

# International **IR** Rectifier

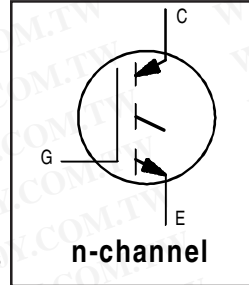
PD - 91657B

## IRG4PC50W

### INSULATED GATE BIPOLAR TRANSISTOR

#### Features

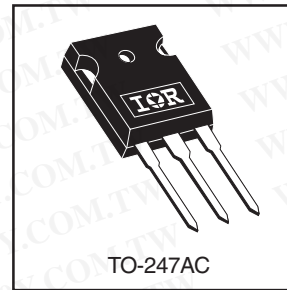
- Designed expressly for Switch-Mode Power Supply and PFC (power factor correction) applications
- Industry-benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest-generation IGBT design and construction offers tighter parameters distribution, exceptional reliability



$V_{CES} = 600V$
$V_{CE(on) max.} = 2.30V$
@ $V_{GE} = 15V, I_C = 27A$

#### Benefits

- Lower switching losses allow more cost-effective operation than power MOSFETs up to 150 kHz ("hard switched" mode)
- Of particular benefit to single-ended converters and boost PFC topologies 150W and higher
- Low conduction losses and minimal minority-carrier recombination make these an excellent option for resonant mode switching as well (up to >300 kHz)



#### 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	55	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	27	
$I_{CM}$	Pulsed Collector Current ①	220	
$I_{LM}$	Clamped Inductive Load Current ②	220	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	170	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
$T_J$	Operating Junction and	-55 to + 150	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm from case )	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

#### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	0.64	°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)

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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	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)CES}$	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	—	0.41	—	$V/^\circ\text{C}$	$V_{GE} = 0V, I_C = 5.0mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	1.93	2.3	V	$I_C = 27A, V_{GE} = 15V$
		—	2.25	—		$I_C = 55A, \text{See Fig.2, 5}$
		—	1.71	—		$I_C = 27A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	$mV/^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA$
$g_{fe}$	Forward Transconductance ⑤	27	41	—	S	$V_{CE} = 100V, I_C = 27A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	5000		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

