

# International **IR** Rectifier

## SMPS MOSFET

PD - 93936A

IRF3706  
 IRF3706S  
 IRF3706L

HEXFET® Power MOSFET

### Applications

- High Frequency Isolated DC-DC Converters with Synchronous Rectification for Telecom and Industrial Use
- High Frequency Buck Converters for Computer Processor Power

### Benefits

- Ultra-Low Gate Impedance
- Very Low  $R_{DS(on)}$  at 4.5V  $V_{GS}$
- Fully Characterized Avalanche Voltage and Current

$V_{DSS}$	$R_{DS(on)}$ max	$I_D$
20V	8.5mΩ	77A



### Absolute Maximum Ratings

Symbol	Parameter	Max.	Units
$V_{DS}$	Drain-Source Voltage	20	V
$V_{GS}$	Gate-to-Source Voltage	± 12	V
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	77	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	54	
$I_{DM}$	Pulsed Drain Current <sup>①</sup>	280	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation <sup>③</sup>	88	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation <sup>③</sup>	44	W
	Linear Derating Factor	0.59	W/°C
$T_J, T_{STG}$	Junction and Storage Temperature Range	-55 to + 175	°C

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	1.7	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface <sup>④</sup>	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient <sup>④</sup>	—	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB mount) <sup>⑤</sup>	—	40	

Notes ① through ⑤ are on page 11

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	20	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.021	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}, I_D = 1mA$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	6.0	8.5	m $\Omega$	$V_{GS} = 10V, I_D = 36A$ ③
		—	7.3	10.5		$V_{GS} = 4.5V, I_D = 28A$ ③
		—	11	22		$V_{GS} = 2.8V, I_D = 18A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	0.6	—	2.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	20	$\mu A$	$V_{DS} = 16V, V_{GS} = 0V$
		—	—	100		$V_{DS} = 16V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{GS} = 12V$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{GS} = -12V$

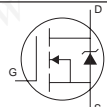
## Dynamic @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$g_{fs}$	Forward Transconductance	53	—	—	S	$V_{DS} = 16V, I_D = 57A$
$Q_g$	Total Gate Charge	—	23	35	nC	$I_D = 28A$
$Q_{gs}$	Gate-to-Source Charge	—	8.0	12		$V_{DS} = 10V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	5.5	8.3		$V_{GS} = 4.5V$ ③
$Q_{oss}$	Output Gate Charge	—	16	24		$V_{GS} = 0V, V_{DS} = 10V$
$t_{d(on)}$	Turn-On Delay Time	—	6.8	—	ns	$V_{DD} = 10V$
$t_r$	Rise Time	—	87	—		$I_D = 28A$
$t_{d(off)}$	Turn-Off Delay Time	—	17	—		$R_G = 1.8\Omega$
$t_f$	Fall Time	—	4.8	—		$V_{GS} = 4.5V$ ③
$C_{iss}$	Input Capacitance	—	2410	—		$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	1070	—	$pF$	$V_{DS} = 10V$
$C_{rss}$	Reverse Transfer Capacitance	—	140	—		$f = 1.0MHz$

## Avalanche Characteristics

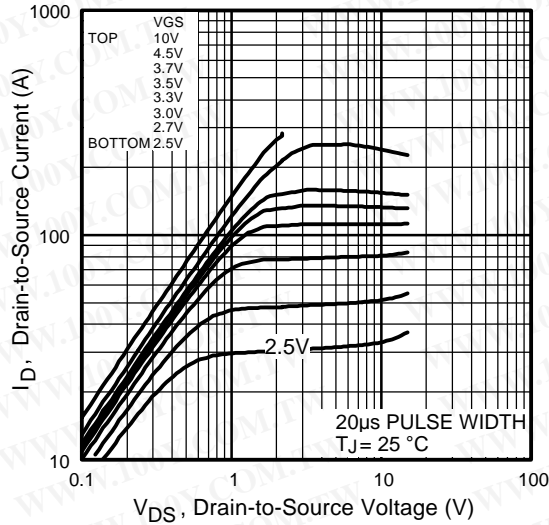
Symbol	Parameter	Typ.	Max.	Units
$E_{AS}$	Single Pulse Avalanche Energy②	—	220	mJ
$I_{AR}$	Avalanche Current①	—	28	A

