

# International **IR** Rectifier

## SMPS MOSFET

PD- 93903

IRFB33N15D  
 IRFS33N15D  
 IRFSL33N15D

HEXFET® Power MOSFET

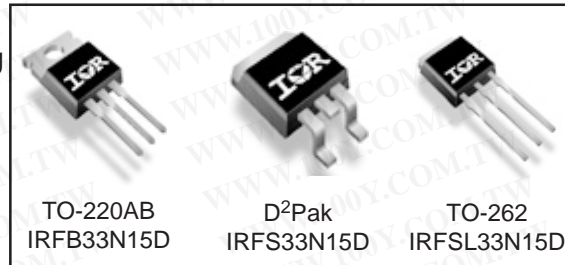
### Applications

- High frequency DC-DC converters

$V_{DSS}$	$R_{DS(on)}$ max	$I_D$
150V	0.056Ω	33A

### Benefits

- Low Gate-to-Drain Charge to Reduce Switching Losses
- Fully Characterized Capacitance Including Effective  $C_{OSS}$  to Simplify Design, (See App. Note AN1001)
- Fully Characterized Avalanche Voltage and Current



### Absolute Maximum Ratings

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	33	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	24	
$I_{DM}$	Pulsed Drain Current ①	130	
$P_D @ T_A = 25^\circ\text{C}$	Power Dissipation ②	3.8	W
$P_D @ T_C = 25^\circ\text{C}$	Power Dissipation	170	
	Linear Derating Factor	1.1	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 30$	V
dv/dt	Peak Diode Recovery dv/dt ③	4.4	V/ns
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds		
	Mounting torque, 6-32 or M3 screw④	10 lbf•in (1.1N•m)	

### Typical SMPS Topologies

- Telecom 48V input Active Clamp Forward Converter

Notes ① through ④ are on page 11

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# IRFB/IRFS/IRFSL33N15D

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

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	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	150	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.18	—	$V/^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$ ④
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.056	$\Omega$	$V_{GS} = 10V, I_D = 20A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	3.0	—	5.5	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	25	$\mu A$	$V_{DS} = 150V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 120V, V_{GS} = 0V, T_J = 150^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 30V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -30V$

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$g_{fs}$	Forward Transconductance	14	—	—	S	$V_{DS} = 50V, I_D = 20A$
$Q_g$	Total Gate Charge	—	60	90	nC	$I_D = 20A$ $V_{DS} = 120V$ $V_{GS} = 10V, \text{④⑥}$
$Q_{gs}$	Gate-to-Source Charge	—	17	26		
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	27	41		
$t_{d(on)}$	Turn-On Delay Time	—	13	—		
$t_r$	Rise Time	—	38	—	ns	$V_{DD} = 75V$ $I_D = 20A$ $R_G = 3.6\Omega$ $V_{GS} = 10V, \text{④}$
$t_{d(off)}$	Turn-Off Delay Time	—	23	—		
$t_f$	Fall Time	—	21	—		
$C_{iss}$	Input Capacitance	—	2020	—	pF	$V_{GS} = 0V$ $V_{DS} = 25V$ $f = 1.0\text{MHz}$ ⑥
$C_{oss}$	Output Capacitance	—	400	—		
$C_{rss}$	Reverse Transfer Capacitance	—	91	—		
$C_{oss}$	Output Capacitance	—	2440	—		
$C_{oss}$	Output Capacitance	—	180	—		
$C_{oss\text{ eff.}}$	Effective Output Capacitance	—	320	—		

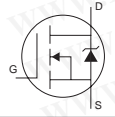
## Avalanche Characteristics

	Parameter	Typ.	Max.	Units
$E_{AS}$	Single Pulse Avalanche Energy ②⑥	—	330	mJ
$I_{AR}$	Avalanche Current ①	—	20	A
$E_{AR}$	Repetitive Avalanche Energy ①	—	17	mJ

