

International  
**IR** Rectifier

INSULATED GATE BIPOLAR TRANSISTOR

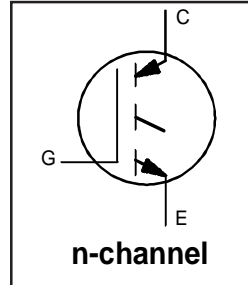
PD 95389

**IRG4RC10KPbF**

Short Circuit Rated  
UltraFast IGBT

### Features

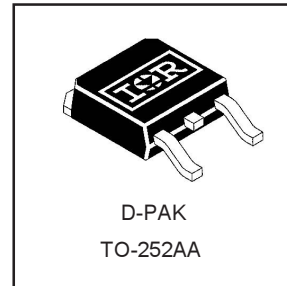
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10 $\mu$ s @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides higher efficiency than Generation 3
- Industry standard TO-252AA package
- Lead-Free



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 2.39V$
@ $V_{GE} = 15V, I_C = 5.0A$

### Benefits

- Generation 4 IGBT's offer highest efficiency available
- IGBT's optimized for specified application conditions



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Breakdown Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	9.0	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	5.0	
$I_{CM}$	Pulsed Collector Current ①	18	
$I_{LM}$	Clamped Inductive Load Current ②	18	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu$ s
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	34	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	38	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	15	
$T_J$	Operating Junction and	-55 to + 150	$^\circ C$
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case )	

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	3.3	$^\circ C/W$
$R_{\theta JA}$	Junction-to-Ambient (PCB mount)*	—	50	
Wt	Weight	0.3 (0.01)	—	g (oz)

\* 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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# IRG4RC10KPbF

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ①	18	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.58	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	2.39	2.62	V	$I_C = 5.0A$ $V_{GE} = 15V$ See Fig.2, 5
		—	3.25	—		
		—	2.63	—		
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ②	1.2	1.8	—	S	$V_{CE} = 50V, I_C = 5.0A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	1000		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

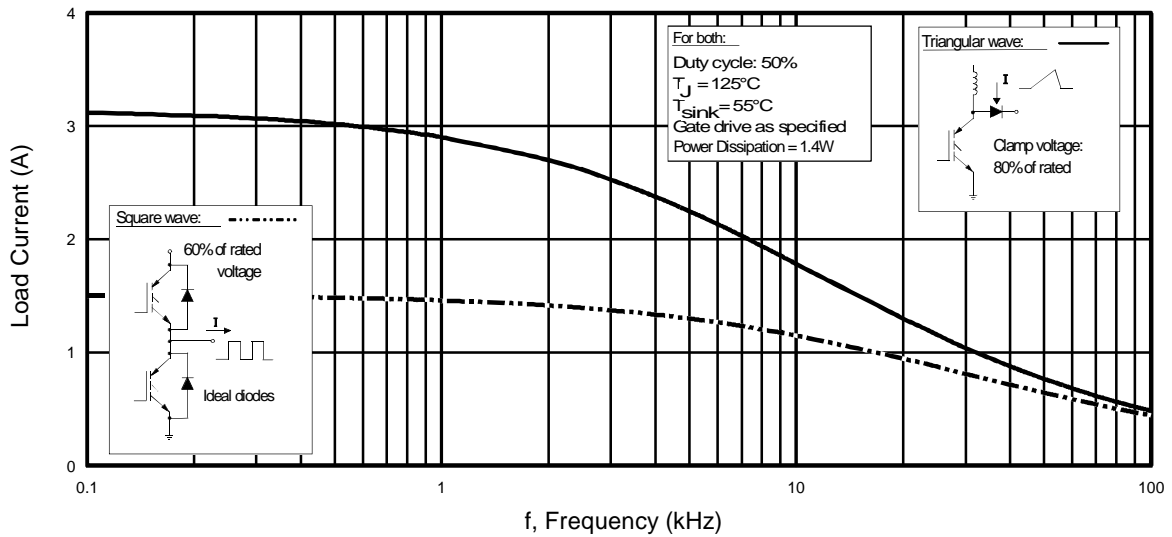
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	19	29	nC	$I_C = 5.0A$ $V_{CC} = 400V$ $V_{GE} = 15V$ See Fig.8
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	2.9	4.3		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	9.8	15		
$t_{d(on)}$	Turn-On Delay Time	—	11	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 5.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 100\Omega$ Energy losses include "tail" See Fig. 9,10,14
$t_r$	Rise Time	—	24	—		
$t_{d(off)}$	Turn-Off Delay Time	—	51	77		
$t_f$	Fall Time	—	190	290		
$E_{on}$	Turn-On Switching Loss	—	0.16	—		
$E_{off}$	Turn-Off Switching Loss	—	0.10	—	mJ	See Fig. 9,10,14
$E_{ts}$	Total Switching Loss	—	0.26	0.32		
$t_{sc}$	Short Circuit Withstand Time	10	—	—	$\mu s$	$V_{CC} = 400V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 100\Omega, V_{CPK} < 500V$
$t_{d(on)}$	Turn-On Delay Time	—	11	—	ns	$T_J = 150^\circ\text{C}$ $I_C = 5.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 100\Omega$ Energy losses include "tail" See Fig. 10,11,14
$t_r$	Rise Time	—	27	—		
$t_{d(off)}$	Turn-Off Delay Time	—	67	—		
$t_f$	Fall Time	—	350	—		
$E_{ts}$	Total Switching Loss	—	0.47	—	mJ	See Fig. 10,11,14
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	220	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7
$C_{oes}$	Output Capacitance	—	29	—		
$C_{res}$	Reverse Transfer Capacitance	—	7.5	—		

