

International **IR** Rectifier

PD- 95234

IRL540NS/LPbF

HEXFET® Power MOSFET

- Advanced Process Technology
- Surface Mount (IRL540NS)
- Low-profile through-hole (IRL540NL)
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Lead-Free

Description

Fifth Generation HEXFETs 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 D²Pak 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 D²Pak 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 (IRF540NL) is available for low-profile applications.

Absolute Maximum Ratings

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ ①	36	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$ ①	26	
I_{DM}	Pulsed Drain Current ①②	120	
$P_D @ T_A = 25^\circ\text{C}$	Power Dissipation	3.8	W
$P_D @ T_C = 25^\circ\text{C}$	Power Dissipation	140	W
	Linear Derating Factor	0.91	W/ $^\circ\text{C}$
V_{GS}	Gate-to-Source Voltage	± 16	V
E_{AS}	Single Pulse Avalanche Energy②③	310	mJ
I_{AR}	Avalanche Current①	18	A
E_{AR}	Repetitive Avalanche Energy①	14	mJ
dv/dt	Peak Diode Recovery dv/dt ③④	5.0	V/ns
T_J	Operating Junction and	-55 to + 175	
T_{STG}	Storage Temperature Range	300 (1.6mm from case)	$^\circ\text{C}$
	Soldering Temperature, for 10 seconds		

Thermal Resistance

	Parameter	Typ.	Max.	Units
R_{thJC}	Junction-to-Case	—	1.1	$^\circ\text{C/W}$
R_{thJA}	Junction-to-Ambient (PCB Mounted,steady-state)**	—	40	

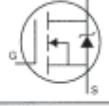
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Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	100	—	—	V	$V_{\text{GS}} = 0\text{V}$, $I_D = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{DSS}/\Delta T_J}$	Breakdown Voltage Temp. Coefficient	—	0.11	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1\text{mA}$ ③
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	—	0.044	Ω	$V_{\text{GS}} = 10\text{V}$, $I_D = 18\text{A}$ ④
		—	—	0.053		$V_{\text{GS}} = 5.0\text{V}$, $I_D = 18\text{A}$ ④
		—	—	0.063		$V_{\text{GS}} = 4.0\text{V}$, $I_D = 15\text{A}$ ④
$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	1.0	—	2.0	V	$V_{\text{DS}} = V_{\text{GS}}$, $I_D = 250\mu\text{A}$
g_{fs}	Forward Transconductance	14	—	—	S	$V_{\text{DS}} = 25\text{V}$, $I_D = 18\text{A}$ ⑤
I_{DSS}	Drain-to-Source Leakage Current	—	—	25	A	$V_{\text{DS}} = 100\text{V}$, $V_{\text{GS}} = 0\text{V}$
		—	—	250		$V_{\text{DS}} = 80\text{V}$, $V_{\text{GS}} = 0\text{V}$, $T_J = 150^\circ\text{C}$
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{\text{GS}} = 16\text{V}$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{\text{GS}} = -16\text{V}$
Q_g	Total Gate Charge	—	—	74	nC	$I_D = 18\text{A}$
Q_{gs}	Gate-to-Source Charge	—	—	9.4		$V_{\text{DS}} = 80\text{V}$
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	—	38		$V_{\text{GS}} = 5.0\text{V}$, See Fig. 6 and 13 ④⑤
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	—	11	ns	$V_{\text{DD}} = 50\text{V}$
t_r	Rise Time	—	—	81		$I_D = 18\text{A}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	—	39		$R_G = 5.0\Omega$, $V_{\text{GS}} = 5.0\text{V}$
t_f	Fall Time	—	—	62	ns	$R_D = 2.7\Omega$, See Fig. 10 ④⑤
L_s	Internal Source Inductance	—	—	7.5		Between lead, and center of die contact
C_{iss}	Input Capacitance	—	—	1800	pF	$V_{\text{GS}} = 0\text{V}$
C_{oss}	Output Capacitance	—	—	350		$V_{\text{DS}} = 25\text{V}$
C_{rss}	Reverse Transfer Capacitance	—	—	170		$f = 1.0\text{MHz}$, See Fig. 5③