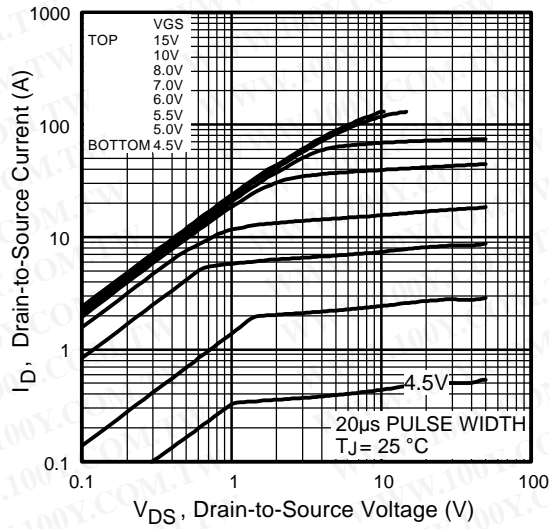
## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	0.90	$^\circ\text{C/W}$
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface ⑥	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient ⑥	—	62	
$R_{\theta JA}$	Junction-to-Ambient ⑦	—	40	

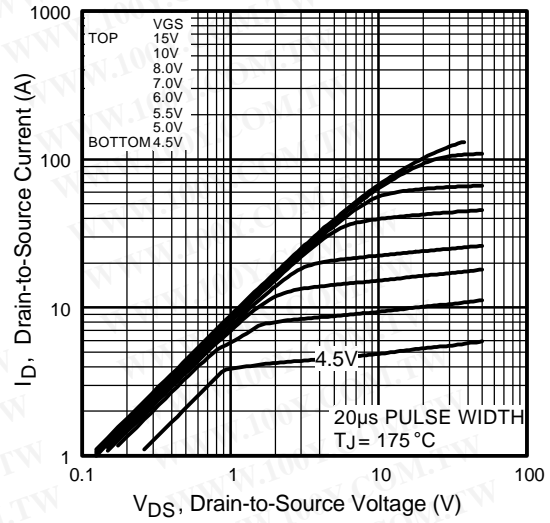
## Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	33	A	MOSFET symbol showing the integral reverse p-n junction diode. 
$I_{SM}$	Pulsed Source Current (Body Diode) ①⑥	—	—	130		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}, I_S = 20A, V_{GS} = 0V$ ④
$t_{rr}$	Reverse Recovery Time	—	150	—	ns	$T_J = 25^\circ\text{C}, I_F = 20A$
$Q_{rr}$	Reverse Recovery Charge	—	920	—	nC	$di/dt = 100A/\mu s$ ④
$t_{on}$	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ )				

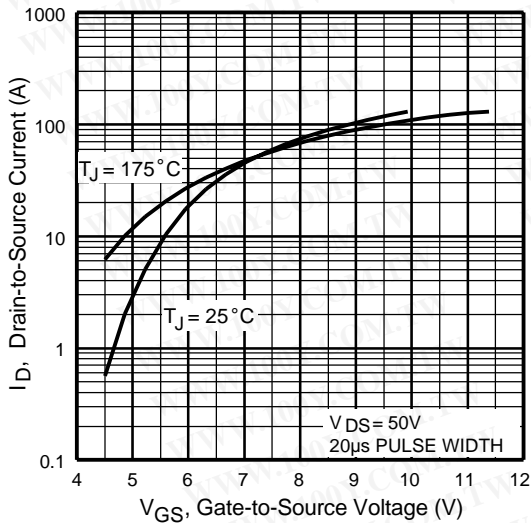
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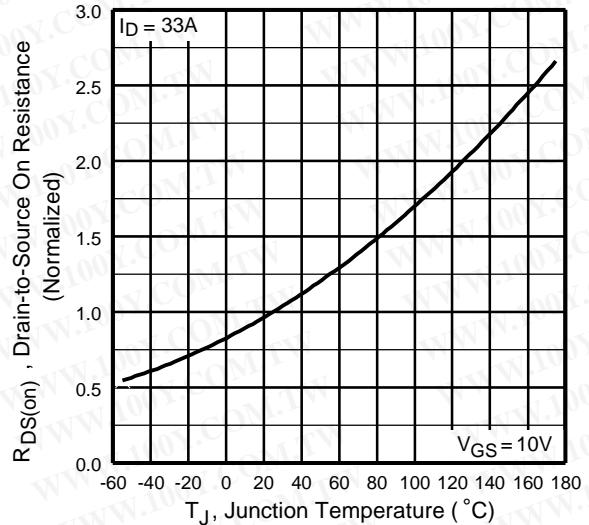
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



