

# International **IR** Rectifier

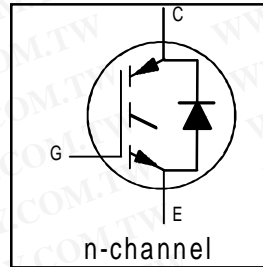
## IRG4PC30FD

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT

### Features

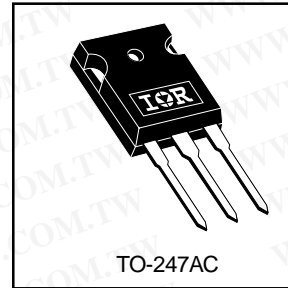
- Fast: Optimized for medium operating frequencies ( 1-5 kHz in hard switching, >20 kHz in resonant mode).
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.59V$
@ $V_{GE} = 15V, I_C = 17A$

### Benefits

- Generation -4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBT's



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	31	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	17	
$I_{CM}$	Pulsed Collector Current ①	120	
$I_{LM}$	Clamped Inductive Load Current ②	120	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	12	
$I_{FM}$	Diode Maximum Forward Current	120	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	100	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	42	
$T_J$	Operating Junction and	-55 to +150	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 sec.		
	Mounting Torque, 6-32 or M3 Screw.	10 lbf•in (1.1 N•m)	

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	1.2	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	2.5	
$R_{\theta CS}$	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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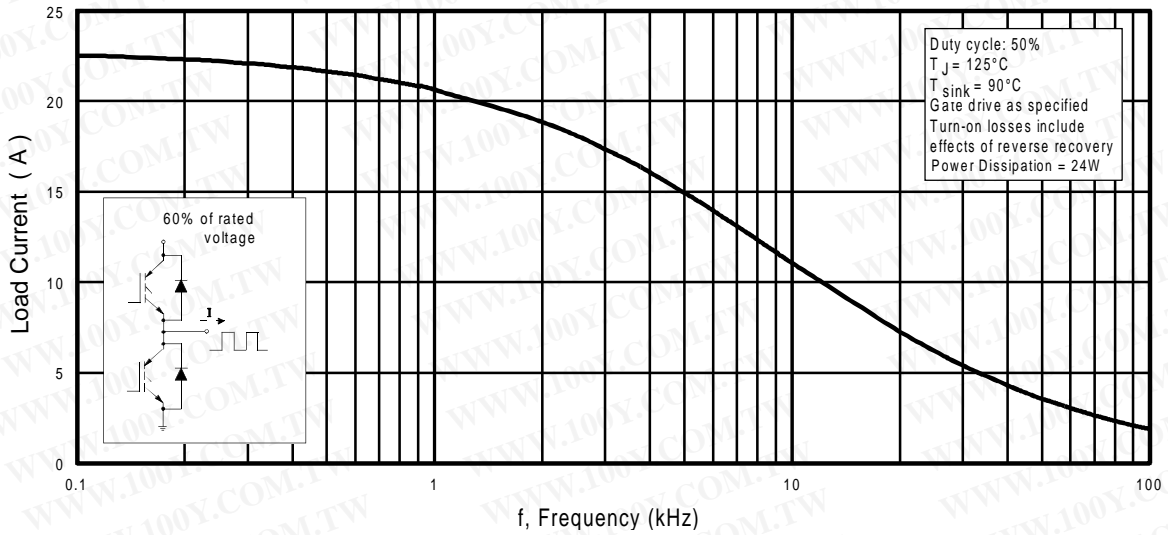
## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.69	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.59	1.8	V	$I_C = 17A, V_{GE} = 15V$ See Fig. 2, 5
		—	1.99	—		
		—	1.70	—		
$V_{GE(th)}$	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/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance <sup>④</sup>	6.1	10	—	S	$V_{CE} = 100V, I_C = 17A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	2500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ C$
$V_{FM}$	Diode Forward Voltage Drop	—	1.4	1.7	V	$I_C = 12A$ See Fig. 13
		—	1.3	1.6		$I_C = 12A, T_J = 150^\circ C$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