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_s	Continuous Source Current (Body Diode)	—	—	36	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{sm}	Pulsed Source Current (Body Diode) ①⑤	—	—	120		
V_{SD}	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}$, $I_S = 18\text{A}$, $V_{\text{GS}} = 0\text{V}$ ④⑤
t_{rr}	Reverse Recovery Time	—	190	290	ns	$T_J = 25^\circ\text{C}$, $I_F = 18\text{A}$
Q_{rr}	Reverse Recovery Charge	—	1.1	1.7	μC	$di/dt = 100\text{A}/\mu\text{s}$ ④⑤
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 fig. 11)

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

② Starting $T_J = 25^\circ\text{C}$, $L = 1.9\text{mH}$
 $R_G = 25\Omega$, $I_{AS} = 18\text{A}$. (See Figure 12)

⑤ Uses IRL540N data and test conditions

③ $I_{SD} \leq 18\text{A}$, $di/dt \leq 180\text{A}/\mu\text{s}$, $V_{\text{DD}} \leq V_{(\text{BR})\text{DSS}}$, $T_J \leq 175^\circ\text{C}$

** When mounted on 1" square PCB (FR-4 or G-10 Material).

For recommended soldering techniques refer to application note #AN-994.

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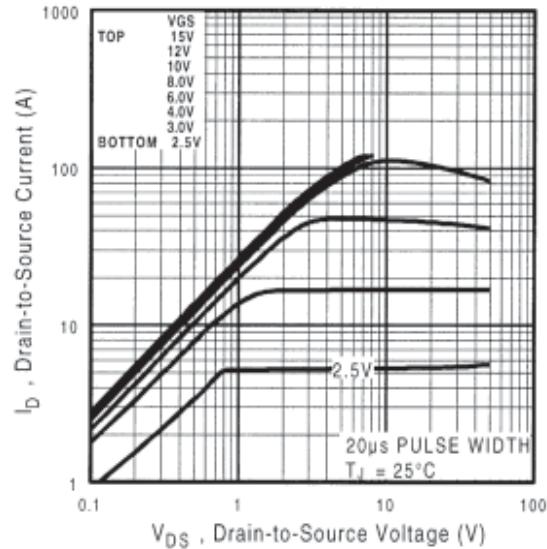