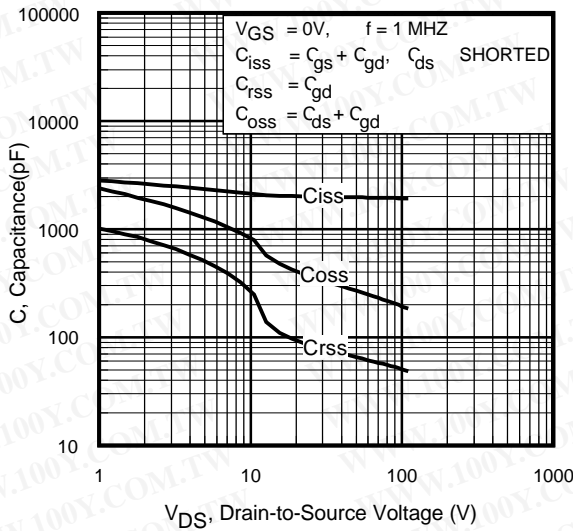
**Fig 3.** Typical Transfer Characteristics



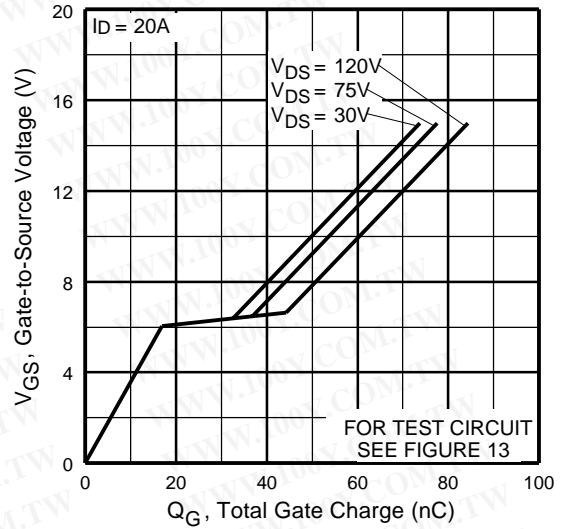
**Fig 4.** Normalized On-Resistance Vs. Temperature

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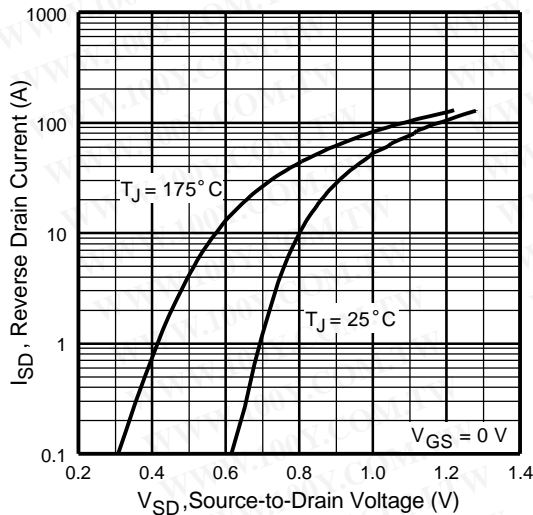
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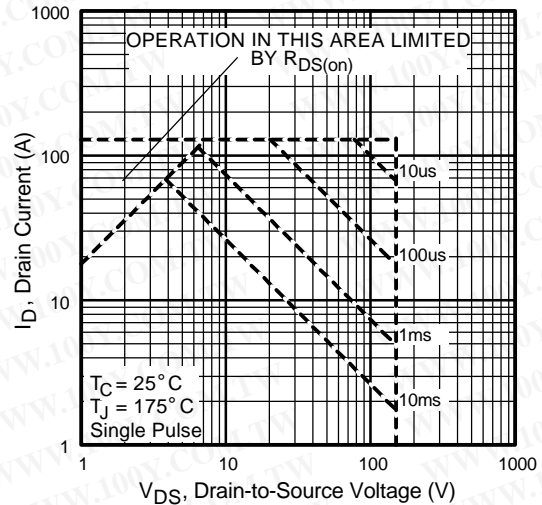
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



