

# International **IR** Rectifier

PD - 91574B

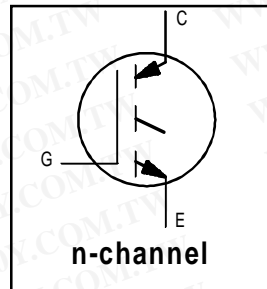
## IRG4PH50U

INSULATED GATE BIPOLAR TRANSISTOR

Ultra Fast Speed IGBT

### Features

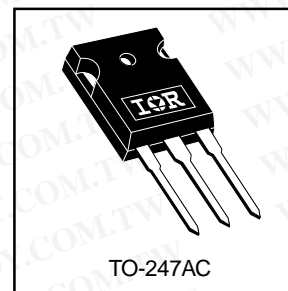
- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- Optimized for power conversion; SMPS, UPS and welding
- Industry standard TO-247AC package



$V_{CES} = 1200V$
$V_{CE(on) typ.} = 2.78V$
@ $V_{GE} = 15V, I_C = 24A$

### Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- Much lower conduction losses than MOSFETs
- More efficient than short circuit rated IGBTs



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Breakdown Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	45	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	24	
$I_{CM}$	Pulsed Collector Current ①	180	W
$I_{LM}$	Clamped Inductive Load Current ②	180	
$V_{GE}$	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 Storage Temperature Range	-55 to +150	$^\circ C$
$T_{STG}$	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	$^\circ C/W$
$R_{\theta CS}$	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)

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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	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	—	1.20	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	2.56	3.5	V	$I_C = 20A$ $I_C = 24A$ $I_C = 45A$ $I_C = 24A, T_J = 150^\circ\text{C}$ $V_{GE} = 15V$ See Fig. 2, 5
		—	2.78	3.7		
		—	3.20	—		
		—	2.54	—		
$V_{GE(th)}$	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	—	-13	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ⑤	23	35	—	S	$V_{CE} = 100V, I_C = 24A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 1200V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 24V, T_J = 25^\circ\text{C}$
		—	—	5000		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

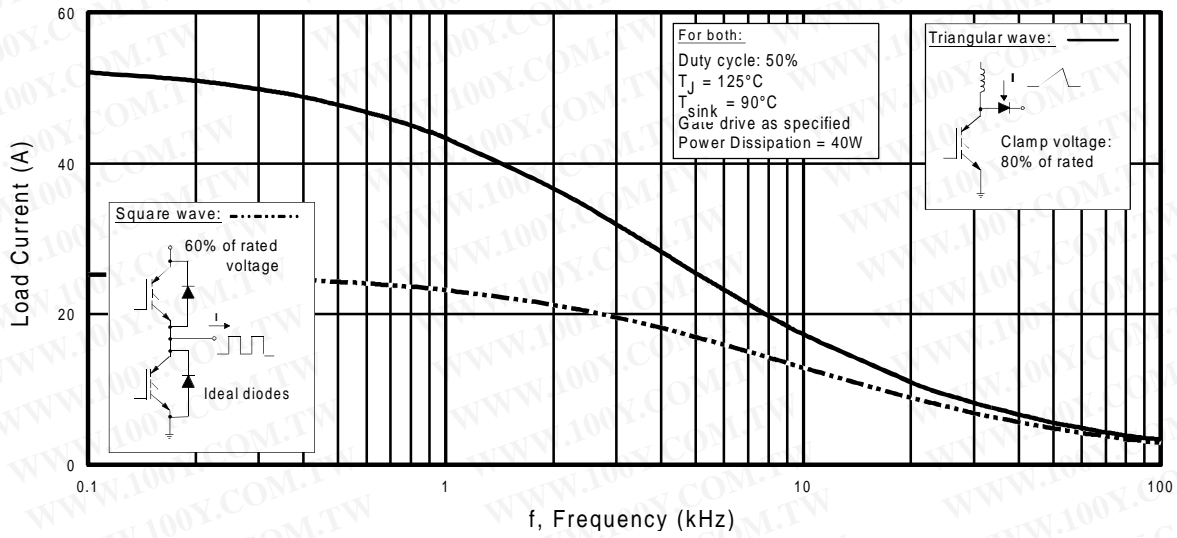
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	160	250	nC	$I_C = 24A$ $V_{CC} = 400V$ $V_{GE} = 15V$ See Fig. 8
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	27	40		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	53	83		
$t_{d(on)}$	Turn-On Delay Time	—	35	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail" See Fig. 9, 10, 14
$t_r$	Rise Time	—	15	—		
$t_{d(off)}$	Turn-Off Delay Time	—	200	350		
$t_f$	Fall Time	—	290	500		
$E_{on}$	Turn-On Switching Loss	—	0.53	—	mJ	$T_J = 150^\circ\text{C}$ $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail" See Fig. 11, 14
$E_{off}$	Turn-Off Switching Loss	—	1.41	—		
$E_{ts}$	Total Switching Loss	—	1.94	2.6		
$t_{d(on)}$	Turn-On Delay Time	—	31	—	ns	$T_J = 25^\circ\text{C}, V_{GE} = 15V, R_G = 5.0\Omega$ $I_C = 20A, V_{CC} = 960V$ Energy losses include "tail" See Fig. 9, 10, 11, 14, $T_J = 150^\circ\text{C}$
$t_r$	Rise Time	—	18	—		
$t_{d(off)}$	Turn-Off Delay Time	—	320	—		
$t_f$	Fall Time	—	280	—		
$E_{on}$	Turn-On Switching Loss	—	0.35	—	mJ	$T_J = 25^\circ\text{C}, V_{GE} = 15V, R_G = 5.0\Omega$ $I_C = 20A, V_{CC} = 960V$ Energy losses include "tail" See Fig. 9, 10, 11, 14, $T_J = 150^\circ\text{C}$
$E_{off}$	Turn-Off Switching Loss	—	1.43	—		
$E_{ts}$	Total Switching Loss	—	1.78	2.9		
$E_{ts}$	Total Switching Loss	—	4.56	—		
$L_E$	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	3600	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7
$C_{oes}$	Output Capacitance	—	160	—		
$C_{res}$	Reverse Transfer Capacitance	—	31	—		