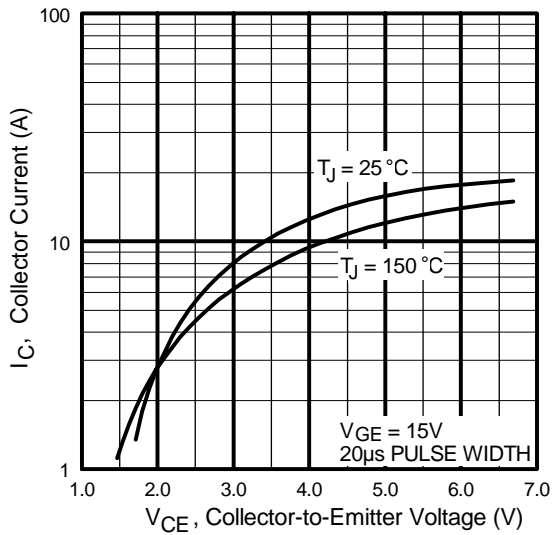
### Notes:

- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES}), V_{GE} = 20V, L = 10\mu H, R_G = 100\Omega$ , (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ⑤ Pulse width  $5.0\mu s$ , single shot.

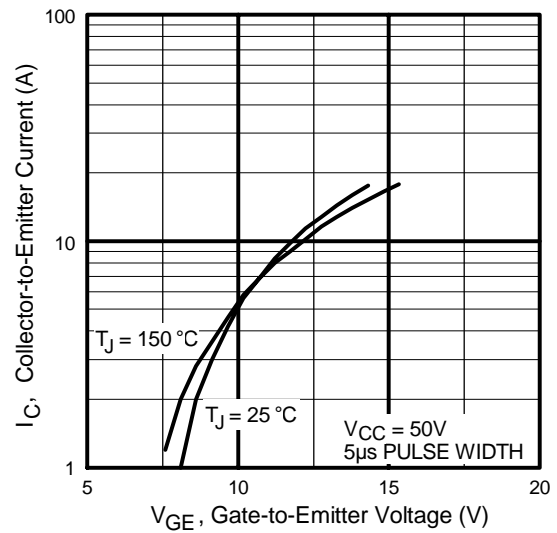
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**Fig. 1** - Typical Load Current vs. Frequency  
(Load Current =  $I_{RMS}$  of fundamental)



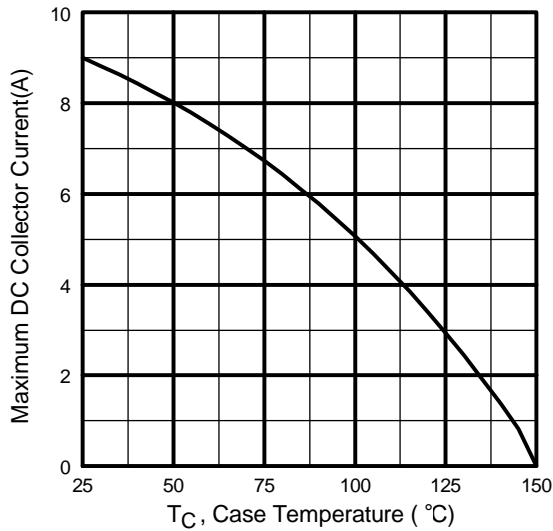
**Fig. 2** - Typical Output Characteristics