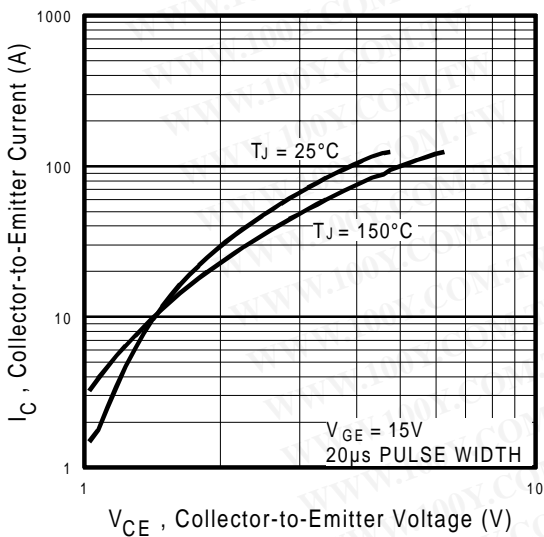
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	51	77	nC	$I_C = 17A$ $V_{CC} = 400V$ See Fig. 8 $V_{GE} = 15V$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	7.9	12		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	19	28		
$t_{d(on)}$	Turn-On Delay Time	—	42	—	ns	$T_J = 25^\circ C$ $I_C = 17A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 23\Omega$ Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
$t_r$	Rise Time	—	26	—		
$t_{d(off)}$	Turn-Off Delay Time	—	230	350		
$t_f$	Fall Time	—	160	230	mJ	$T_J = 150^\circ C$ , See Fig. 9, 10, 11, 18 $I_C = 17A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 23\Omega$ Energy losses include "tail" and diode reverse recovery.
$E_{on}$	Turn-On Switching Loss	—	0.63	—		
$E_{off}$	Turn-Off Switching Loss	—	1.39	—		
$E_{ts}$	Total Switching Loss	—	2.02	3.9	mJ	Measured 5mm from package
$t_{d(on)}$	Turn-On Delay Time	—	42	—		
$t_r$	Rise Time	—	27	—		
$t_{d(off)}$	Turn-Off Delay Time	—	310	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ See Fig. 7 $f = 1.0MHz$
$t_f$	Fall Time	—	310	—		
$E_{ts}$	Total Switching Loss	—	3.2	—		
$L_E$	Internal Emitter Inductance	—	13	—	ns	$I_F = 12A$ $V_R = 200V$
$C_{ies}$	Input Capacitance	—	1100	—		
$C_{oes}$	Output Capacitance	—	74	—		
$C_{res}$	Reverse Transfer Capacitance	—	14	—	nA	$T_J = 25^\circ C$ See Fig. 14 $T_J = 125^\circ C$ 15
$t_{rr}$	Diode Reverse Recovery Time	—	42	60		
		—	80	120		
$I_{rr}$	Diode Peak Reverse Recovery Current	—	3.5	6.0	A	$T_J = 25^\circ C$ See Fig. 15 $T_J = 125^\circ C$ 16
		—	5.6	10		
$Q_{rr}$	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ C$ See Fig. 16 $T_J = 125^\circ C$ 17
		—	220	600		
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	180	—	A/ $\mu s$	$T_J = 25^\circ C$ See Fig. 17 $T_J = 125^\circ C$ 17
		—	120	—		

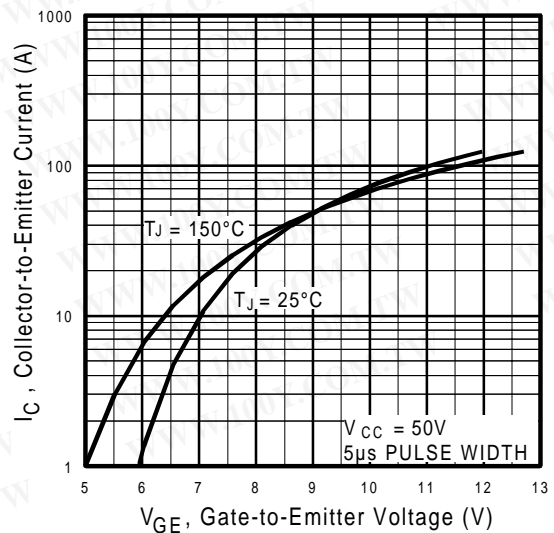
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**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{RMS}$  of fundamental)



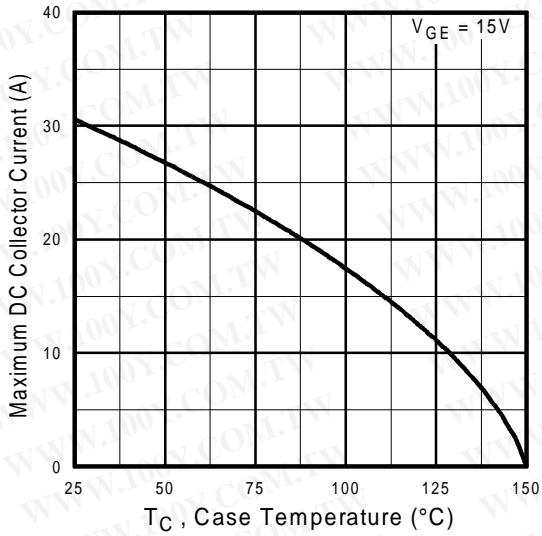
**Fig. 2 - Typical Output Characteristics**