Fig 1. Typical Output Characteristics

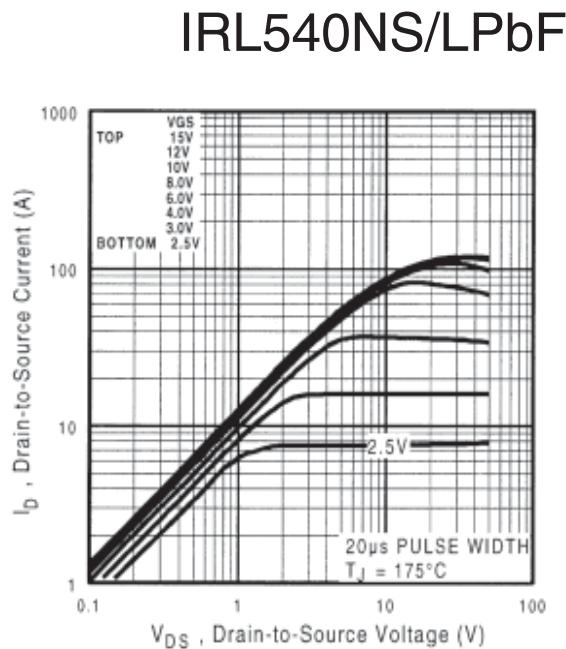


Fig 2. Typical Output Characteristics

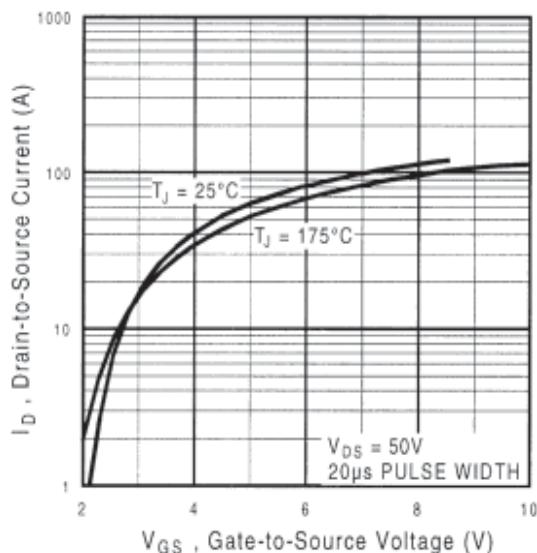


Fig 3. Typical Transfer Characteristics

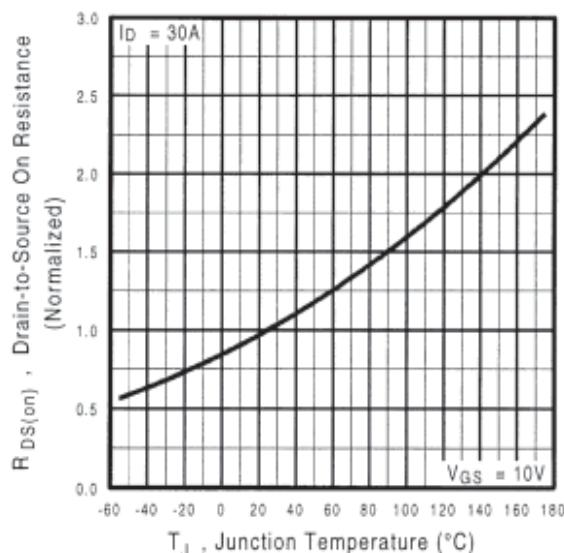


Fig 4. Normalized On-Resistance
Vs. Temperature

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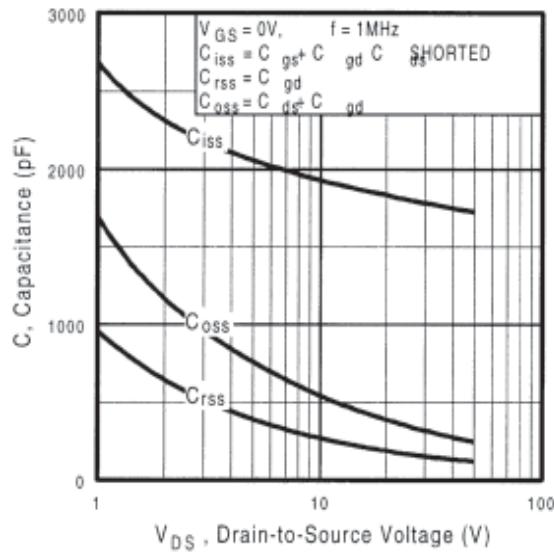