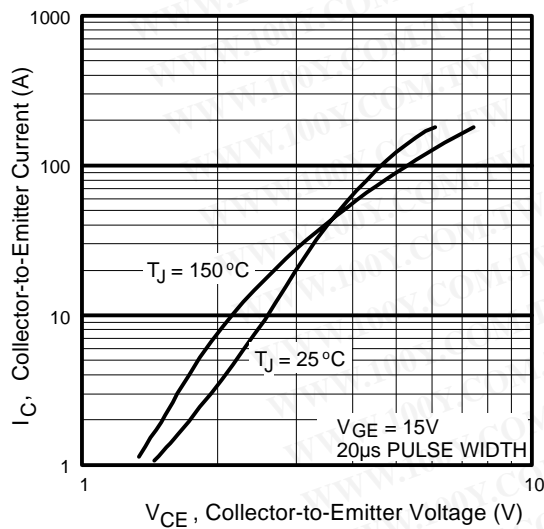
### Notes:

- 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.

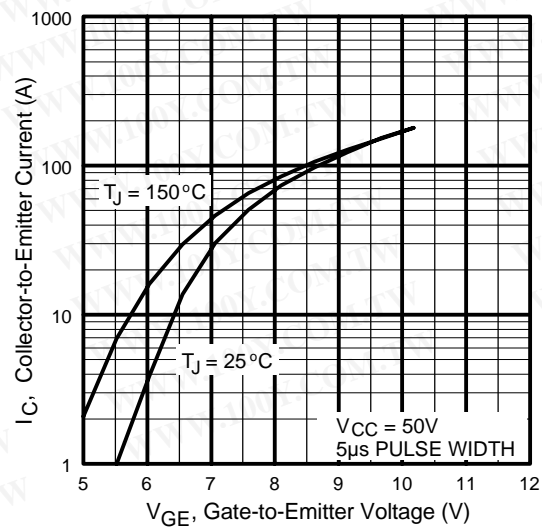
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**Fig. 1** - Typical Load Current vs. Frequency  
 (Load Current =  $I_{RMS}$  of fundamental)



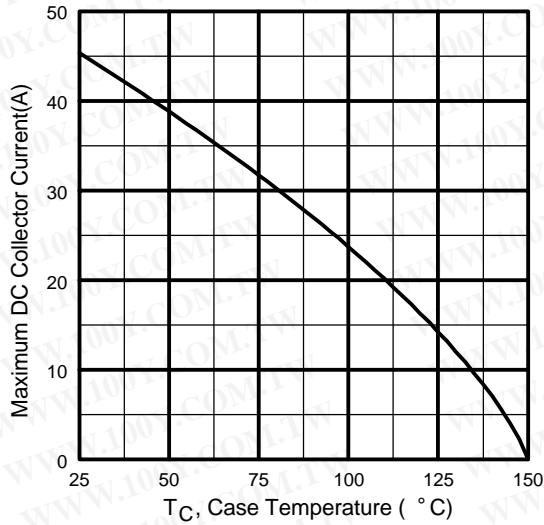
**Fig. 2** - Typical Output Characteristics



