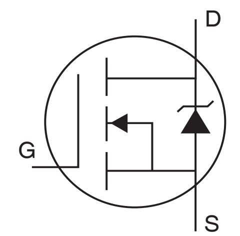
International Rectifier

PD - 94859

IRF644NPbF
IRF644NS
IRF644NL

HEXFET® Power MOSFET

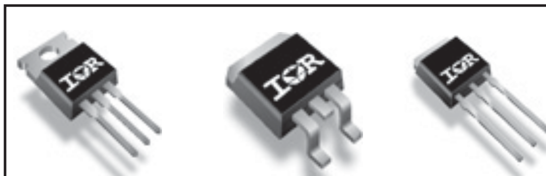
- Advanced Process Technology
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Ease of Paralleling
- Simple Drive Requirements
- Lead-Free (only the TO-220AB version is currently available in a lead-free configuration)



V_{DSS} = 250V

$R_{DS(on)}$ = 240mΩ

I_D = 14A



TO-220AB	D²Pak	TO-262
IRF644NPbF	IRF644NS	IRF644NL

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.

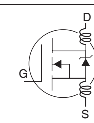
The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

The D^2Pak 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^2Pak 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.

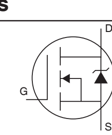
Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	14	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	9.9	
I_{DM}	Pulsed Drain Current ①	56	
P_D @T_C = 25°C	Power Dissipation	150	W
	Linear Derating Factor	1.0	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy②	180⑥	mJ
I_{AR}	Avalanche Current①	8.4	A
E_{AR}	Repetitive Avalanche Energy①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	7.9	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 srew	10 lbf•in (1.1N•m)	

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	250	–––	–––	V	V_{GS} = 0V, I_D = 250μA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	–––	0.33	–––	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	–––	–––	240	mΩ	V_{GS} = 10V, I_D = 8.4A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	–––	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
g_{fs}	Forward Transconductance	8.8	–––	–––	S	V_{DS} = 50V, I_D = 8.4A④
I_{DSS}	Drain-to-Source Leakage Current	–––	–––	25	μA	V_{DS} = 250V, V_{GS} = 0V
		–––	–––	250		V_{DS} = 200V, V_{GS} = 0V, T_J = 150°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	–––	–––	54	nC	I_D = 8.4A
Q_{gs}	Gate-to-Source Charge	–––	–––	9.2		V_{DS} = 200V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	–––	26		V_{GS} = 10V, See Fig. 6 and 13
$t_{d(on)}$	Turn-On Delay Time	–––	10	–––	ns	V_{DD} = 125V
t_r	Rise Time	–––	21	–––		I_D = 8.4A
$t_{d(off)}$	Turn-Off Delay Time	–––	30	–––		R_G = 6.2Ω
t_f	Fall Time	–––	17	–––		V_{GS} = 10V, See Fig. 10 ④
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	–––	1060	–––	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	–––	140	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	38	–––		ƒ = 1.0MHz, See Fig. 5

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	–––	–––	14	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode)①	–––	–––	56		
V_{SD}	Diode Forward Voltage	–––	–––	1.3	V	T_J = 25°C, I_S = 14A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	–––	165	250	ns	T_J = 25°C, I_F = 14A
Q_{rr}	Reverse Recovery Charge	–––	1.0	1.6	nC	di/dt = 100A/μs ④
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	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface ⑦	0.50	–––	
$R_{\theta JA}$	Junction-to-Ambient⑦	–––	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB mount)**	–––	40	