## Diode Characteristics

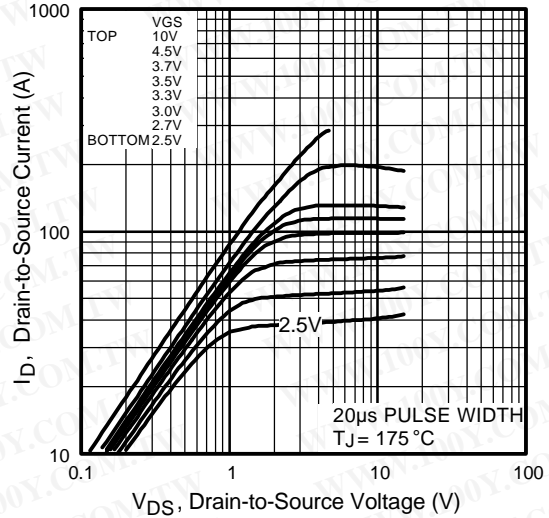
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	77	A	MOSFET symbol showing the integral reverse p-n junction diode. 
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	280		
$V_{SD}$	Diode Forward Voltage	—	0.88	1.3	V	$T_J = 25^\circ\text{C}, I_S = 36A, V_{GS} = 0V$ ③
		—	0.82	—		$T_J = 125^\circ\text{C}, I_S = 36A, V_{GS} = 0V$ ③
$t_{rr}$	Reverse Recovery Time	—	45	68	ns	$T_J = 25^\circ\text{C}, I_F = 36A, V_R = 20V$
$Q_{rr}$	Reverse Recovery Charge	—	65	98	nC	$di/dt = 100A/\mu s$ ③
$t_{rr}$	Reverse Recovery Time	—	49	74	ns	$T_J = 125^\circ\text{C}, I_F = 36A, V_R = 20V$
$Q_{rr}$	Reverse Recovery Charge	—	78	120	nC	$di/dt = 100A/\mu s$ ③

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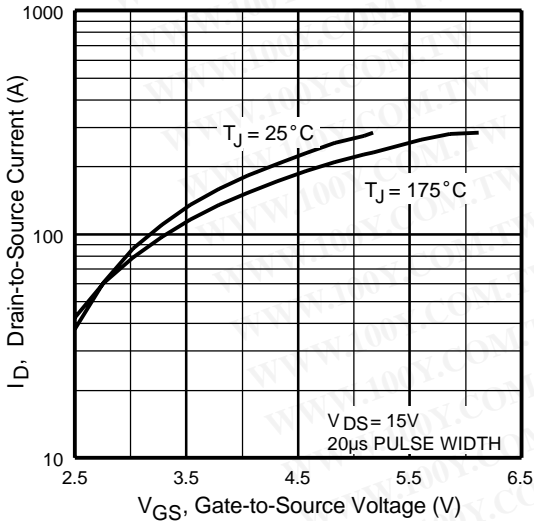
# IRF3706/3706S/3706L



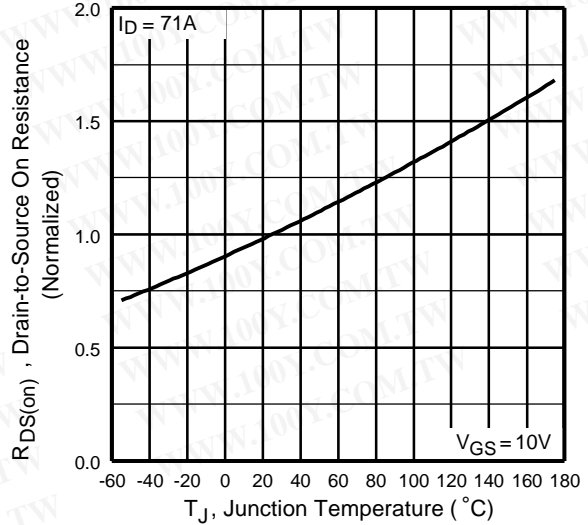
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