Fig 5. Typical Capacitance Vs.
Drain-to-Source Voltage

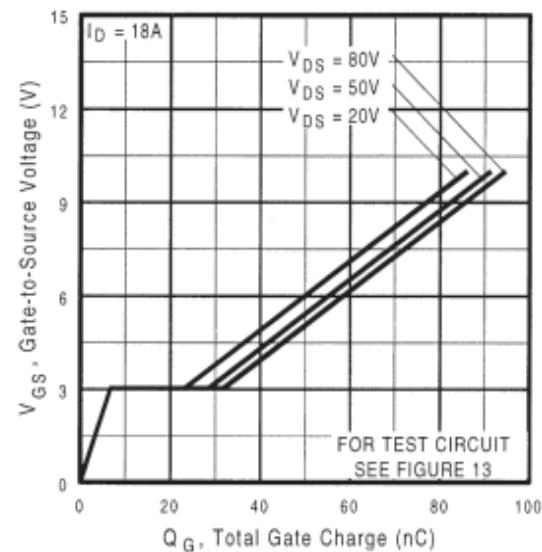


Fig 6. Typical Gate Charge Vs.
Gate-to-Source Voltage

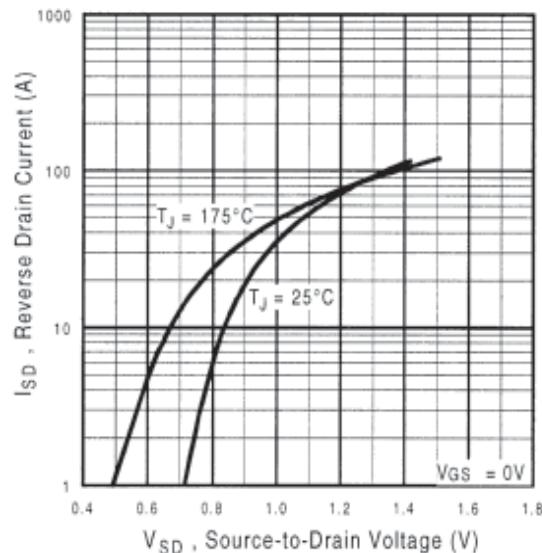


Fig 7. Typical Source-Drain Diode
Forward Voltage

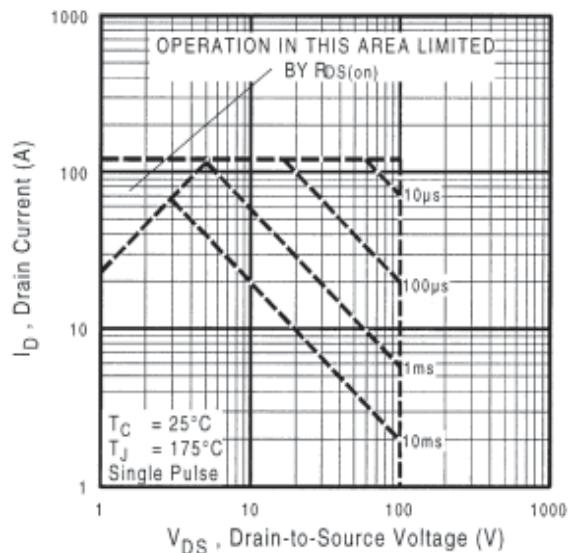


Fig 8. Maximum Safe Operating Area

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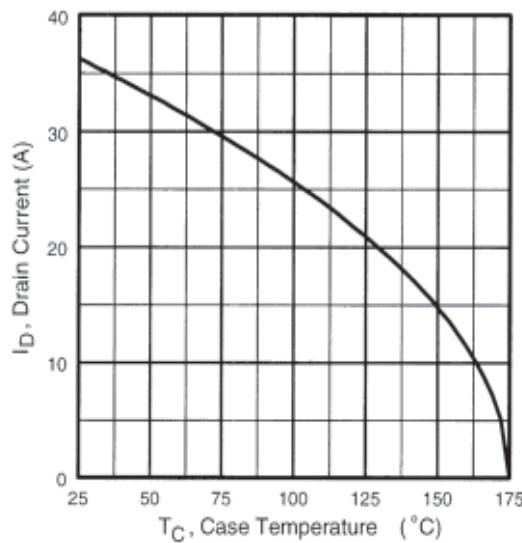


Fig 9. Maximum Drain Current Vs.
Case Temperature

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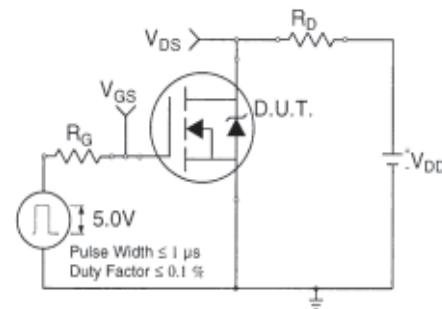