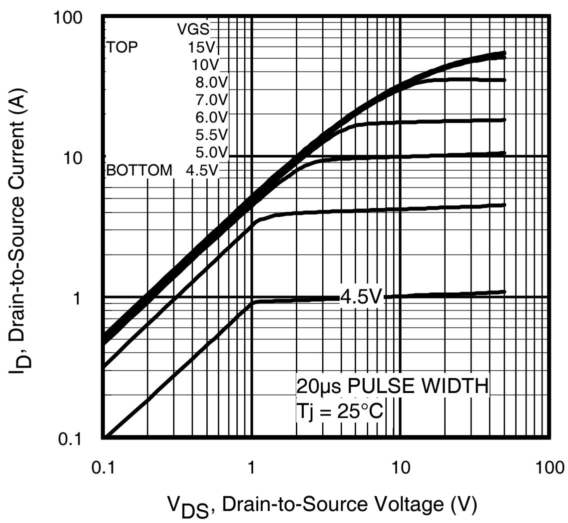


Fig 1. Typical Output Characteristics

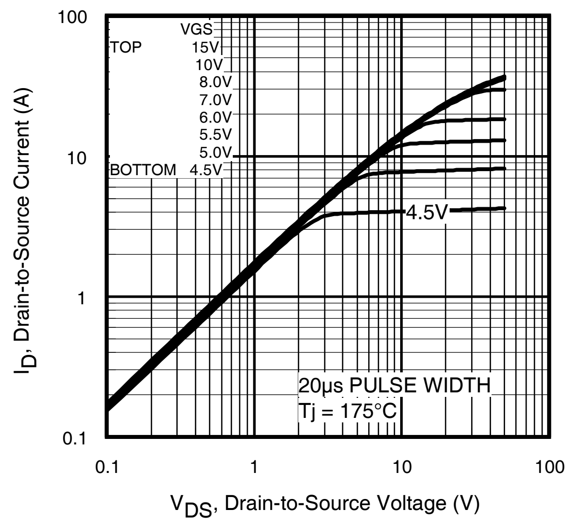


Fig 2. Typical Output Characteristics

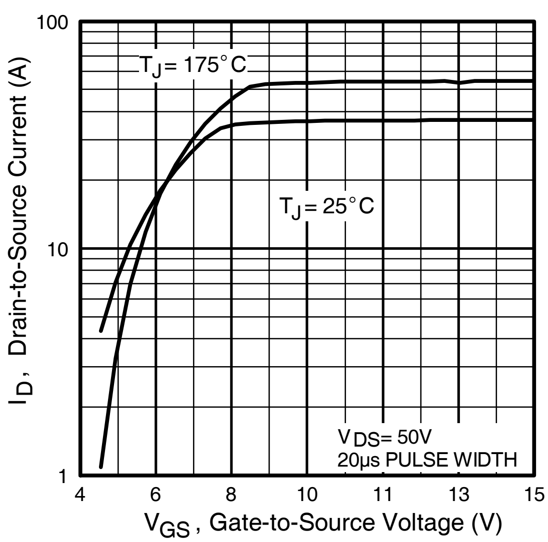


Fig 3. Typical Transfer Characteristics

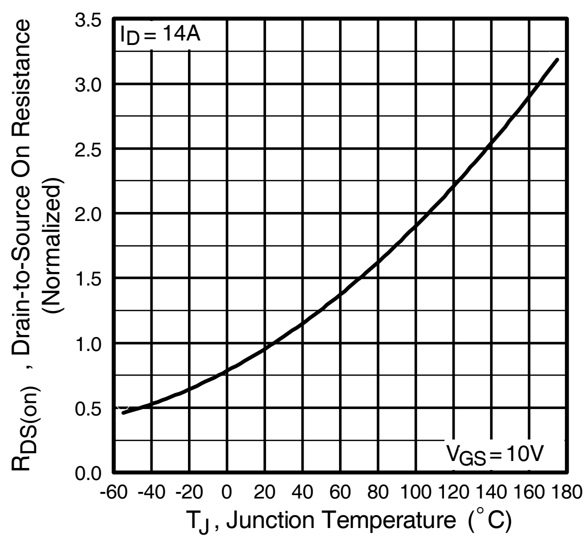


