



**THE DATASHEET OF  
IRG4BH20K-SPBF**



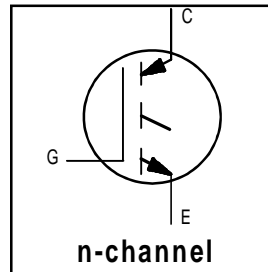
# IRG4BH20K-S

INSULATED GATE BIPOLAR TRANSISTOR

Short Circuit Rated  
UltraFast IGBT

## Features

- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$  @  $V_{CC} = 720V$ ,  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Latest generation design provides tighter parameter distribution and higher efficiency than previous generations
- Industry standard D<sup>2</sup>Pak package



$V_{CES} = 1200V$
$V_{CE(on)} \text{ typ.} = 3.17V$
@ $V_{GE} = 15V, I_C = 5.0A$

## Benefits

- As a Freewheeling Diode we recommend our HEXFRED™ ultrafast, ultrasoft recovery diodes for minimum EMI / Noise and switching losses in the Diode and IGBT
- Latest generation 4 IGBT's offer highest power density motor controls possible



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	11	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	5.0	
$I_{CM}$	Pulsed Collector Current ①	22	
$I_{LM}$	Clamped Inductive Load Current ②	22	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu s$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	130	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	24	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	2.1	$^\circ C/W$
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	40	
Wt	Weight	6 (0.21)	—	g (oz)

## 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	1200	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ④	18	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.13	—	V/°C	$V_{GE} = 0V, I_C = 2.5mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	3.17	4.3	V	$I_C = 5.0A$ $V_{GE} = 15V$
		—	4.04	—		$I_C = 11A$ See Fig.2, 5
		—	2.84	—		$I_C = 5.0A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.5	—	6.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1mA$
$g_{fe}$	Forward Transconductance ⑤	2.3	3.5	—	S	$V_{CE} = 100V, I_C = 5.0A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 1200V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	1000		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

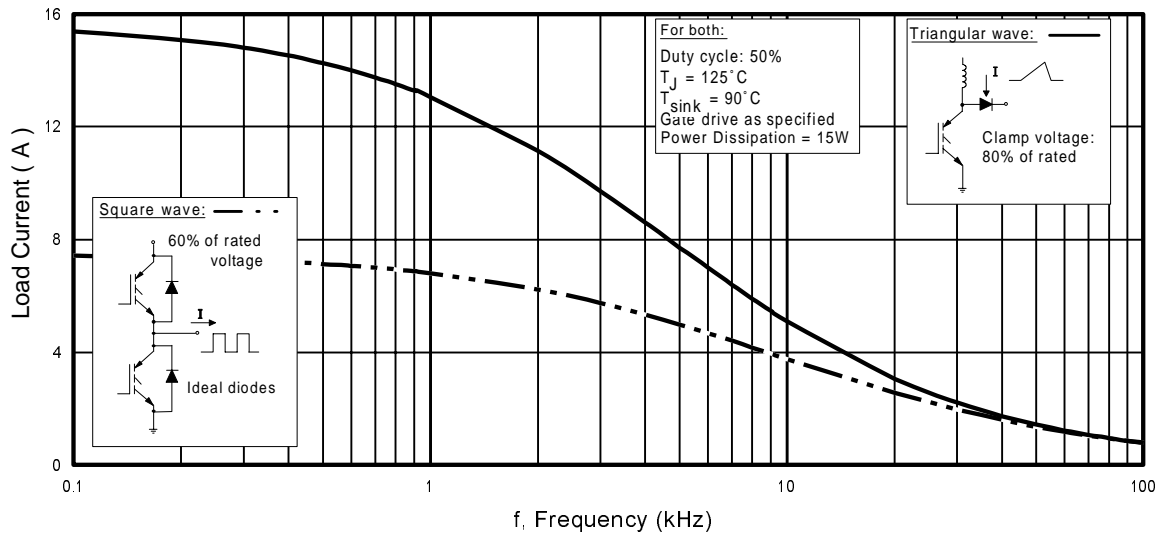
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	28	43	nC	$I_C = 5.0A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	4.4	6.6		$V_{CC} = 400V$ See Fig.8
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	12	18		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	23	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 5.0A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 50\Omega$
$t_r$	Rise Time	—	26	—		
$t_{d(off)}$	Turn-Off Delay Time	—	93	140		
$t_f$	Fall Time	—	270	400		
$E_{on}$	Turn-On Switching Loss	—	0.45	—	mJ	Energy losses include "tail" See Fig. 9,10,14
$E_{off}$	Turn-Off Switching Loss	—	0.44	—		
$E_{ts}$	Total Switching Loss	—	0.89	1.2		
$t_{sc}$	Short Circuit Withstand Time	10	—	—	$\mu s$	$V_{CC} = 720V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 50\Omega$
$t_{d(on)}$	Turn-On Delay Time	—	23	—	ns	$T_J = 150^\circ\text{C}$ , $I_C = 5.0A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 50\Omega$ Energy losses include "tail" See Fig. 10,11,14
$t_r$	Rise Time	—	28	—		
$t_{d(off)}$	Turn-Off Delay Time	—	100	—		
$t_f$	Fall Time	—	620	—		
$E_{ts}$	Total Switching Loss	—	1.7	—	mJ	
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Between lead and center of die contact
$C_{ies}$	Input Capacitance	—	435	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ See Fig. 7 $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	44	—		
$C_{res}$	Reverse Transfer Capacitance	—	8.3	—		