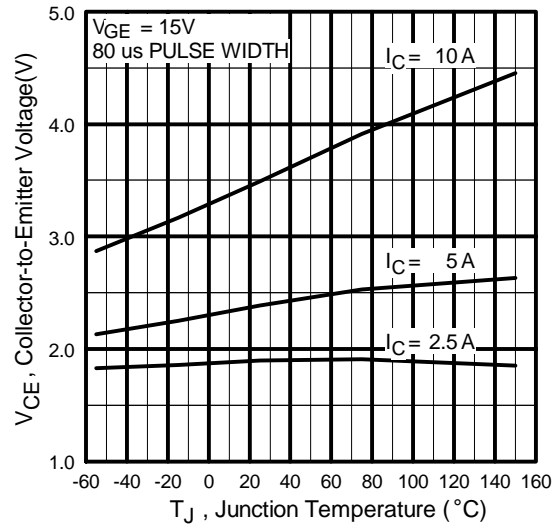
**Fig. 3** - Typical Transfer Characteristics

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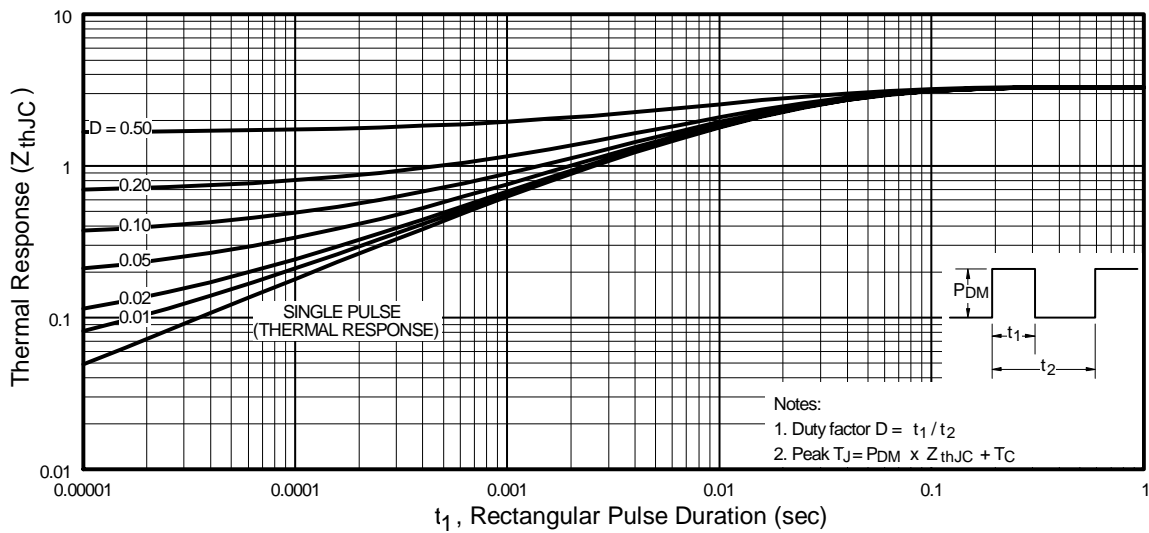
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**Fig. 4** - Maximum Collector Current vs. Case Temperature



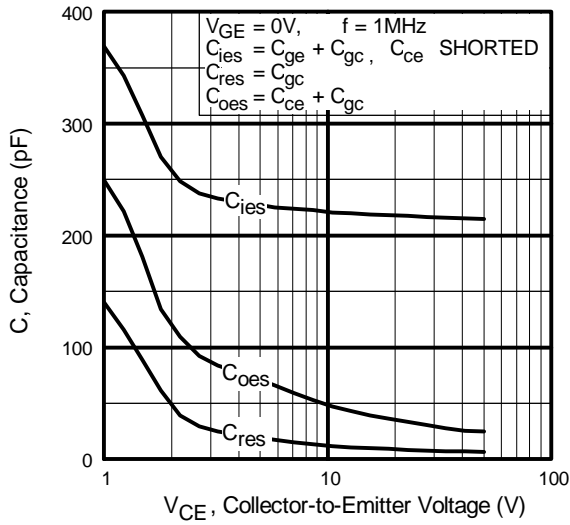
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