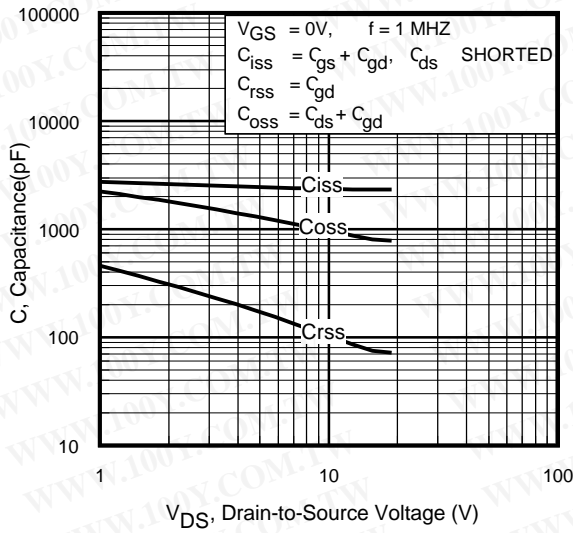
**Fig 3.** Typical Transfer Characteristics



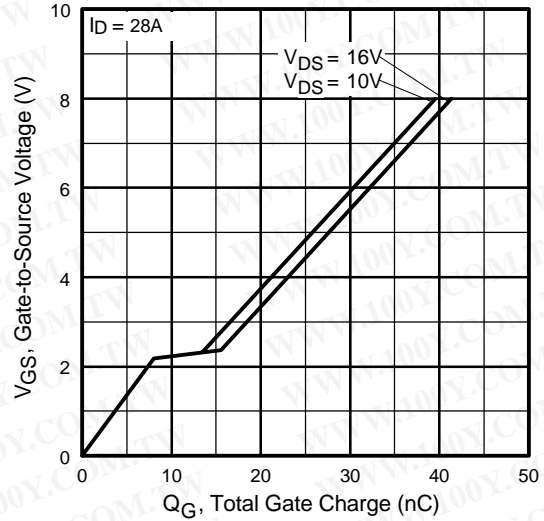
**Fig 4.** Normalized On-Resistance Vs. Temperature

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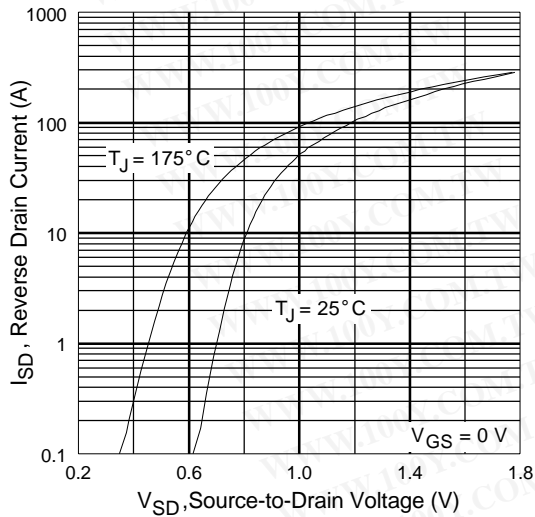
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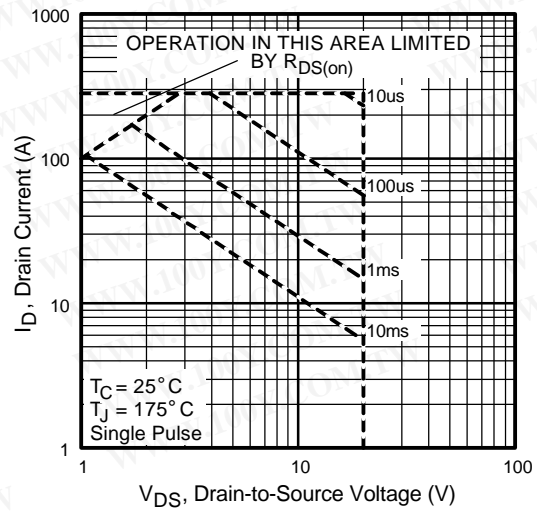
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