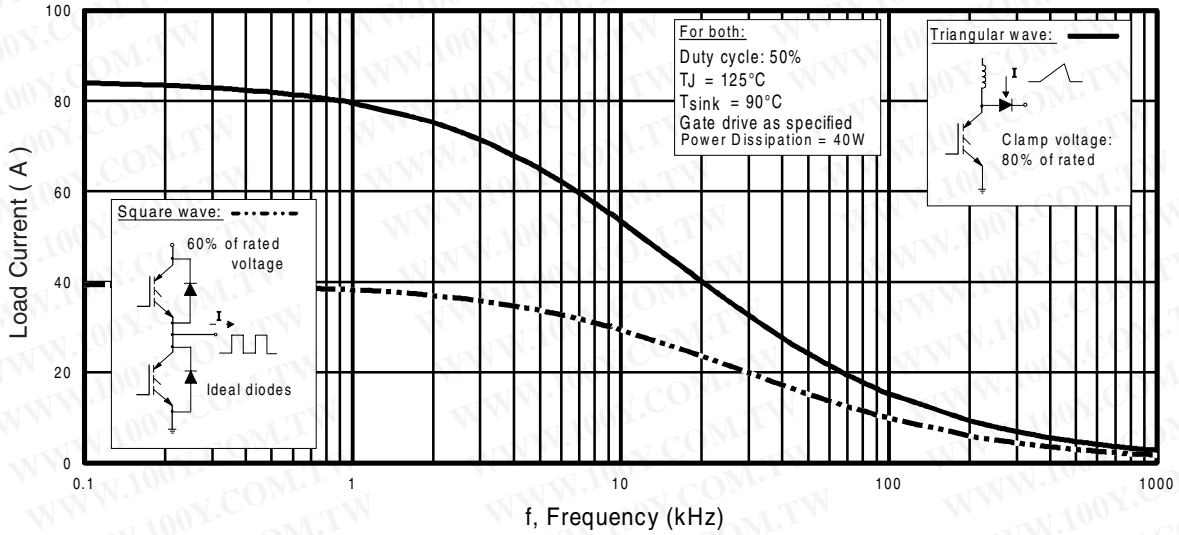
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	180	270	nC	$I_C = 27A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	24	36		$V_{CC} = 400V, \text{See Fig.8}$
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	63	95		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	46	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 5.0\Omega$
$t_r$	Rise Time	—	33	—		
$t_{d(off)}$	Turn-Off Delay Time	—	120	180		
$t_f$	Fall Time	—	57	86	mJ	Energy losses include "tail" See Fig. 9, 10, 14
$E_{on}$	Turn-On Switching Loss	—	0.08	—		
$E_{off}$	Turn-Off Switching Loss	—	0.32	—		
$E_{ts}$	Total Switching Loss	—	0.40	0.5	ns	$T_J = 150^\circ\text{C},$ $I_C = 27A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail" See Fig. 10,11, 14
$t_{d(on)}$	Turn-On Delay Time	—	31	—		
$t_r$	Rise Time	—	43	—		
$t_{d(off)}$	Turn-Off Delay Time	—	210	—	mJ	Measured 5mm from package
$t_f$	Fall Time	—	62	—		
$E_{ts}$	Total Switching Loss	—	1.14	—		
$L_E$	Internal Emitter Inductance	—	13	—	nH	
$C_{ies}$	Input Capacitance	—	3700	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V, \text{See Fig. 7}$ $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	260	—		
$C_{res}$	Reverse Transfer Capacitance	—	68	—		

### Notes:

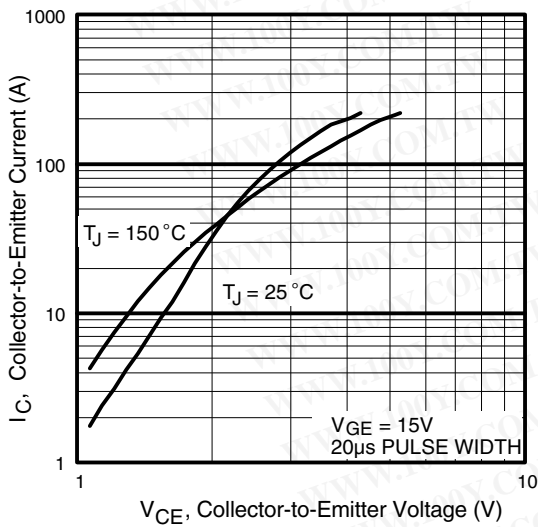
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES}), V_{GE} = 20V, L = 10\mu H, R_G = 5.0\Omega,$  (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu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

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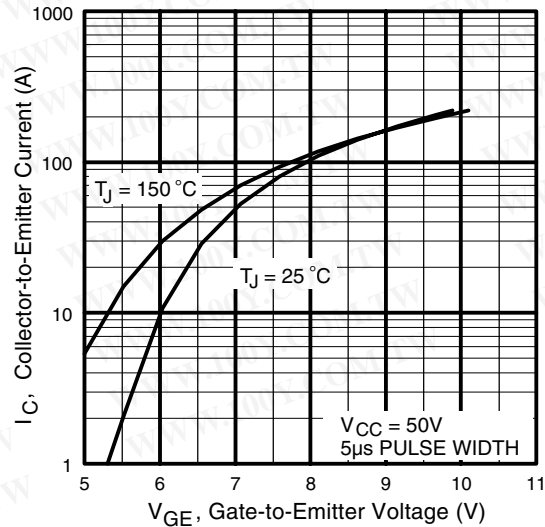
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**Fig. 1** - Typical Load Current vs. Frequency  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)