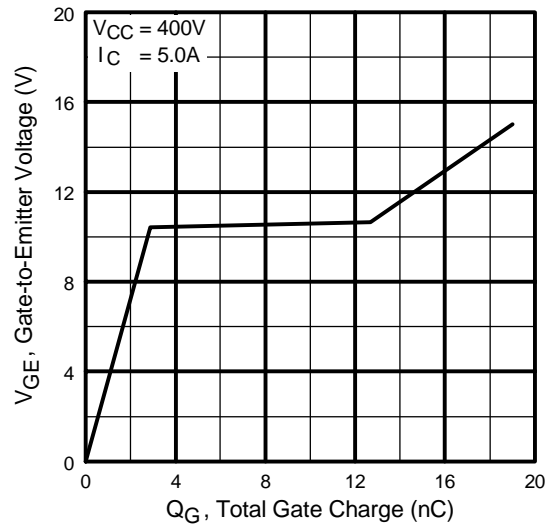
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

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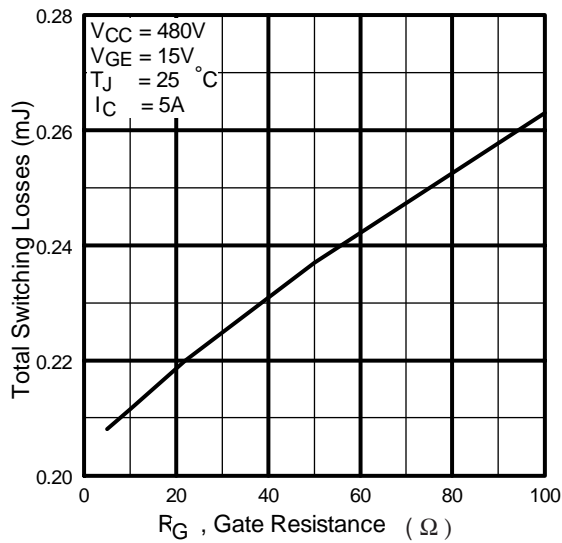
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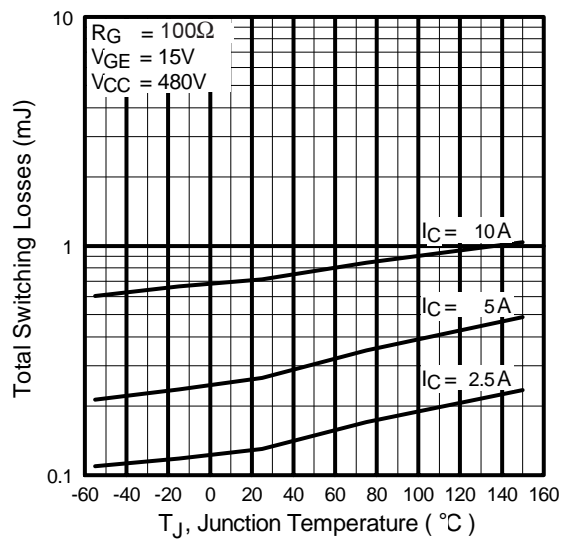
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



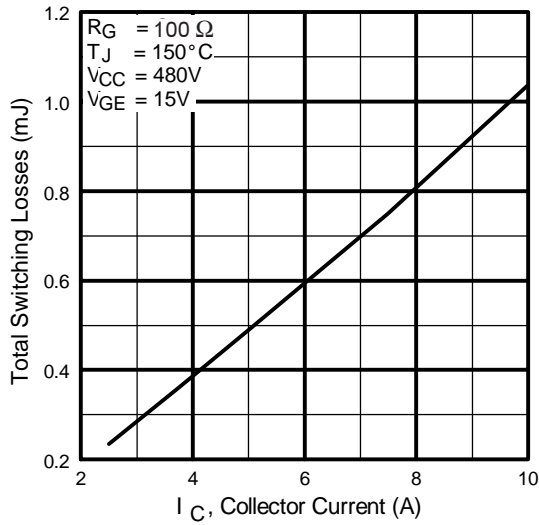
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