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



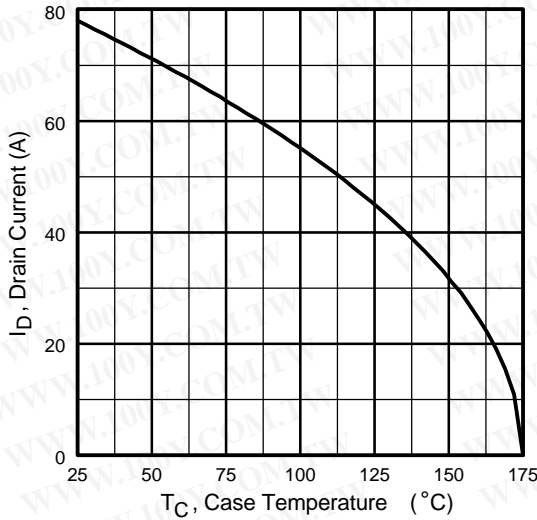
**Fig 7.** Typical Source-Drain Diode Forward Voltage



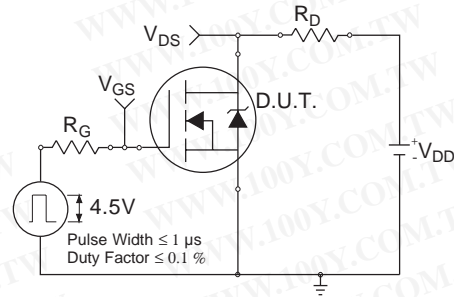
**Fig 8.** Maximum Safe Operating Area

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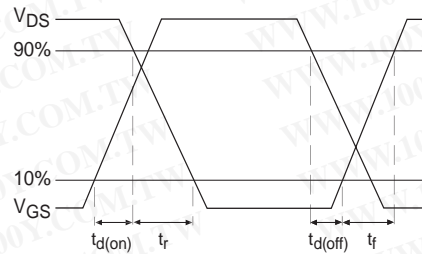
# IRF3706/3706S/3706L



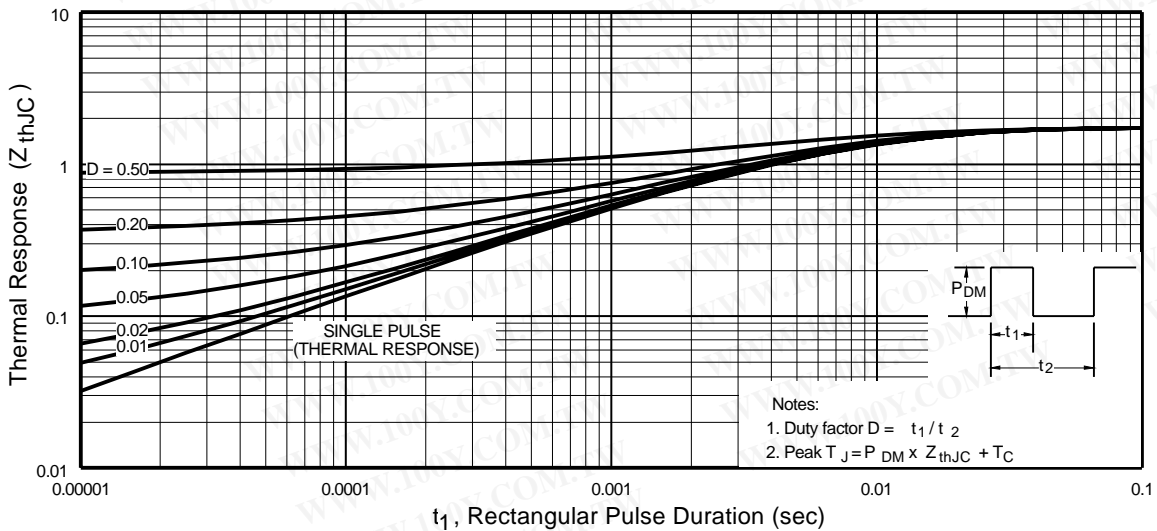
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