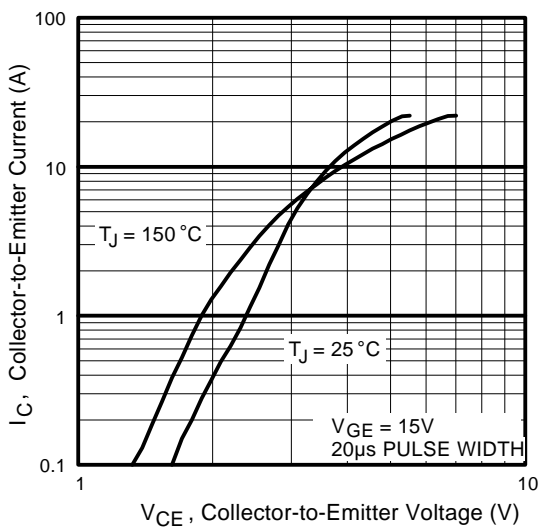
### Notes:

- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 50\Omega$ , (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.

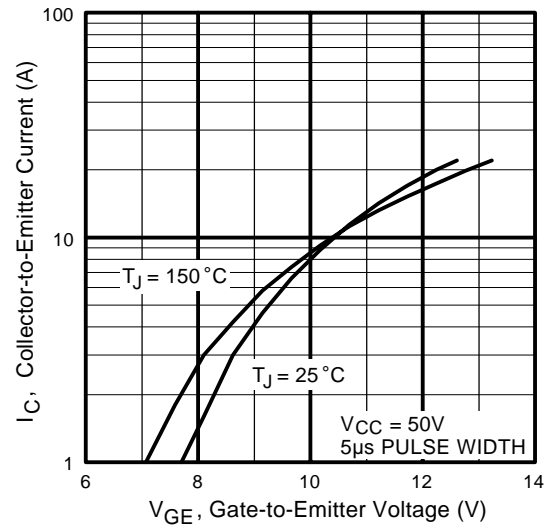
\* When mounted on 1" square PCB (FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.



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



**Fig. 2 - Typical Output Characteristics**  
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**Fig. 3 - Typical Transfer Characteristics**