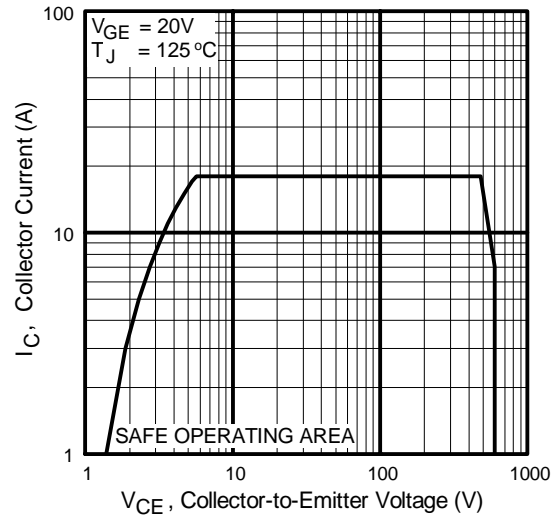
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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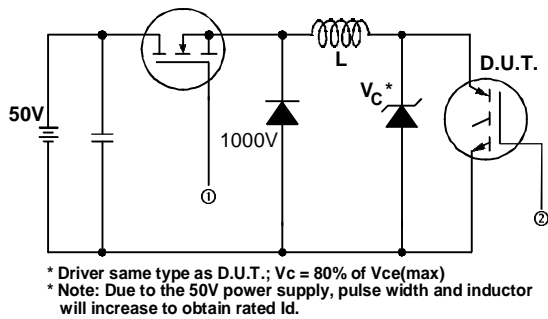
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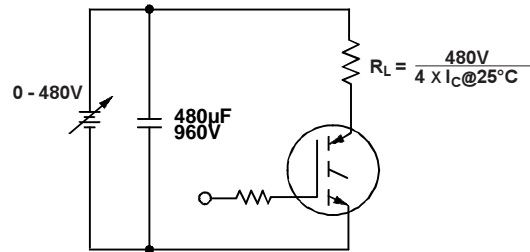
**Fig. 11** - Typical Switching Losses vs. Collector Current



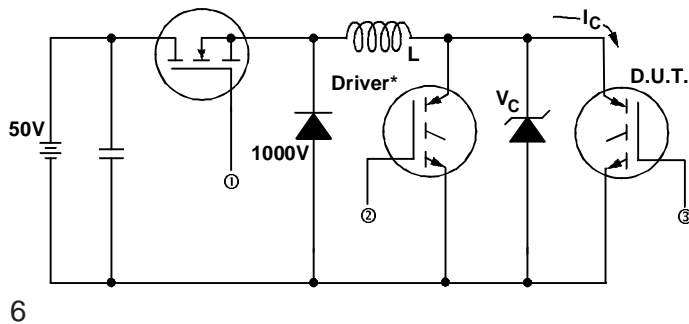
**Fig. 12** - Turn-Off SOA



**Fig. 13a** - Clamped Inductive Load Test Circuit



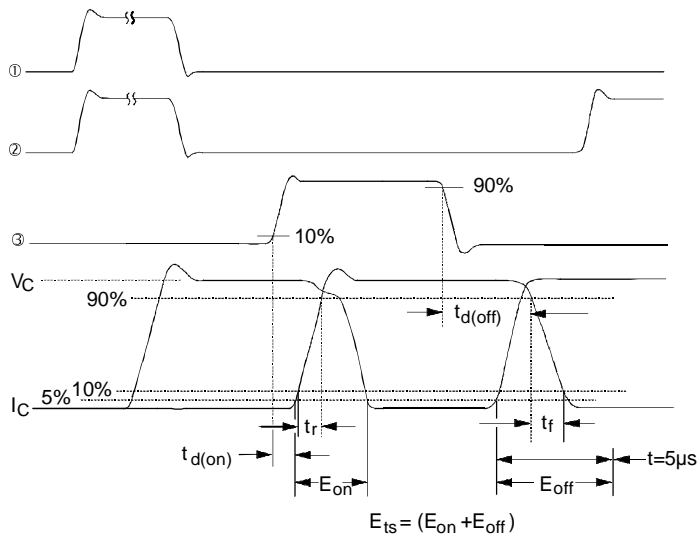
**Fig. 13b** - Pulsed Collector Current Test Circuit