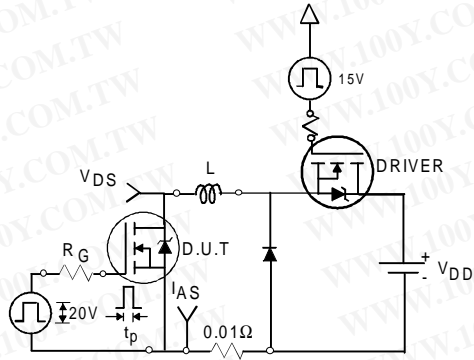
**Fig 10b.** Switching Time Waveforms



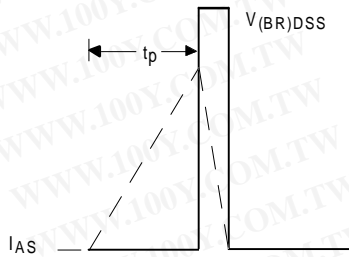
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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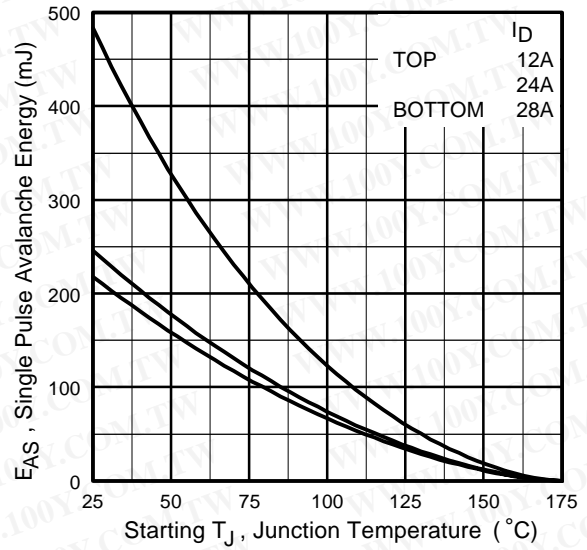
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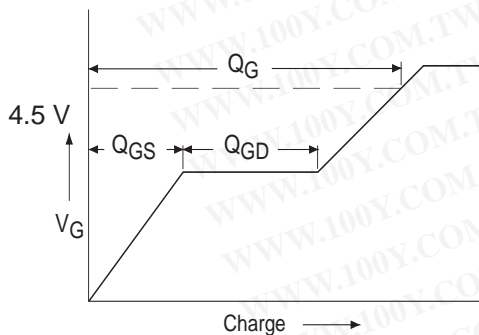
**Fig 12a.** Unclamped Inductive Test Circuit



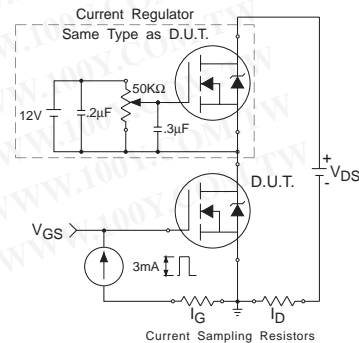
**Fig 12b.** Unclamped Inductive Waveforms