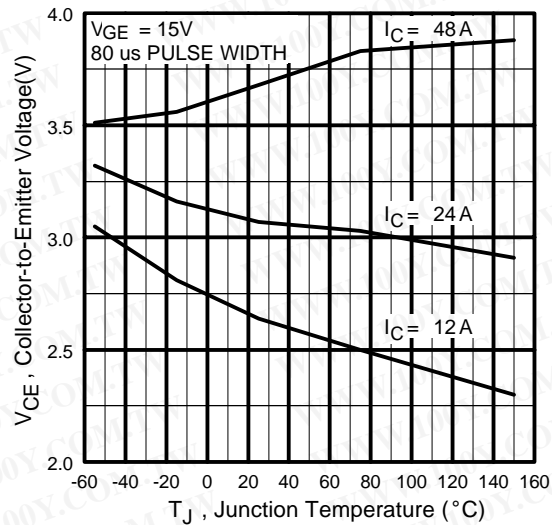
**Fig. 3** - Typical Transfer Characteristics

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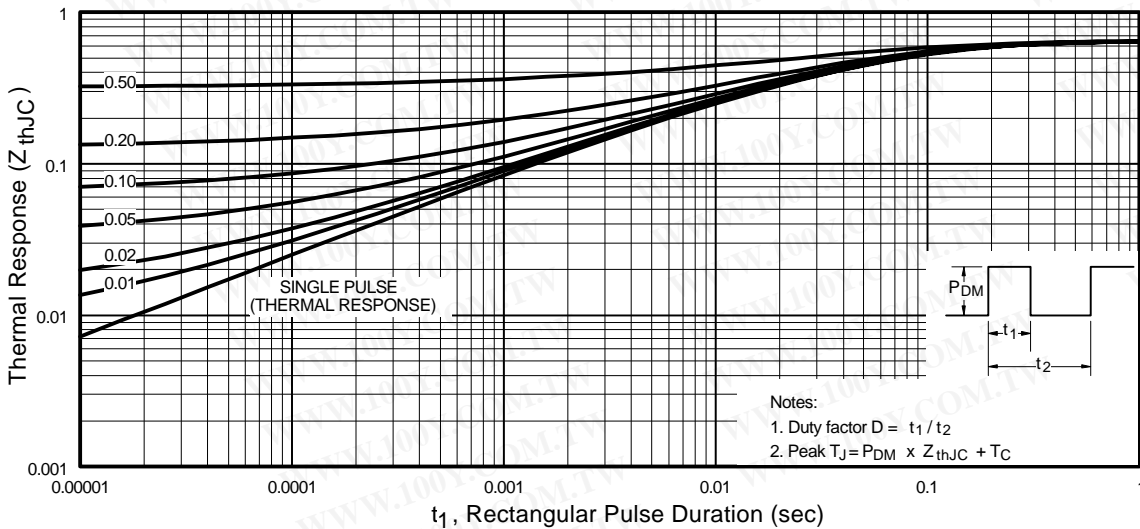
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**Fig. 4 - Maximum Collector Current vs. Case Temperature**



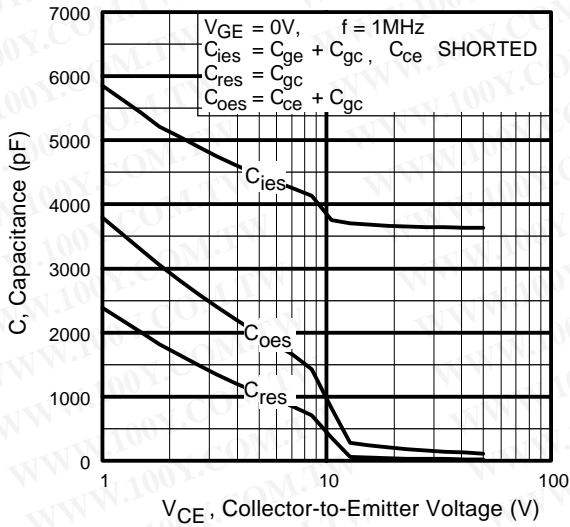
**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**