Fig 4. Normalized On-Resistance
Vs. Temperature

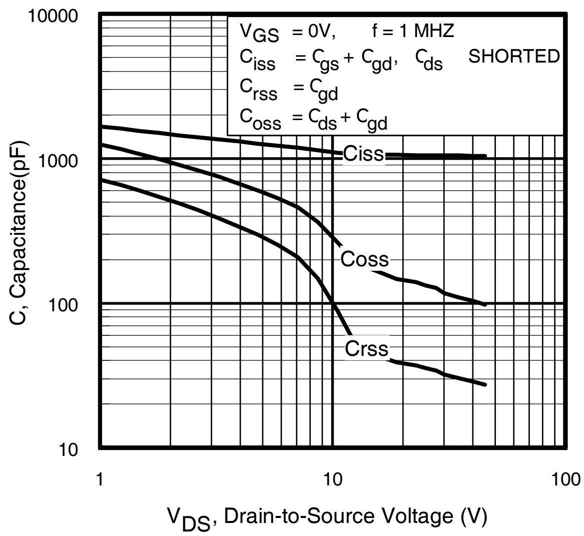


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

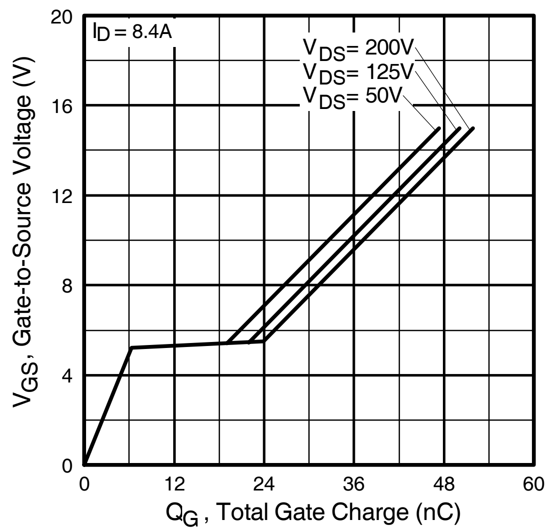


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

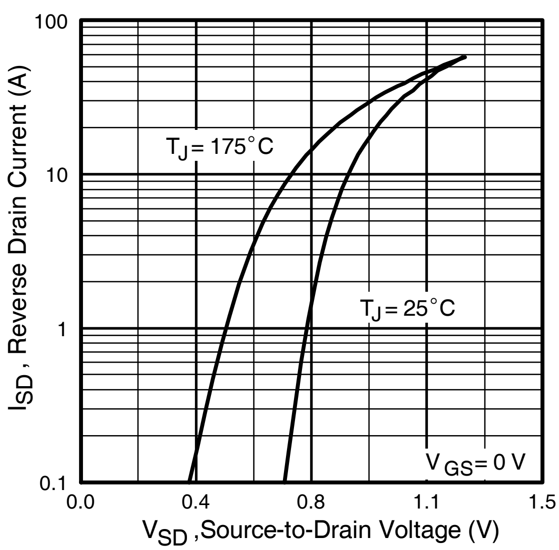


Fig 7. Typical Source-Drain Diode Forward Voltage