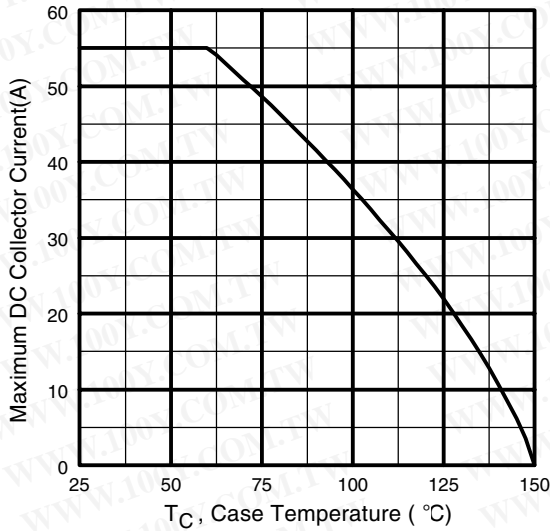
**Fig. 2** - Typical Output Characteristics



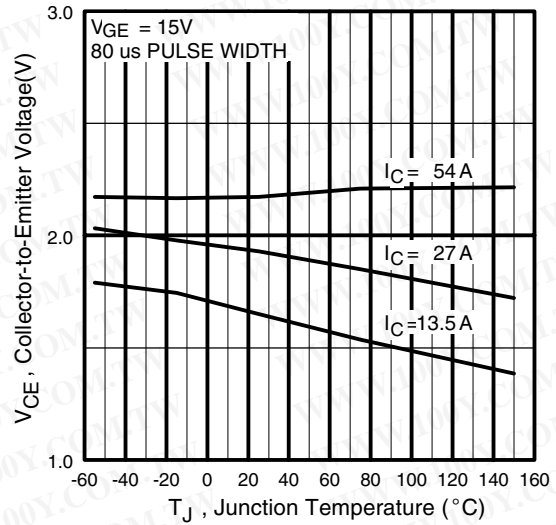
**Fig. 3** - Typical Transfer Characteristics

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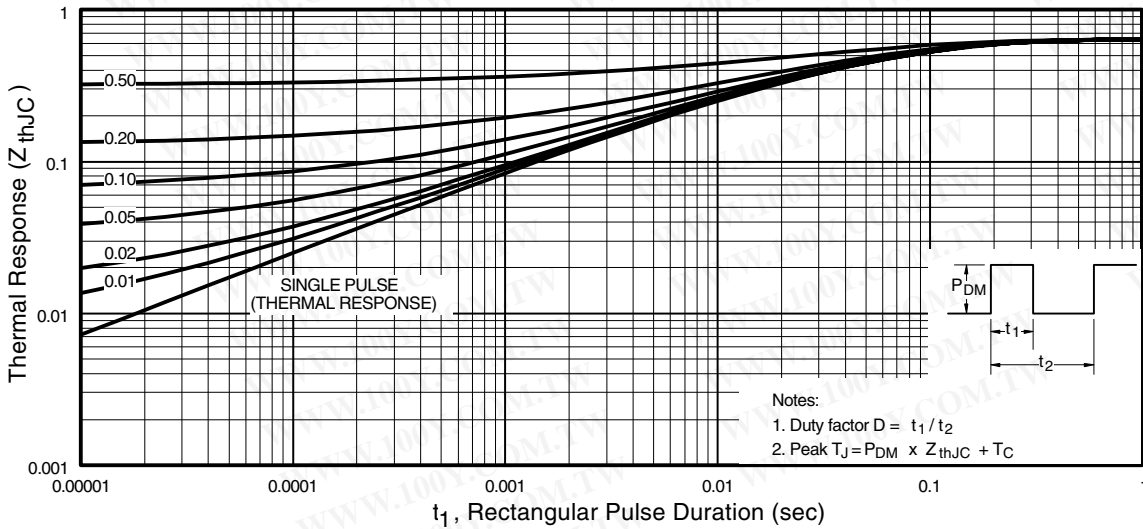
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**Fig. 4 - Maximum Collector Current vs. Case Temperature**