Fig 10a. Switching Time Test Circuit

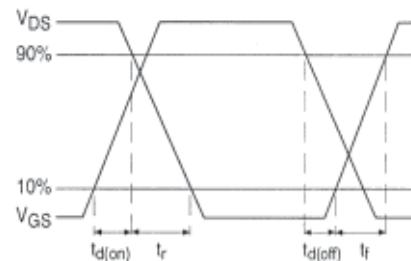


Fig 10b. Switching Time Waveforms

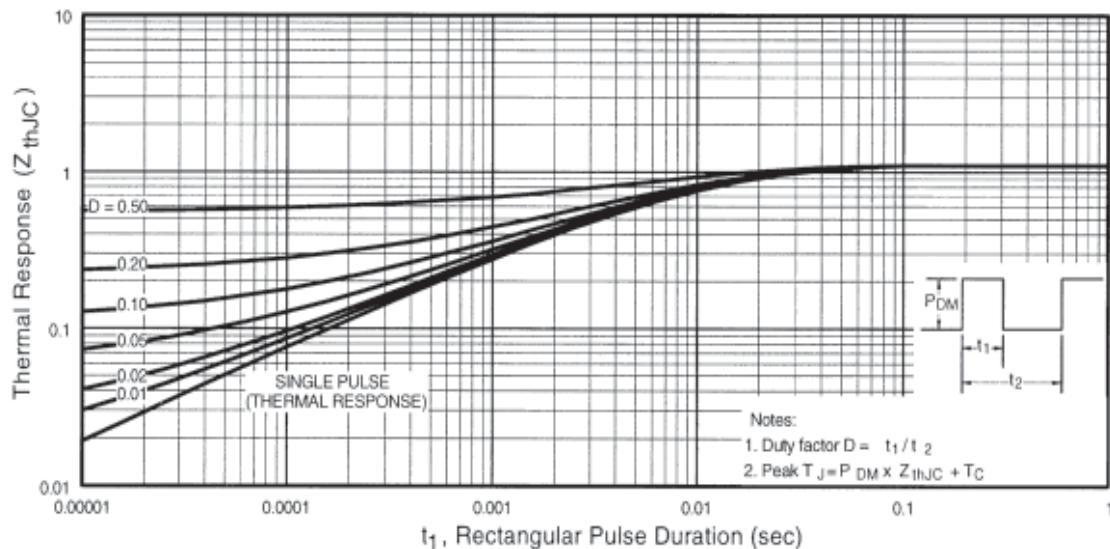


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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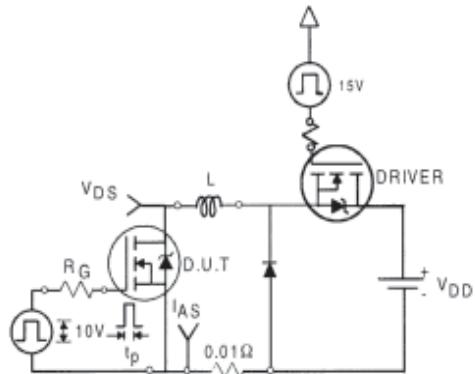