**Fig. 14a** - Switching Loss Test Circuit

\* Driver same type as D.U.T.,  $V_C = 480\text{V}$

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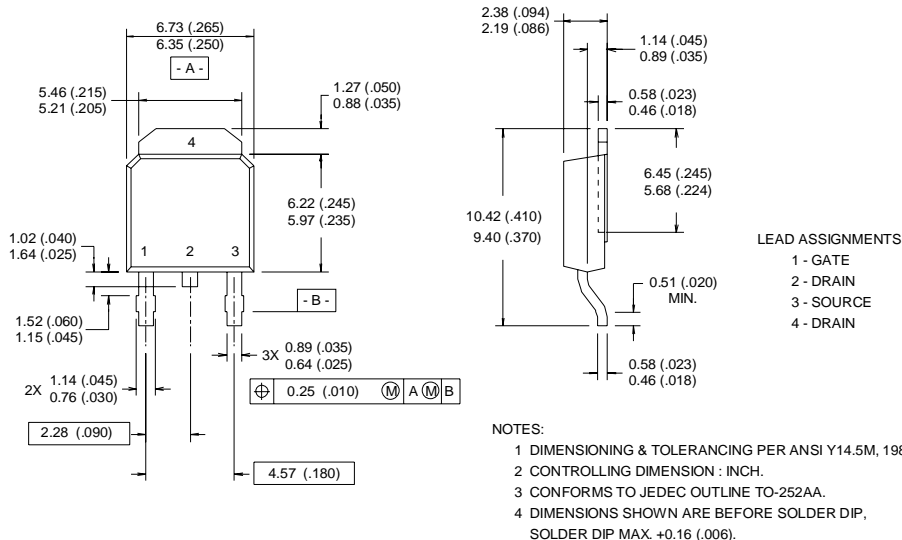
**Fig. 14b** - Switching Loss Waveforms

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## D-Pak (TO-252AA) Package Outline

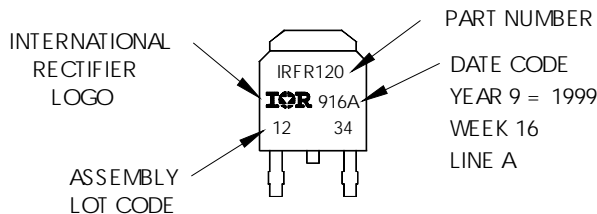
Dimensions are shown in millimeters (inches)



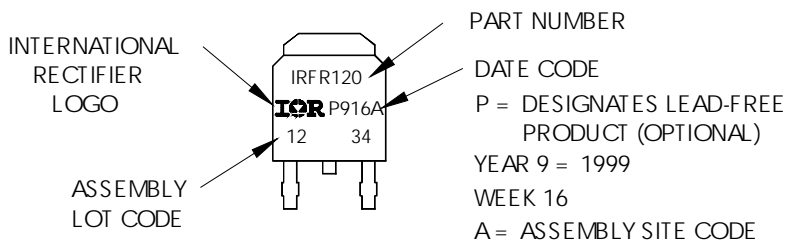
## D-Pak (TO-252AA) Part Marking Information

EXAMPLE: THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON WW 16, 1999  
IN THE ASSEMBLY LINE "A"

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



### OR

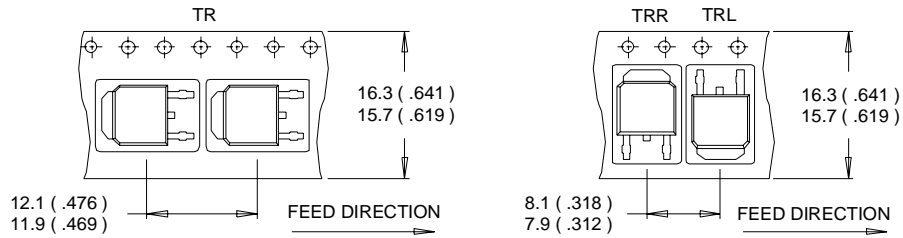




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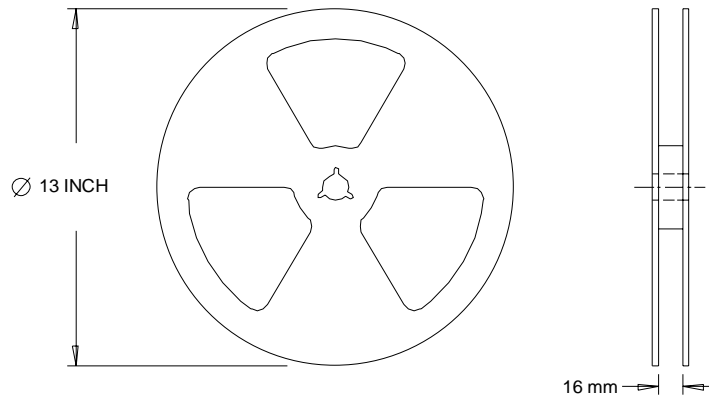
## D-Pak (TO-252AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



**NOTES :**

1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



**NOTES :**

1. OUTLINE CONFORMS TO EIA-481.

Data and specifications subject to change without notice.

Note: For the most current drawings please refer to the IR website at:  
<http://www.irf.com/package/>