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

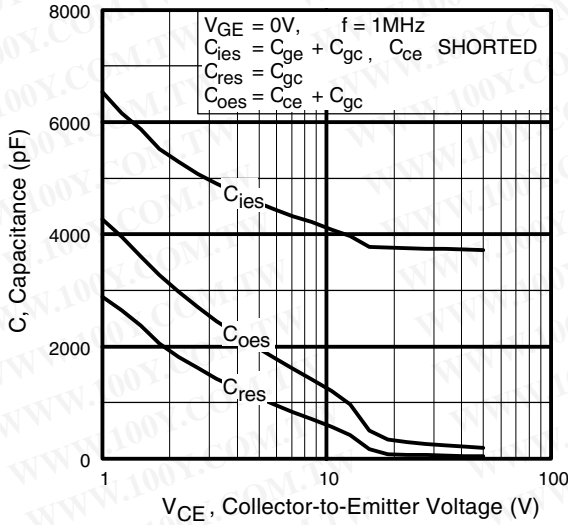


**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

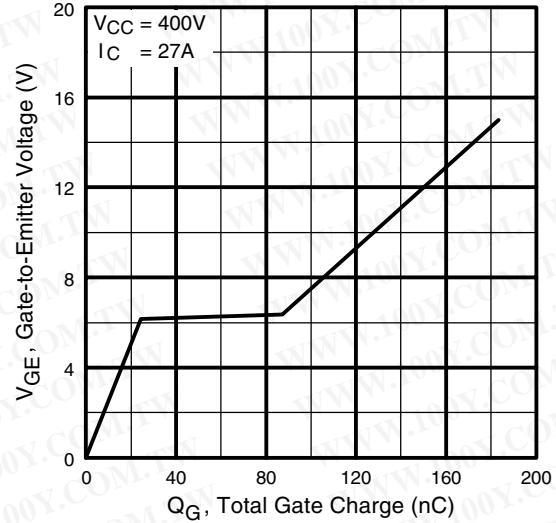


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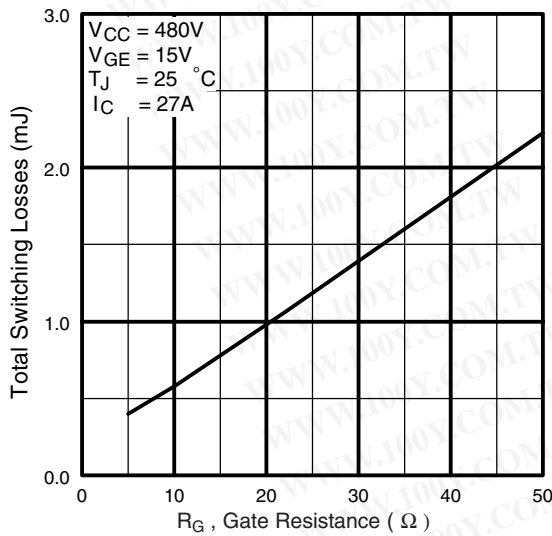
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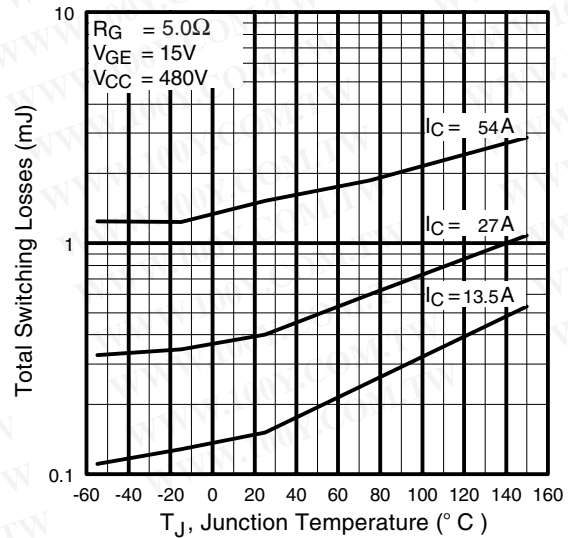
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



