www.irf.com for sales contact information. 06/04

www.irf.com