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

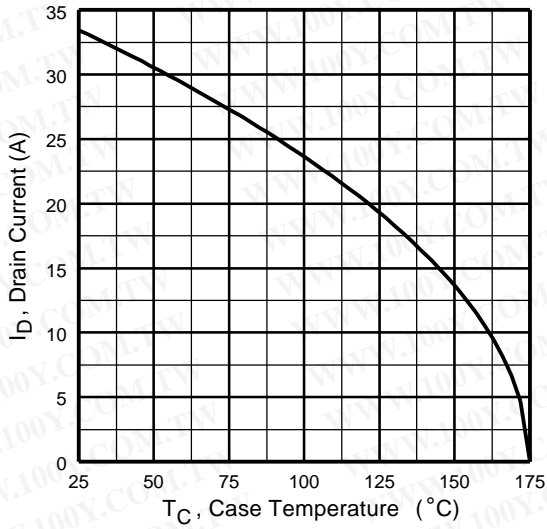


**Fig 7.** Typical Source-Drain Diode Forward Voltage

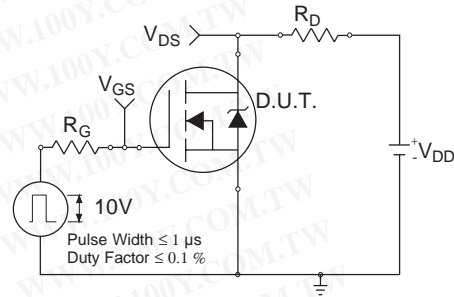


**Fig 8.** Maximum Safe Operating Area

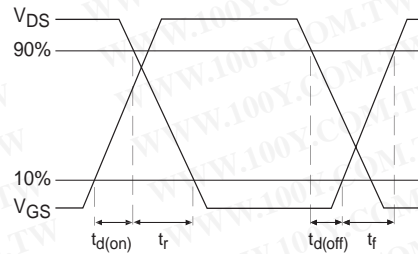




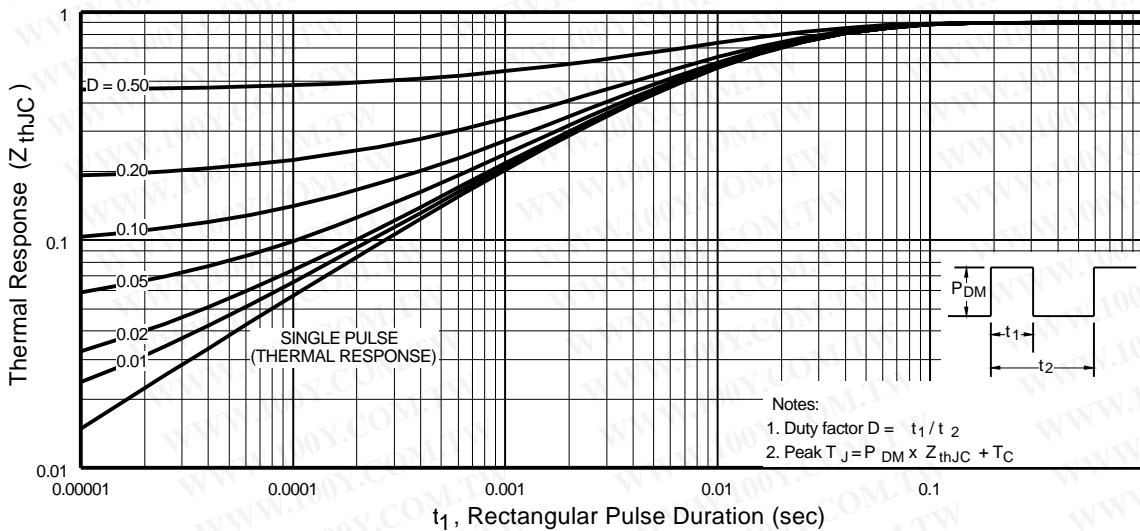
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