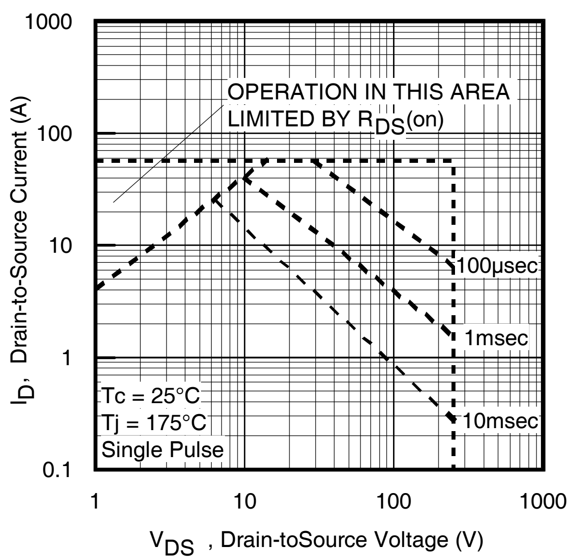


Fig 8. Maximum Safe Operating Area

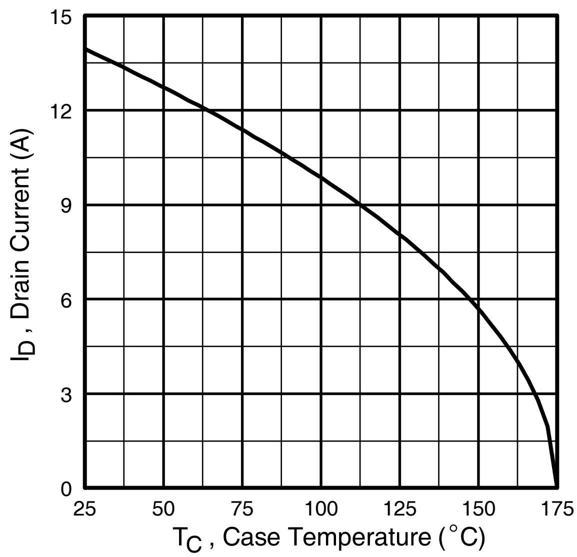


Fig 9. Maximum Drain Current Vs. Case Temperature

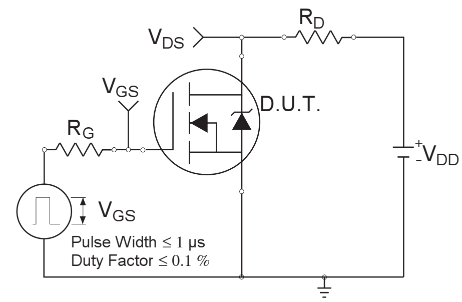


Fig 10a. Switching Time Test Circuit

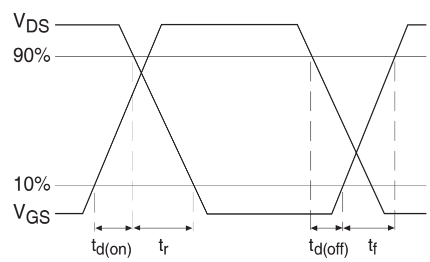