Fig 12a. Unclamped Inductive Test Circuit

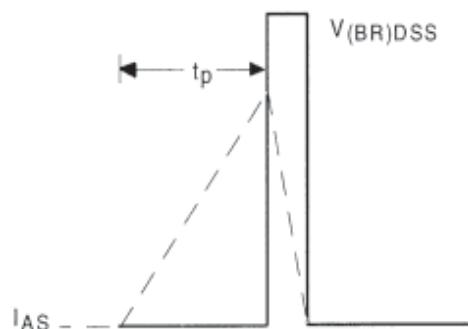


Fig 12b. Unclamped Inductive Waveforms

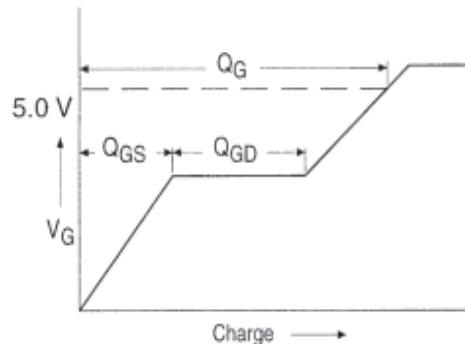


Fig 13a. Basic Gate Charge Waveform

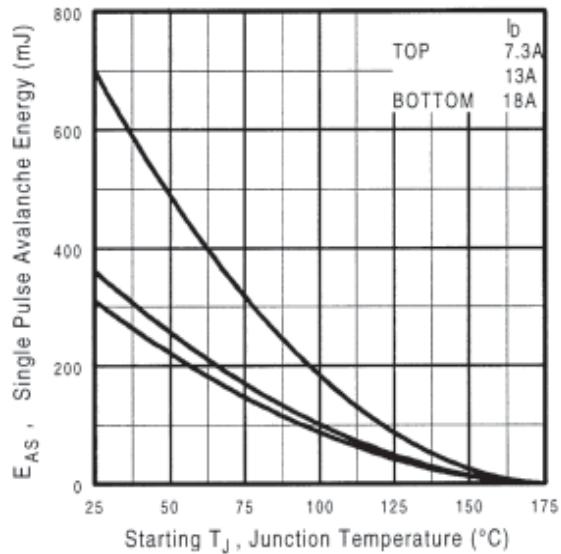


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

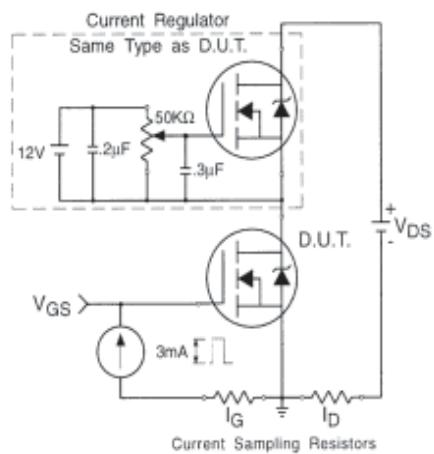
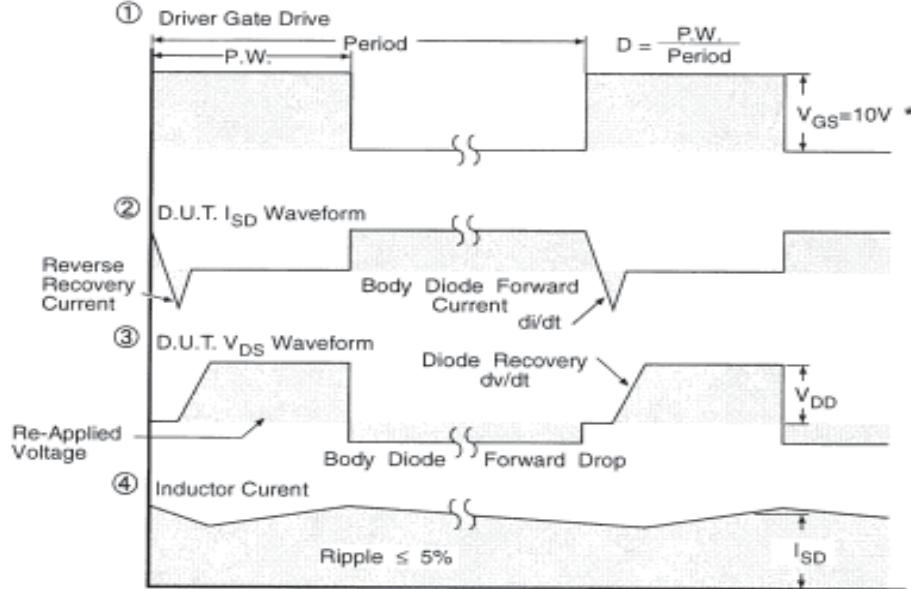
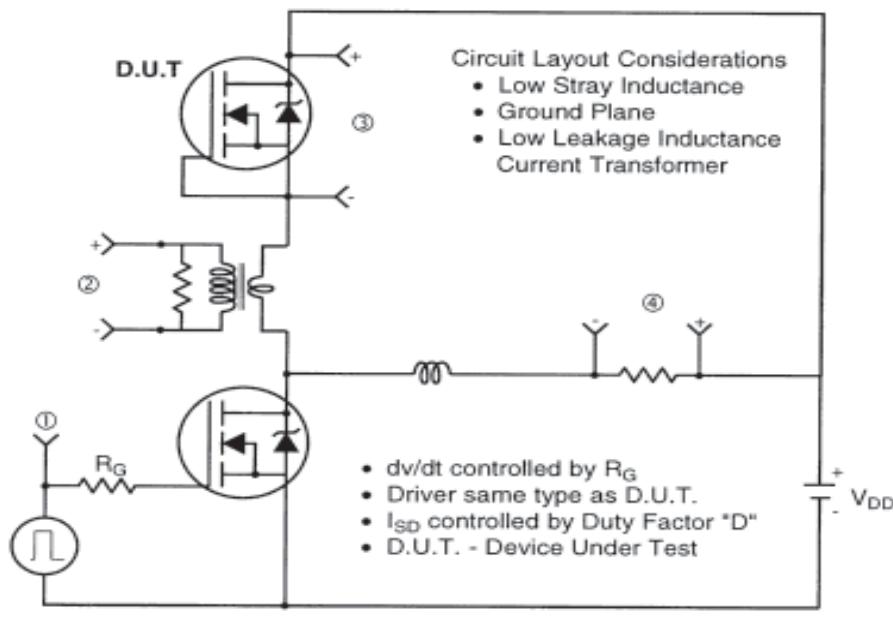