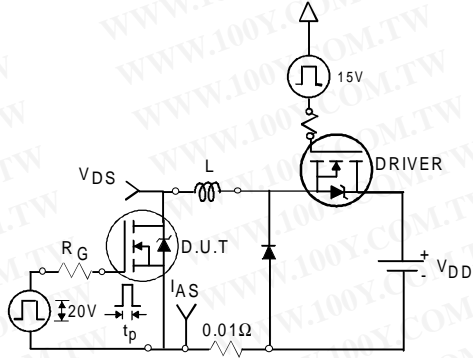
**Fig 10b.** Switching Time Waveforms



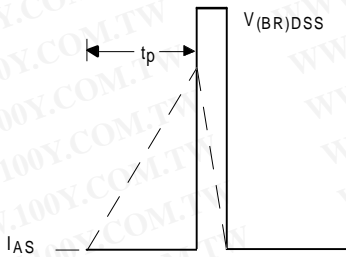
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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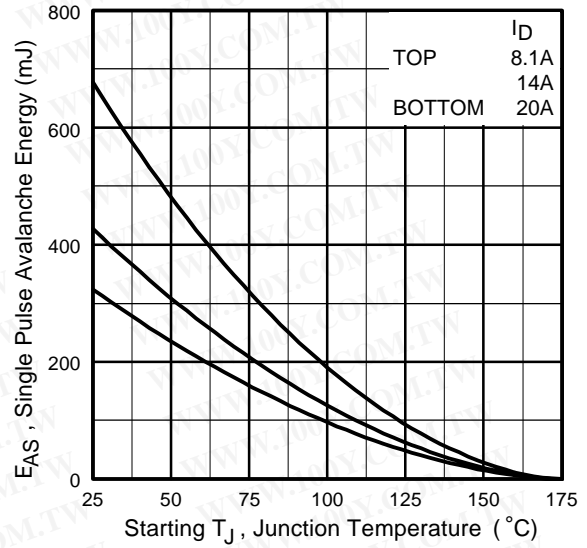
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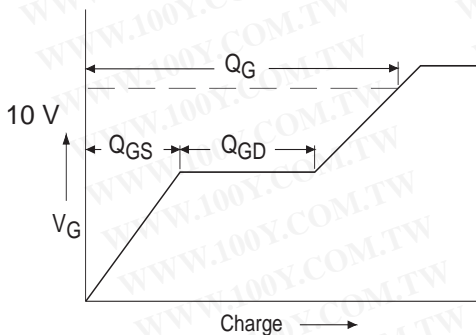
**Fig 12a.** Unclamped Inductive Test Circuit



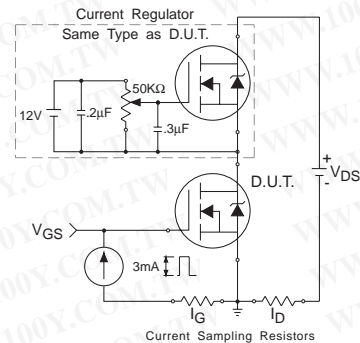
**Fig 12b.** Unclamped Inductive Waveforms