Fig 10b. Switching Time Waveforms

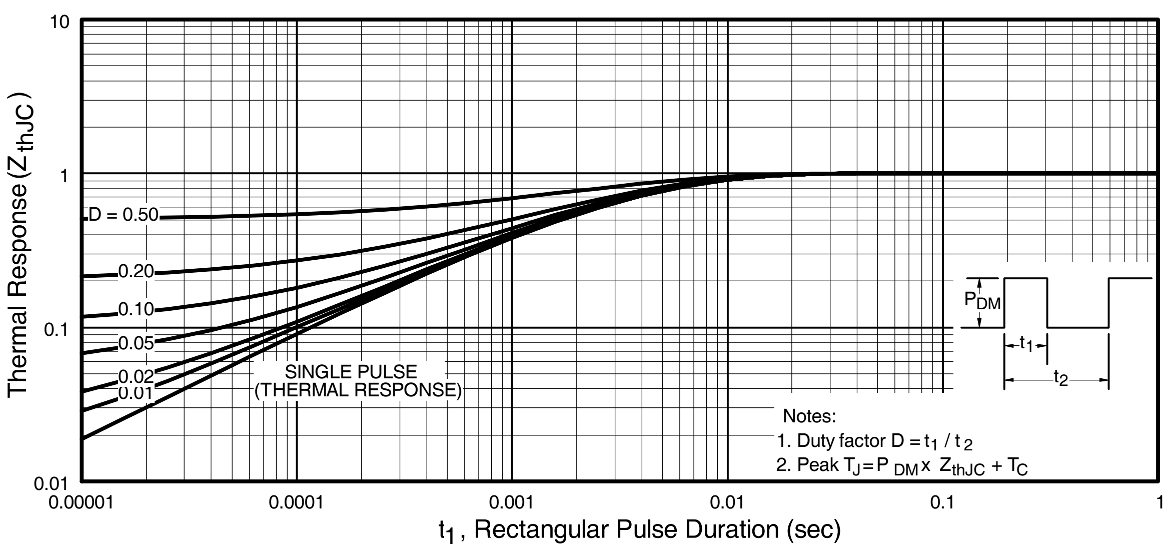


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

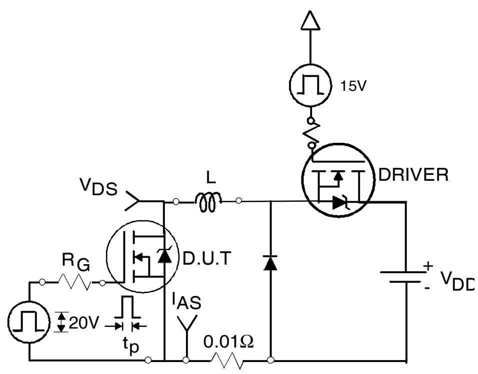


Fig 12a. Unclamped Inductive Test Circuit

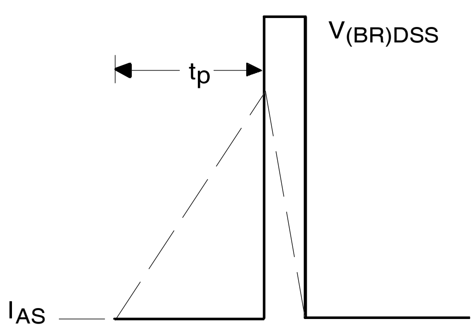


Fig 12b. Unclamped Inductive Waveforms