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



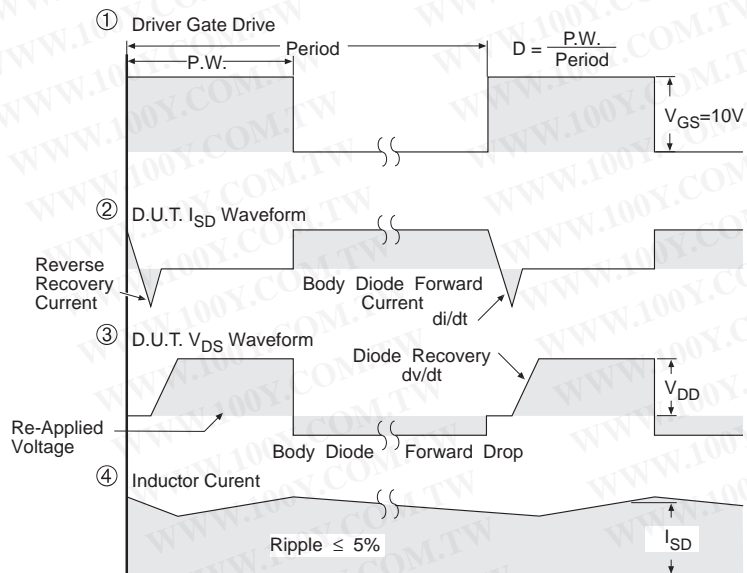
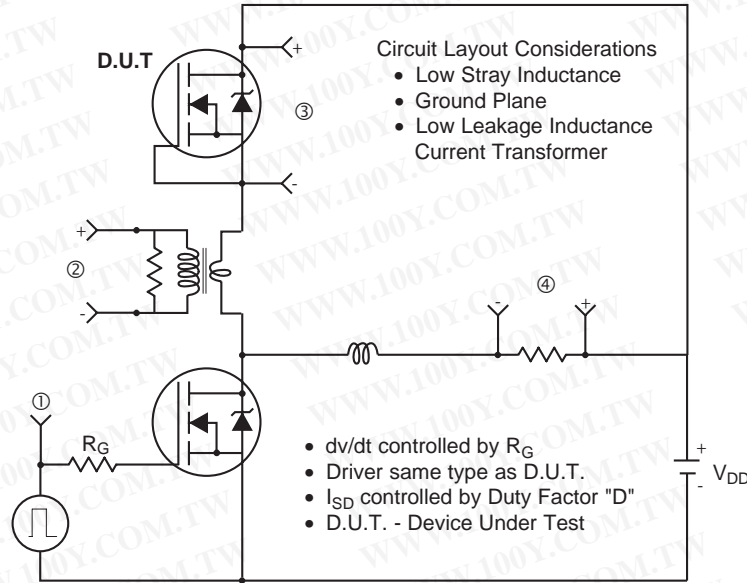
**Fig 13a.** Basic Gate Charge Waveform



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

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## Peak Diode Recovery dv/dt Test Circuit



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

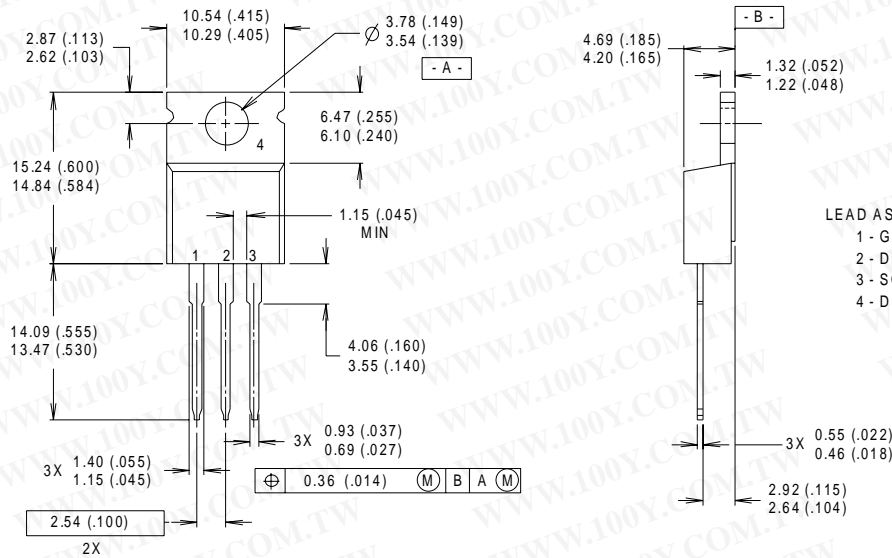
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

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## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