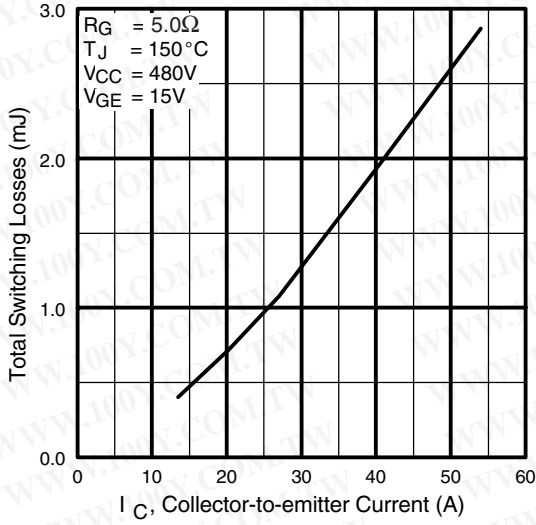
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



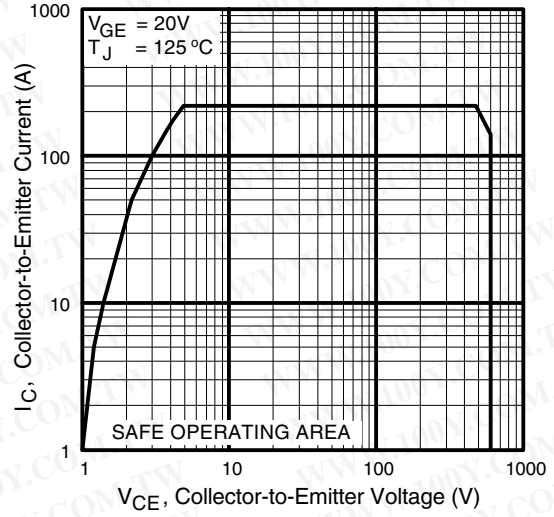
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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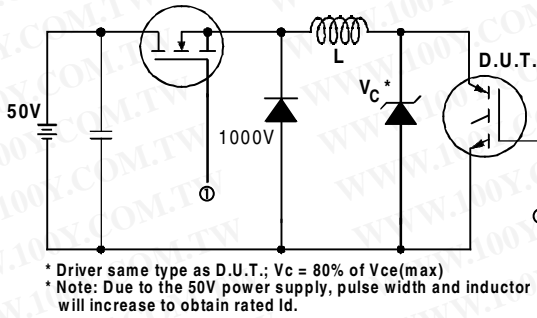
**Fig. 11** - Typical Switching Losses vs. Collector-to-emitter Current