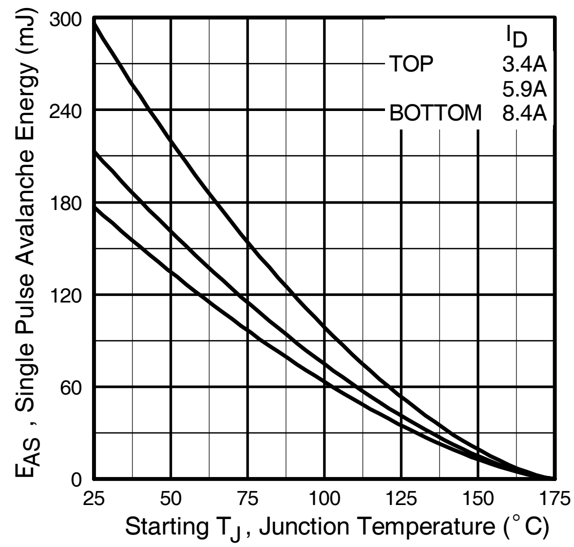


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

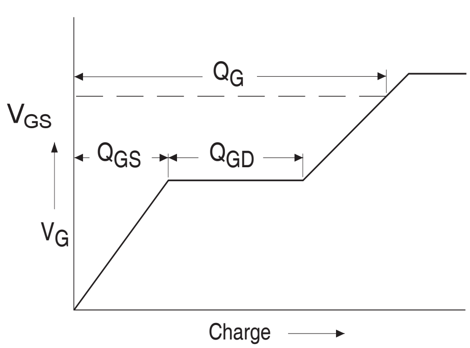


Fig 13a. Basic Gate Charge Waveform

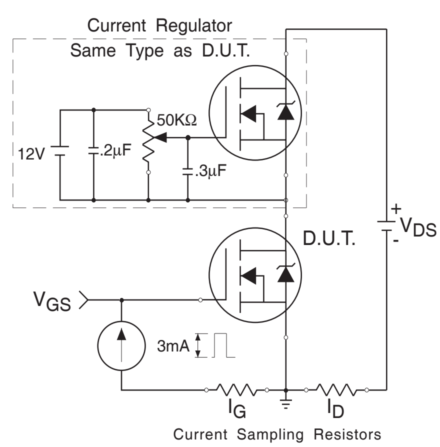
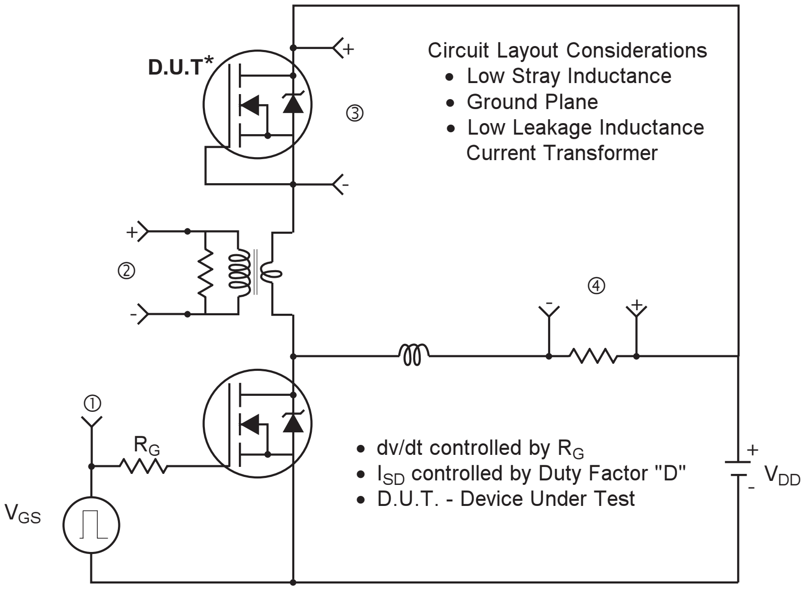
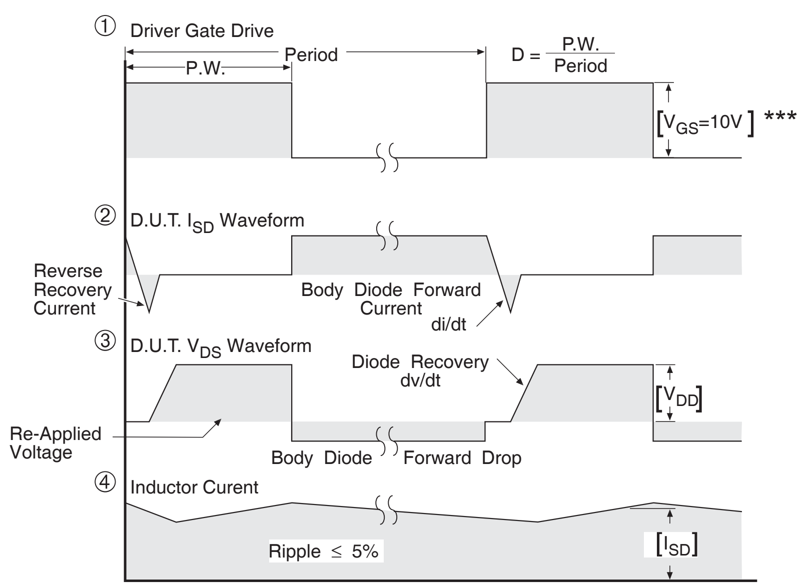