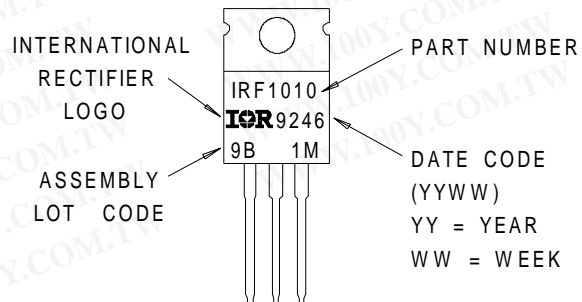
**NOTES:**

- 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  
WITH ASSEMBLY  
LOT CODE 9B1M

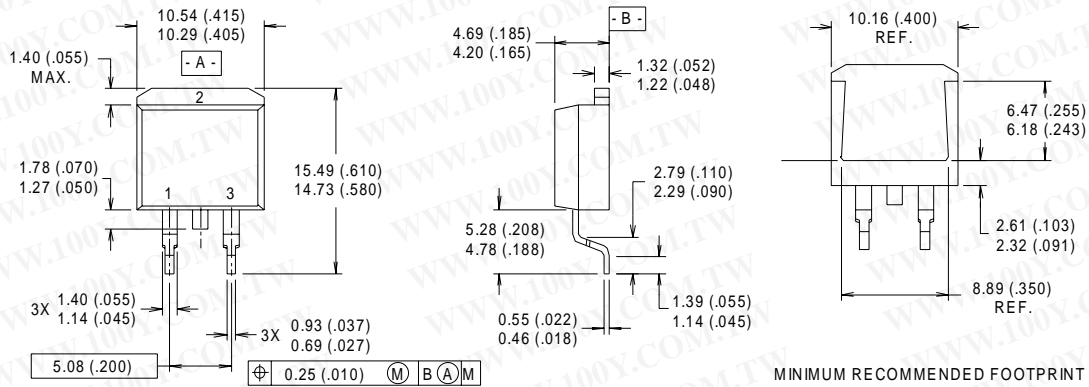




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## D<sup>2</sup>Pak Package Outline

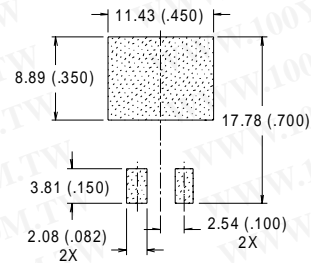


**NOTES:**

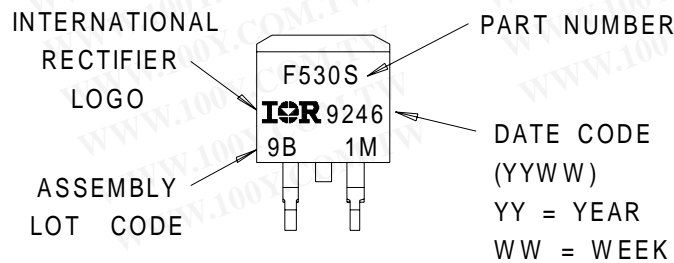
- 1 DIMENSIONS AFTER SOLDER DIP.
- 2 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 3 CONTROLLING DIMENSION : INCH.
- 4 HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

**LEAD ASSIGNMENTS**

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



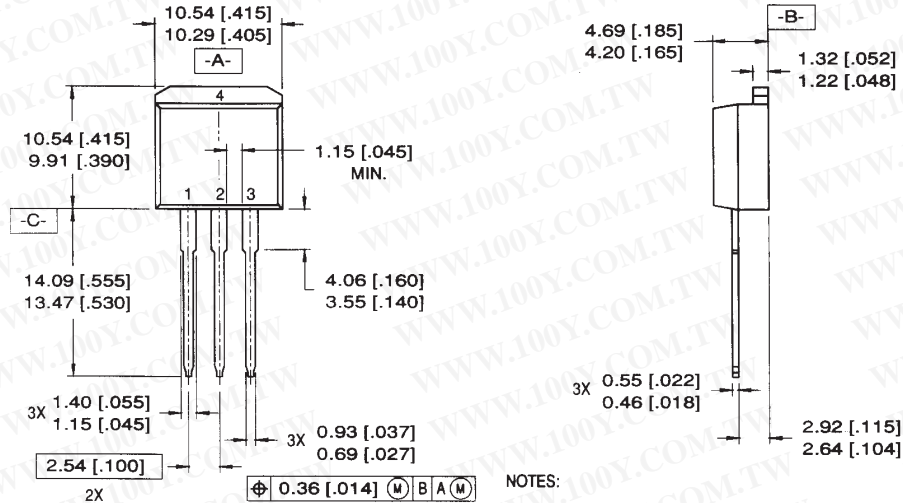
## D<sup>2</sup>Pak Part Marking Information