Fig 13b. Gate Charge Test Circuit

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Peak Diode Recovery dv/dt Test Circuit



* $V_{GS} = 5V$ for Logic Level Devices

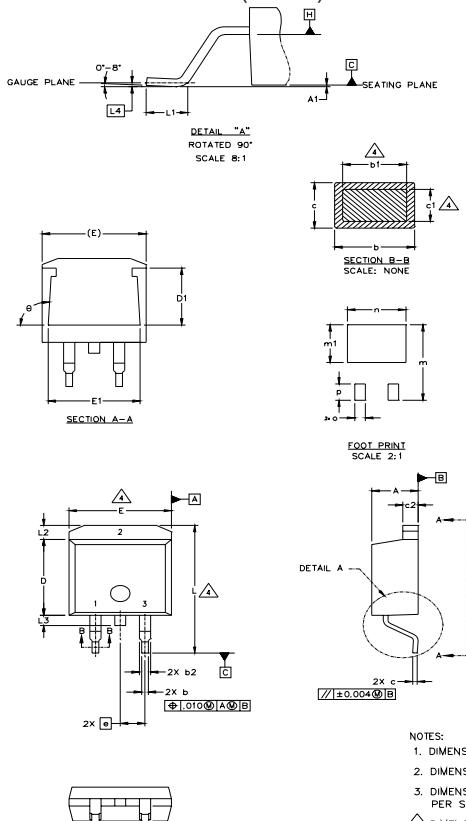
Fig 14. For N-Channel HEXFETs

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D²Pak 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

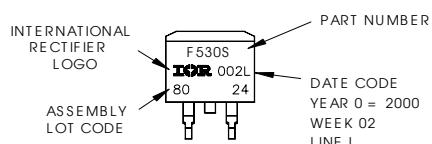
* PART DEPENDENT.

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.

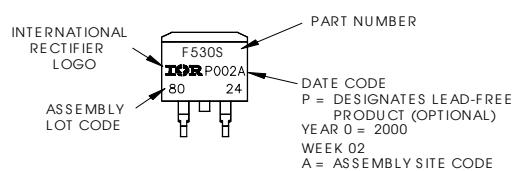
D²Pak Part Marking Information (Lead-Free)

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"



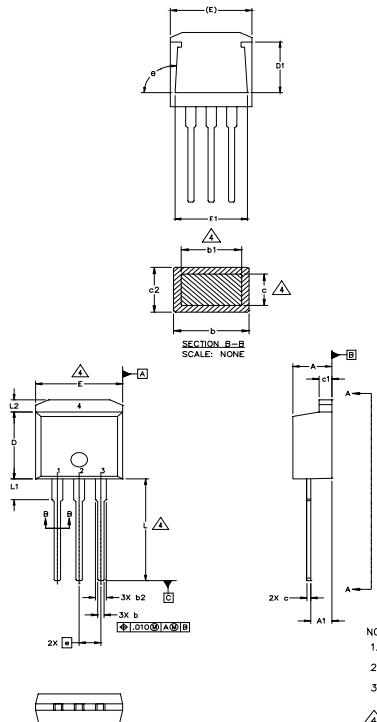
OR



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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