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



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

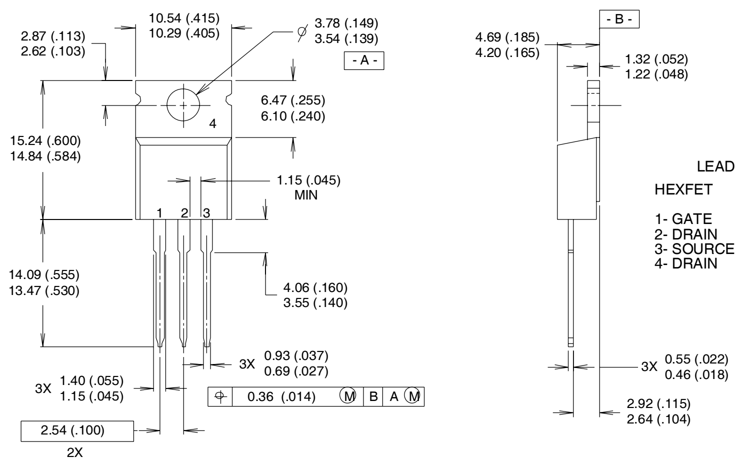


*** V_{GS} = 5.0V for Logic Level and 3V Drive Devices

Fig 14. For N-channel HEXFET® power MOSFETs

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



LEAD ASSIGNMENTS

HEXFET	IGBTs, CoPACK
1- GATE	1- GATE
2- DRAIN	2- COLLECTOR
3- SOURCE	3- EMITTER
4- DRAIN	4- COLLECTOR

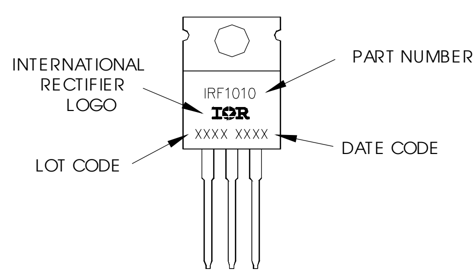
NOTES:

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

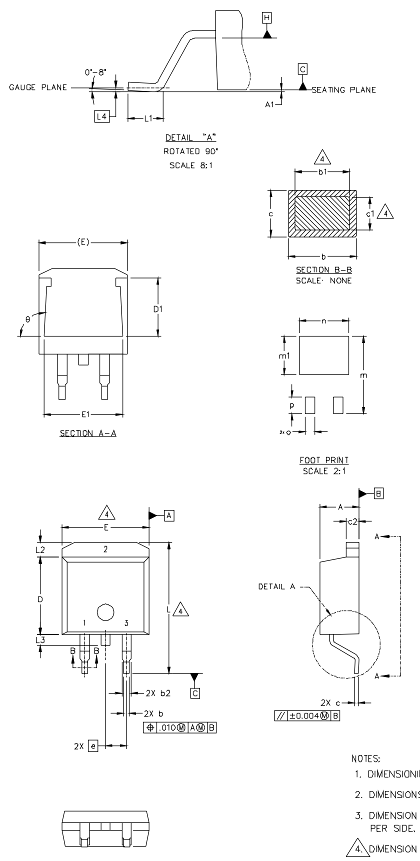
EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

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



D^2Pak Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	4
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	3
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

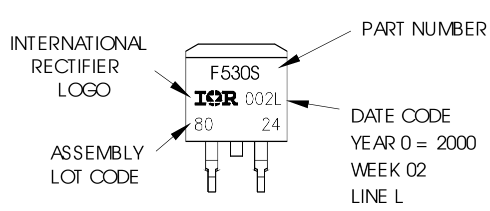
* PART DEPENDENT.

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.

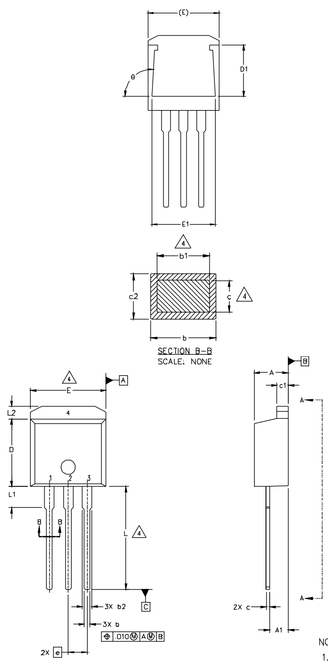
D^2Pak Part Marking Information

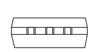
EXAMPLE: THIS IS AN IRF530S WITH
LOT CODE 8024
ASSEMBLED ON WW 02, 2000
IN THE ASSEMBLY LINE "L"