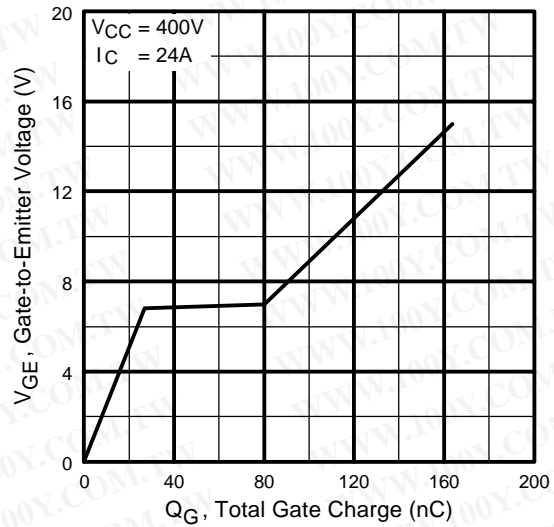
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

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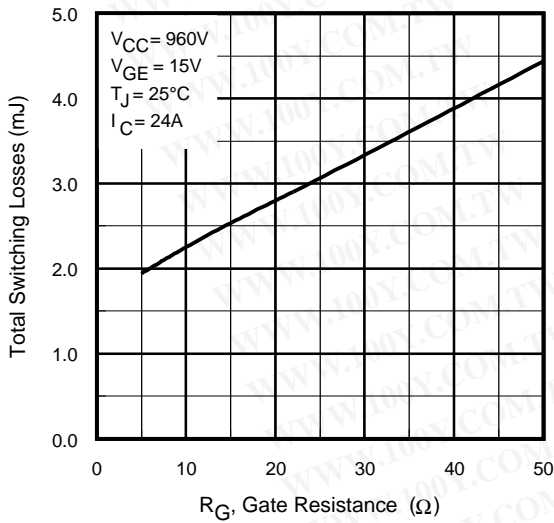
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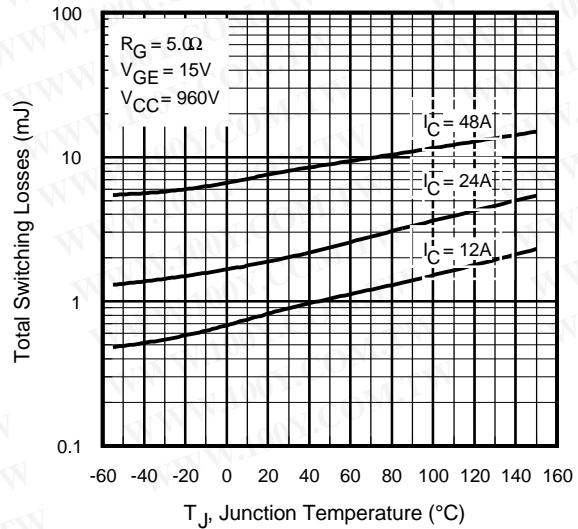
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



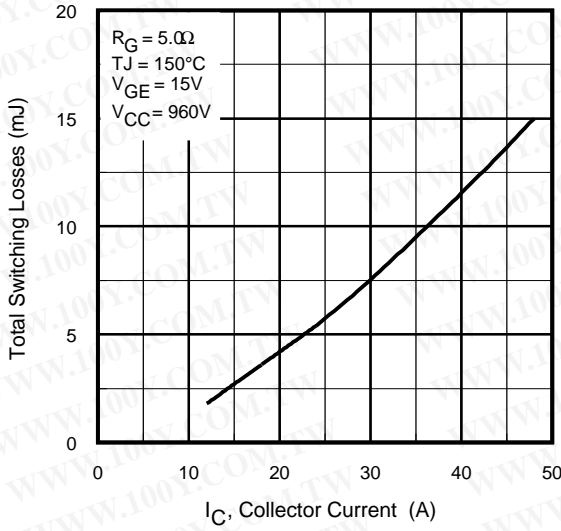
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



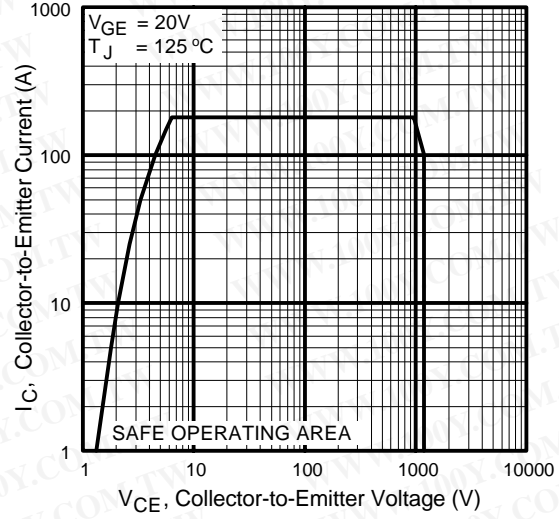
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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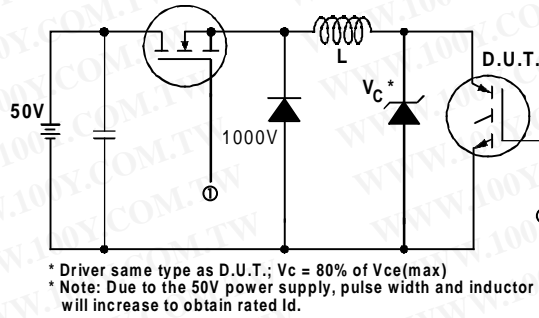
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