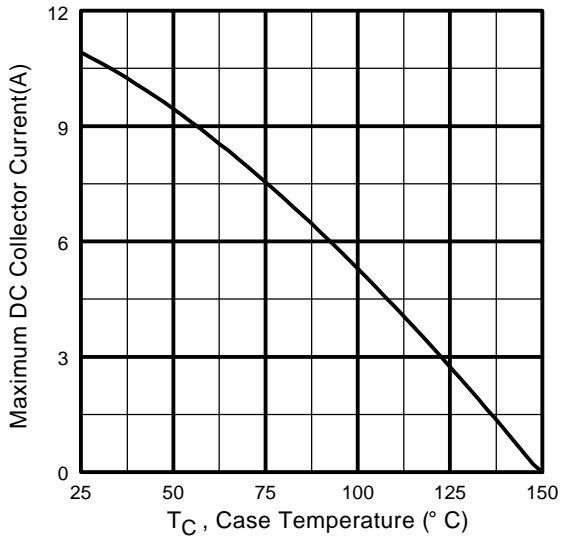


Fig. 4 - Maximum Collector Current vs. Case Temperature

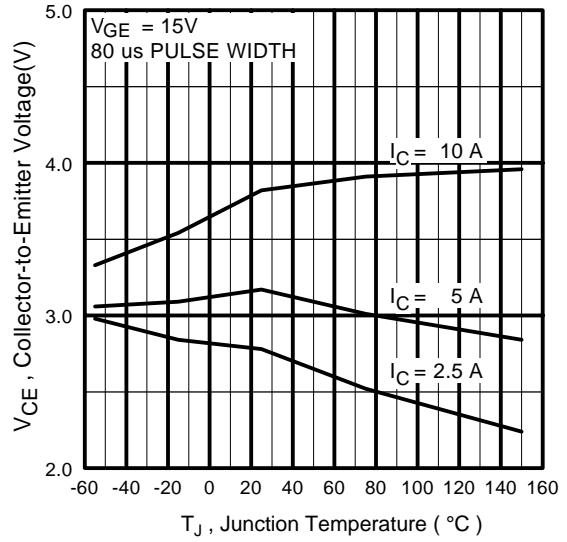


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

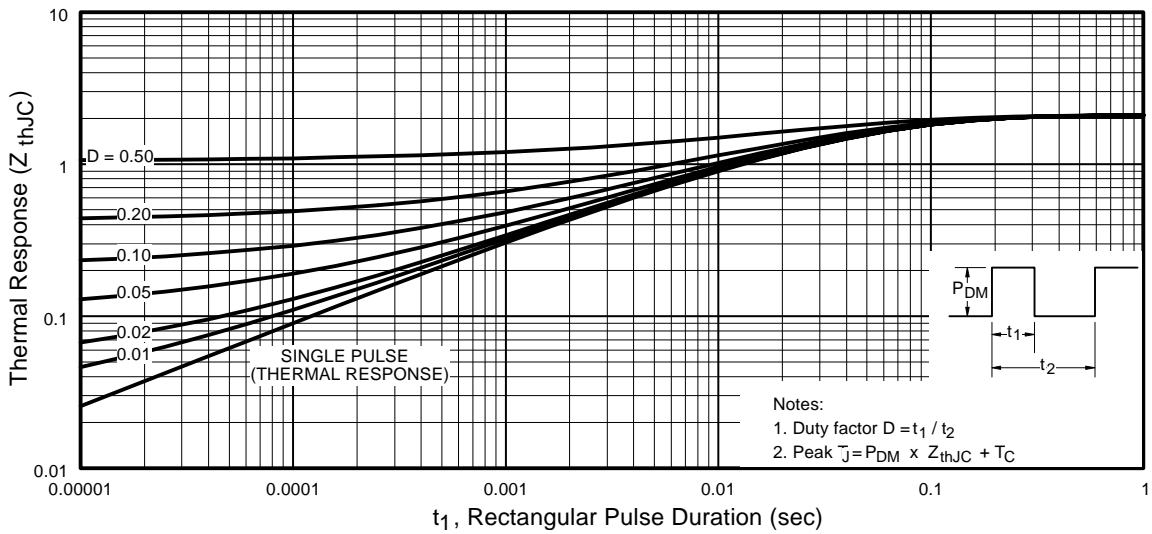
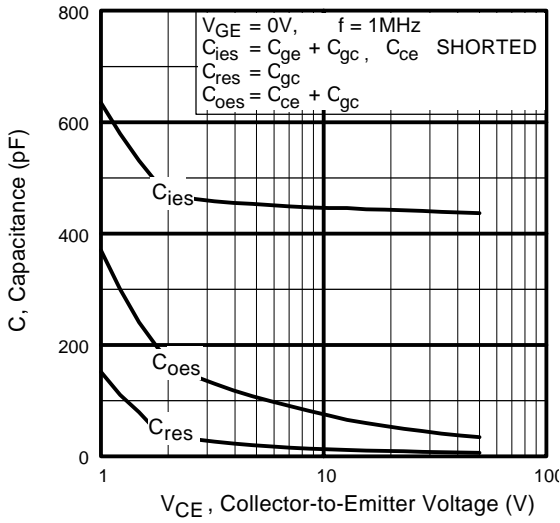
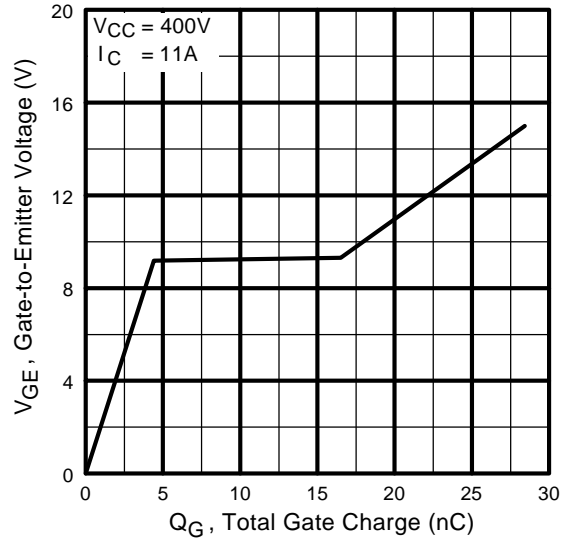