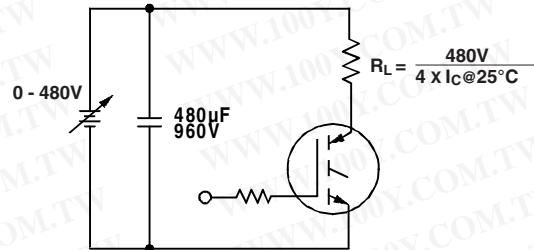
**Fig. 12** - Turn-Off SOA

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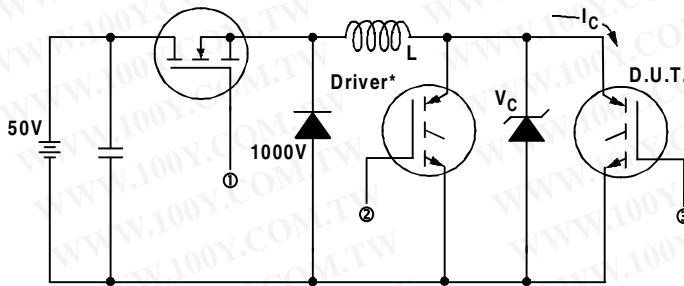
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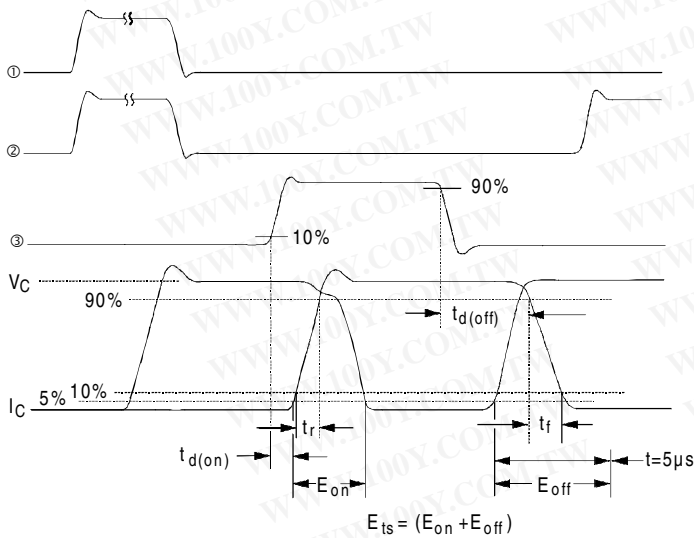
**Fig. 13a** - Clamped Inductive Load Test Circuit



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



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

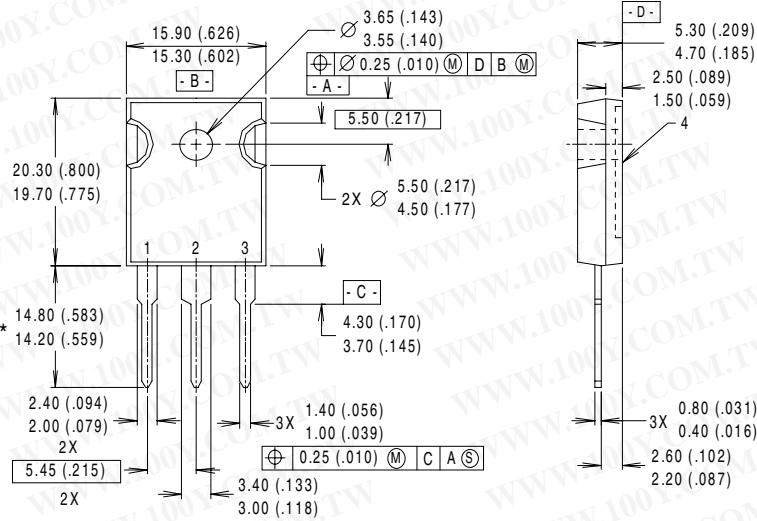


**Fig. 14b** - Switching Loss Waveforms

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## Case Outline and Dimensions — TO-247AC



- NOTES:**
- 1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
  - 2 CONTROLLING DIMENSION : INCH.
  - 3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
  - 4 CONFORMS TO JEDEC OUTLINE TO-247AC.

- LEAD ASSIGNMENTS**
- 1 - GATE
  - 2 - COLLECTOR
  - 3 - EMITTER
  - 4 - COLLECTOR

\* LONGER LEADED (20mm) VERSION AVAILABLE (TO-247AD) TO ORDER ADD "E" SUFFIX TO PART NUMBER

**CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)**  
 Dimensions in Millimeters and (Inches)

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
**IR EUROPEAN REGIONAL CENTRE:** 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. 6/00*