# IRF3706/3706S/3706L

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## TO-262 Package Outline



### LEAD ASSIGNMENTS

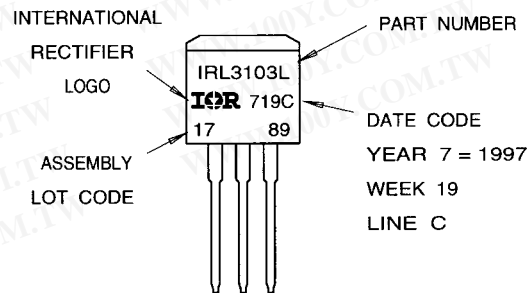
- |           |            |
|-----------|------------|
| 1 = GATE  | 3 = SOURCE |
| 2 = DRAIN | 4 = DRAIN  |

### NOTES:

1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

## TO-262 Part Marking Information

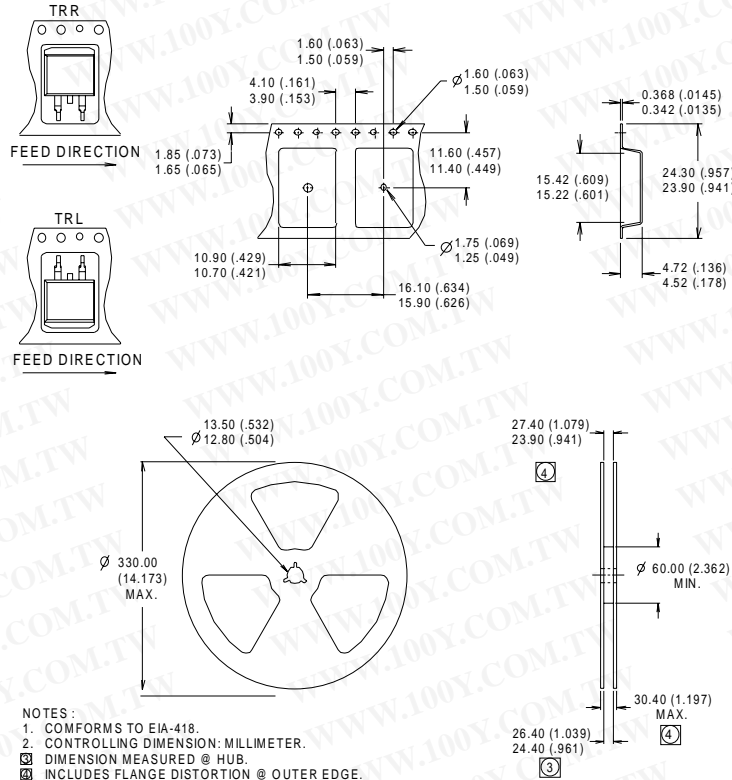
EXAMPLE: THIS IS AN IRL3103L  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"



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



**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.54\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 28\text{A}$ .
- 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.

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**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
**IR EUROPEAN REGIONAL CENTER:** 439/445 Godstone Rd, Whyteleafe, Surrey CR3 OBL, UK Tel: ++ 44 (0)20 8645 8000  
**IR CANADA:** 15 Lincoln Court, Brampton, Ontario L6T3Z2, Tel: (905) 453 2200  
**IR GERMANY:** Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 (0) 6172 96590  
**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 011 451 0111  
**IR JAPAN:** K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo 171 Tel: 81 (0)3 3983 0086  
**IR SOUTHEAST ASIA:** 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: ++ 65 (0)838 4630  
**IR TAIWAN:** 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673 Tel: 886-(0)2 2377 9936

Data and specifications subject to change without notice. 7/00