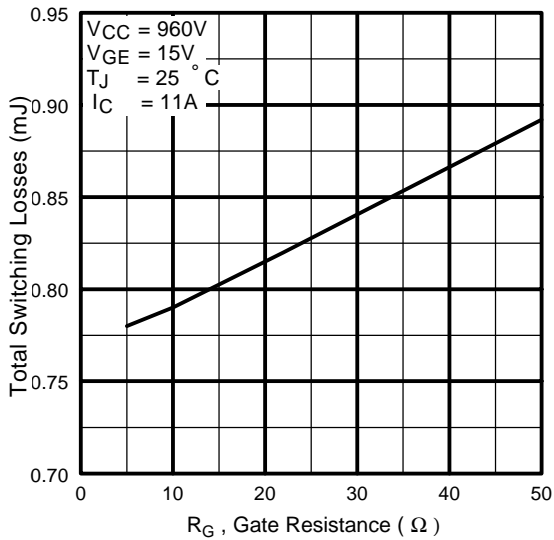
Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



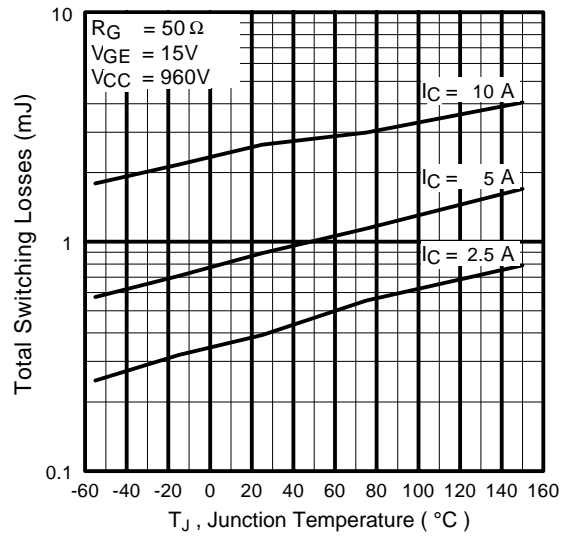
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