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

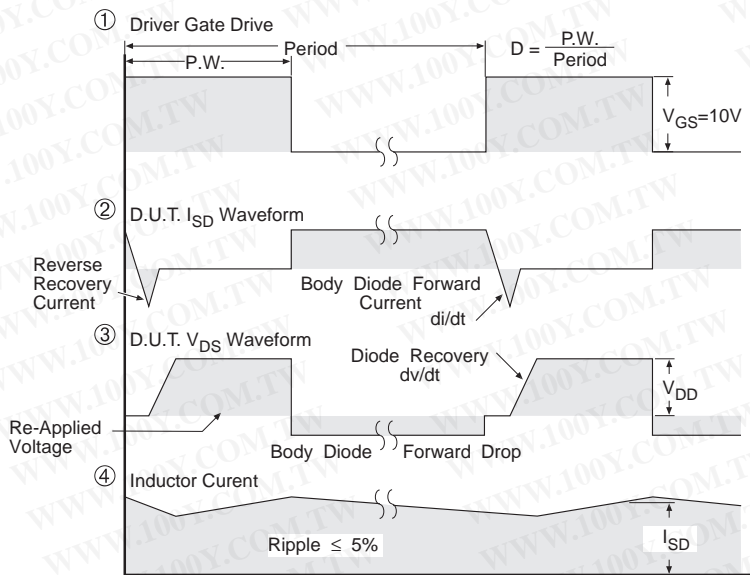
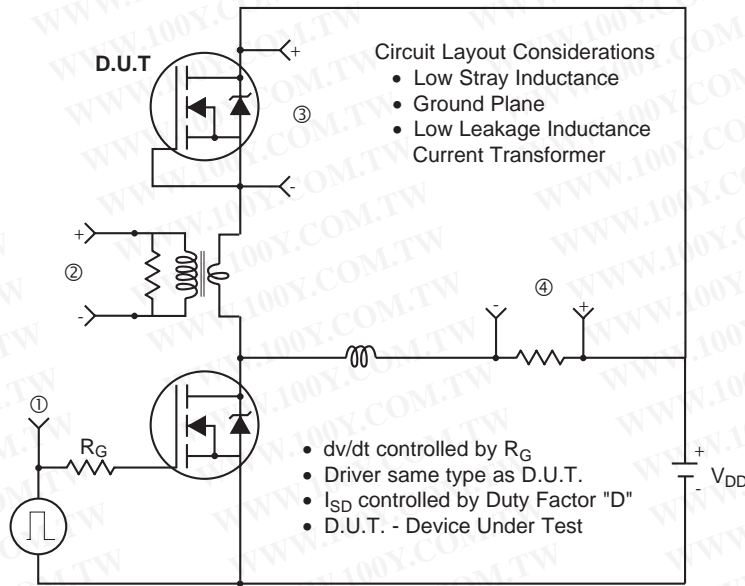


**Fig 13a.** Basic Gate Charge Waveform



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

## Peak Diode Recovery dv/dt Test Circuit



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

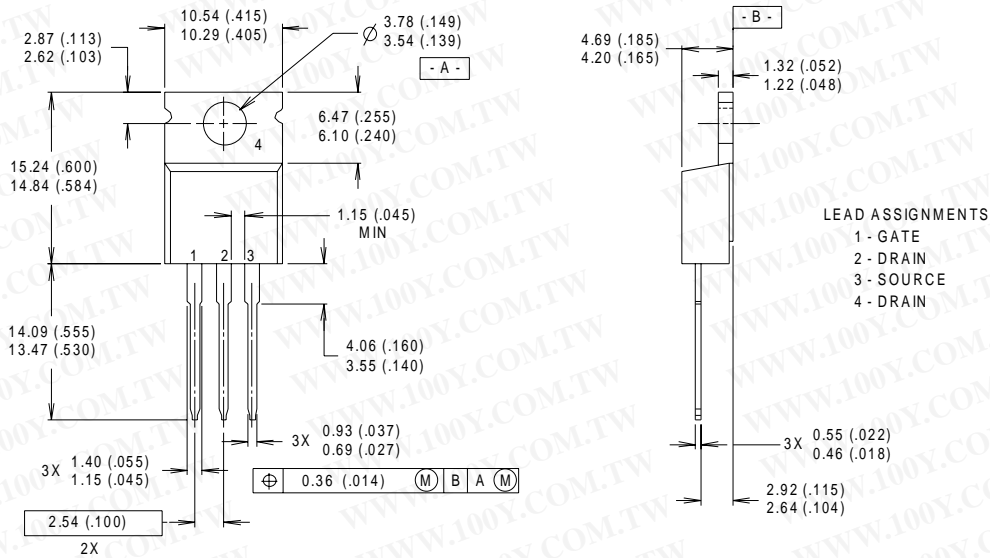
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