IGBT

1. - GATE	1 - GATE
2. - DRAIN	2 - COLLECTOR
3. - SOURCE	3 - Emitter
4. - DRAIN	

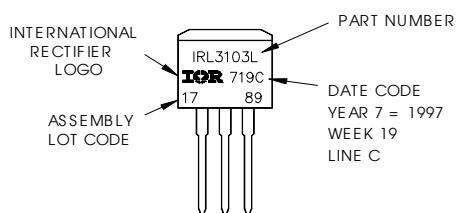
NOTES:

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

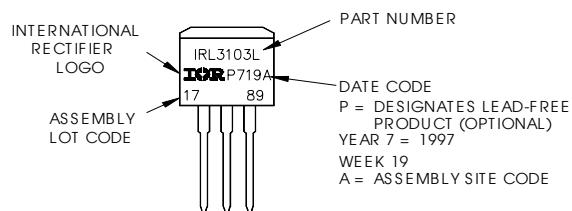
TO-262 Part Marking Information

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

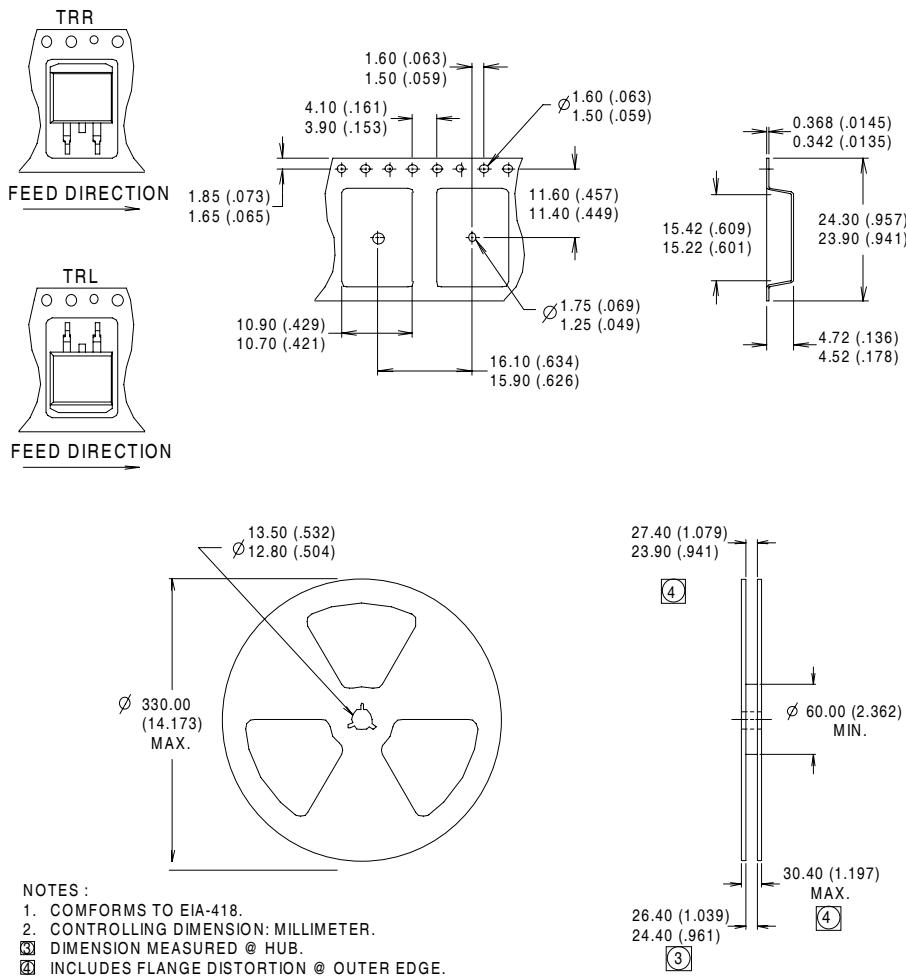


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D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)

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Data and specifications subject to change without notice.

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IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
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Note: For the most current drawings please refer to the IR website at:
<http://www.irf.com/package/>

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