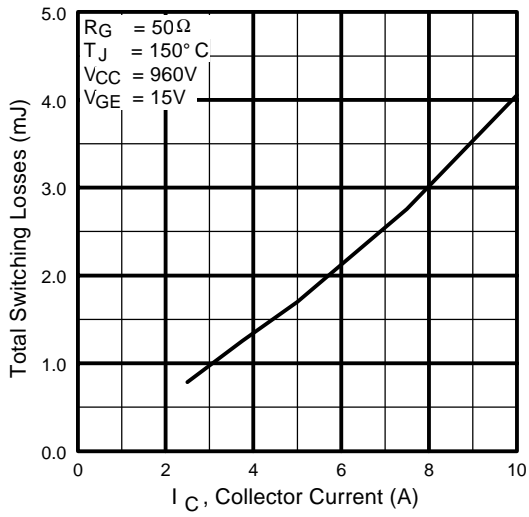


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

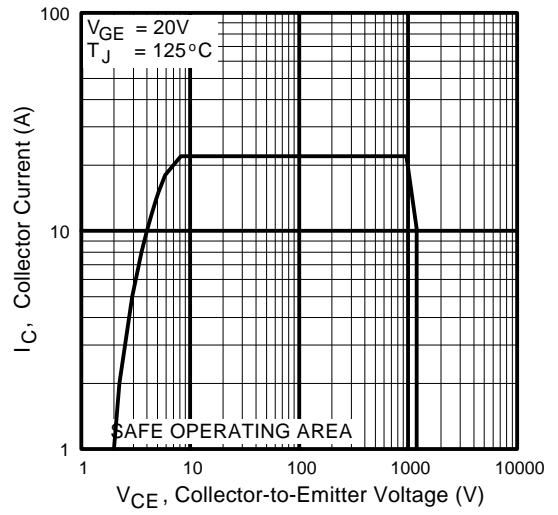


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

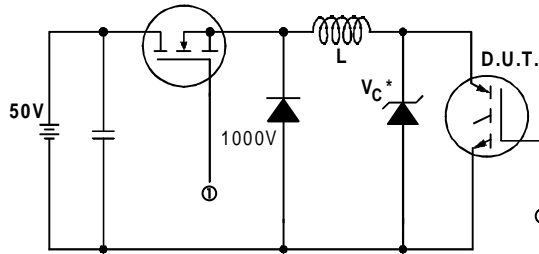
# IRG4BH20K-S



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

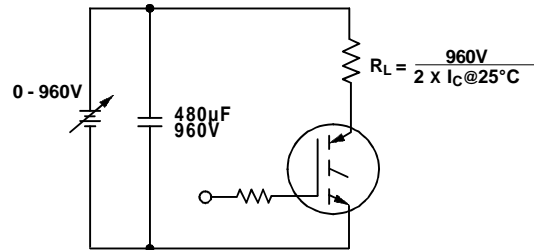


**Fig. 12** - Turn-Off SOA

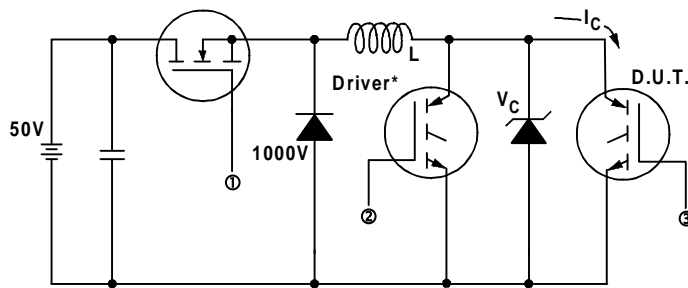


\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

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

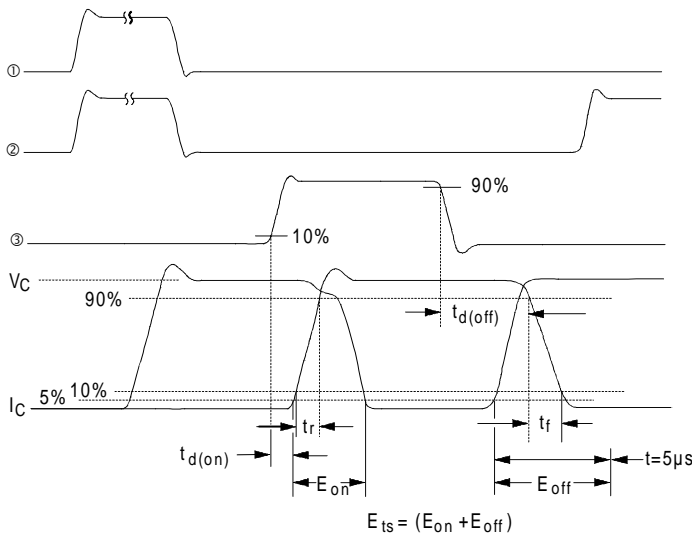


**Fig. 13b** - Pulsed Collector Current Test Circuit



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

\* Driver same type as D.U.T.,  $V_C = 960V$

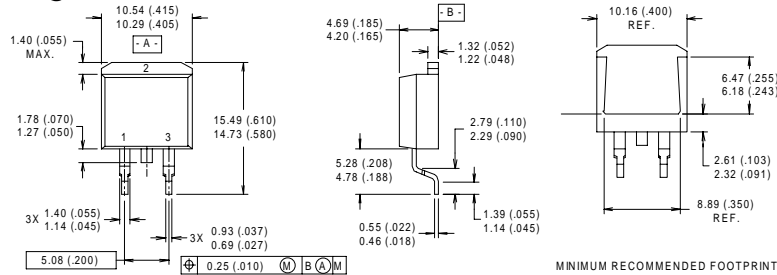


**Fig. 14b** - Switching Loss Waveforms

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

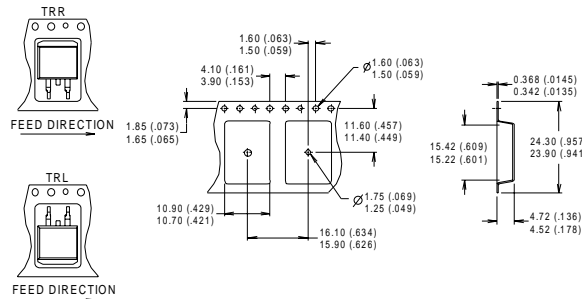
International  
**IR** Rectifier



- 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 Tape and Reel



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

International  
**IR** Rectifier

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**IR EUROPEAN REGIONAL CENTER:** 439/445 Godstone Rd, Whyteleafe, Surrey CR3 0BL, UK Tel: ++ 44 (0)20 8645 8000  
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Data and specifications subject to change without notice. 8/00

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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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