TO-262 Package Outline

Dimensions are shown in millimeters (inches)





SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	2.92	.080	.115	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.38	0.63	.015	.025	4
c1	1.14	1.40	.045	.055	
c2	0.43	.063	.017	.029	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
L	13.46	14.09	.530	.555	
L1	3.56	3.71	.140	.146	
L2		1.65		.065	

LEAD ASSIGNMENTS

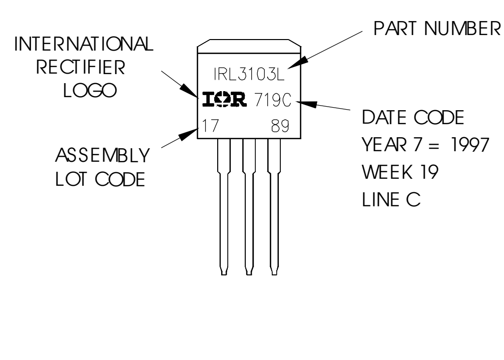
HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

IGBT
1 - GATE
2 - COLLECTOR
3 - EMITTER

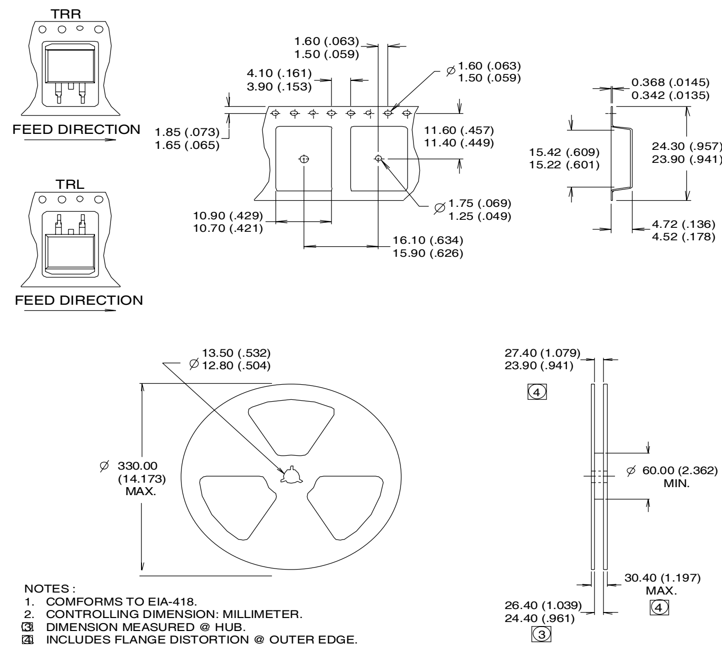
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"



D^2Pak Tape & Reel Information



Notes:

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
② Starting $T_J = 25°C$, $L = 5.0µH$ $R_G = 25Ω$, $I_{AS} = 8.4A$. (See Figure 12)
③ $I_{SD} \le 8.4A$, $di/dt \le 378A/µs$, $V_{DD} \le V_{(BR)DSS}$, $T_J \le 175°C$
④ Pulse width ≤ 400µs; duty cycle ≤ 2%.
⑤ This is a typical value at device destruction and represents operation outside rated limits.
⑥ This is a calculated value limited to $T_J = 175°C$.
⑦ This is only applied to TO-220AB package.

**When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint & soldering techniques refer to application note #AN-994.

Data and specifications subject to change without notice.
This product has been designed and qualified for the (IRF644NPbF) automotive [Q101] & (IRF644NS/L) industrial market.
Qualification Standards can be found on IR's Web site.

International
IGR Rectifier

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TAC Fax: (310) 252-7903
12/03

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