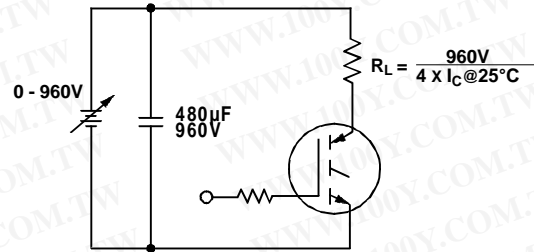
**Fig. 12** - Turn-Off SOA

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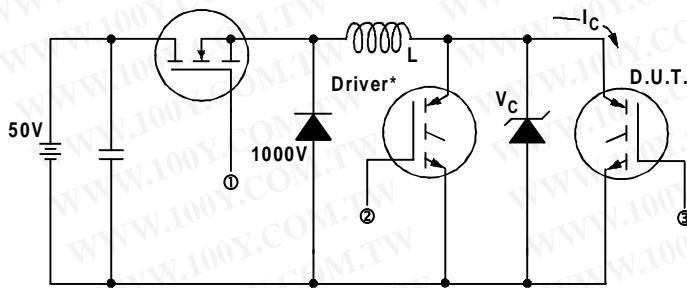
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**Fig. 13a** - Clamped Inductive Load Test Circuit

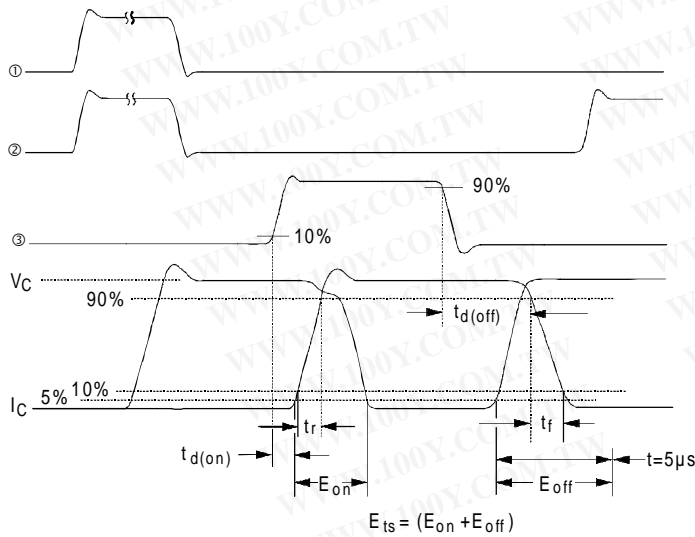


**Fig. 13b** - Pulsed Collector Current Test Circuit



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

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

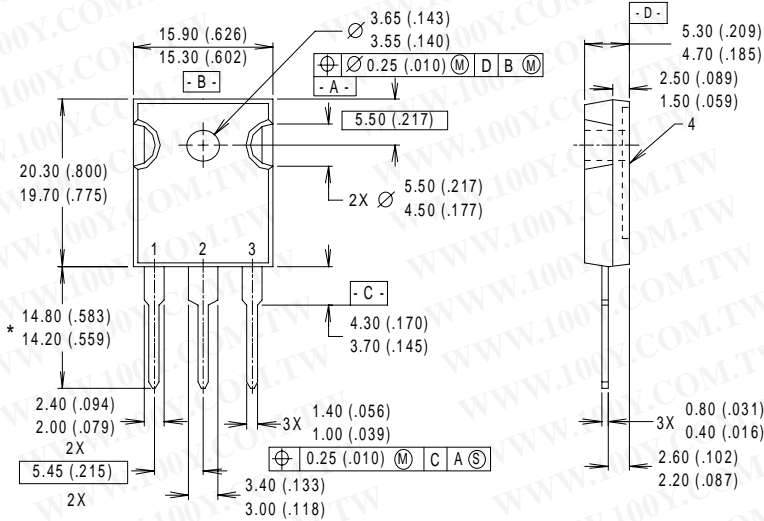


**Fig. 14b** - Switching Loss Waveforms

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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)

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