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## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

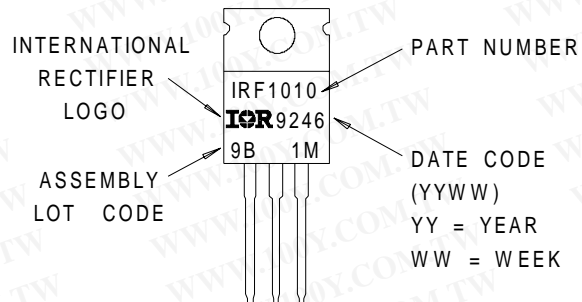


### NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANS 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





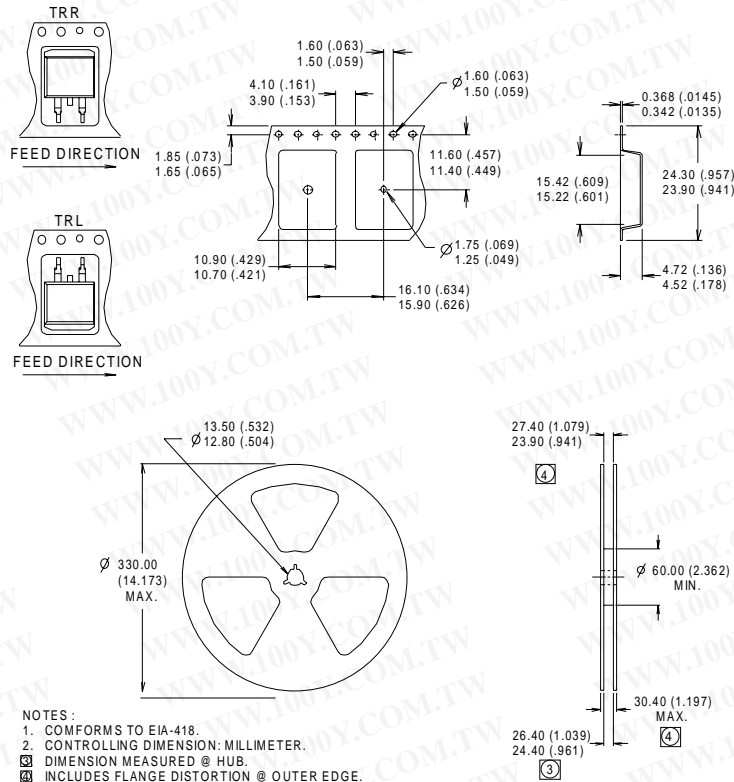




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## D<sup>2</sup>Pak Tape & Reel Information



NOTES:  
 1. CONFORMS TO EIA-418.  
 2. CONTROLLING DIMENSION: MILLIMETER.  
 3. DIMENSION MEASURED @ HUB.  
 4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.7\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 20\text{A}$ .
- ③  $I_{SD} \leq 20\text{A}$ ,  $di/dt \leq 280\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$
- ④ Pulse width  $\leq 300\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{OSS}$  eff. is a fixed capacitance that gives the same charging time as  $C_{OSS}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$
- ⑥ This is only applied to TO-220AB package
- ⑦ 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

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Data and specifications subject to change without notice. 6/00