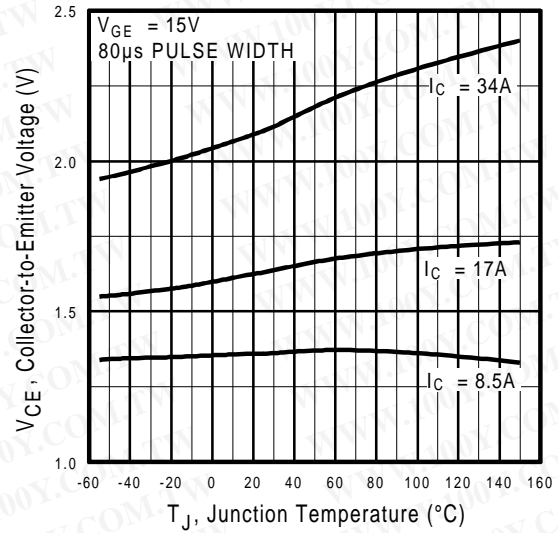
**Fig. 3 - Typical Transfer Characteristics**

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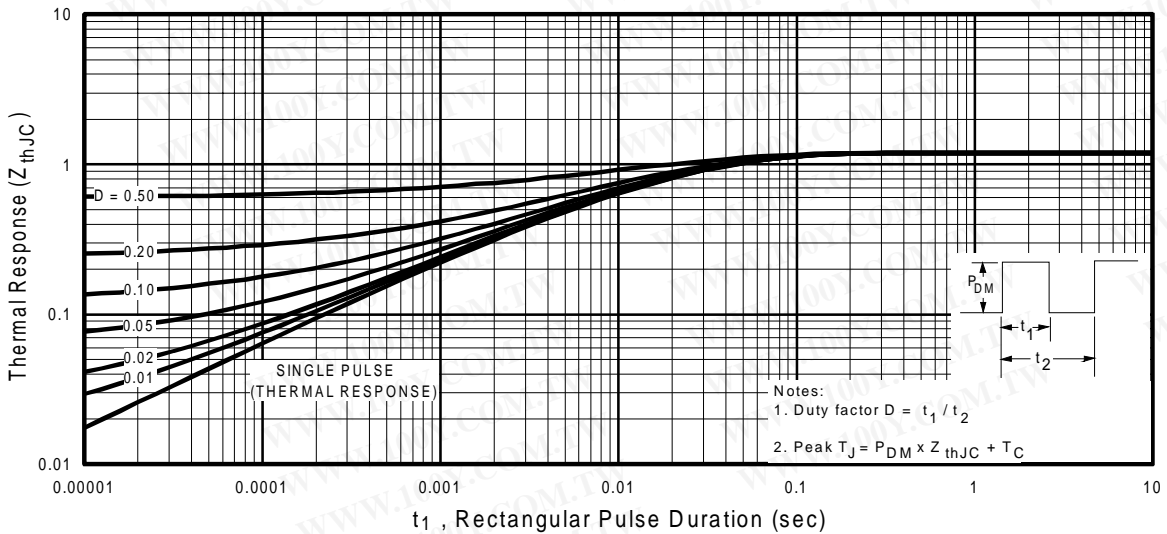
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**Fig. 4 - Maximum Collector Current vs. Case Temperature**



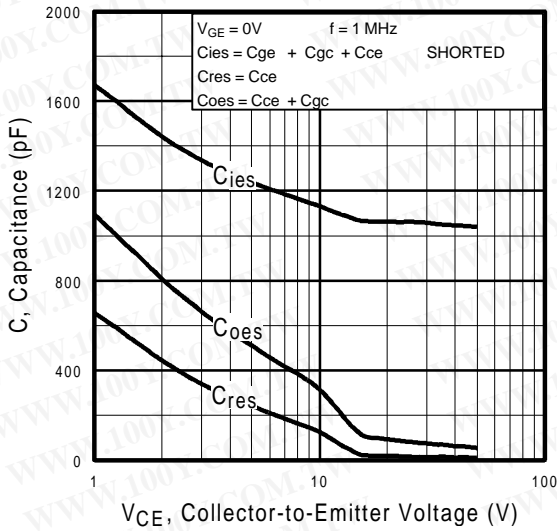
**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**



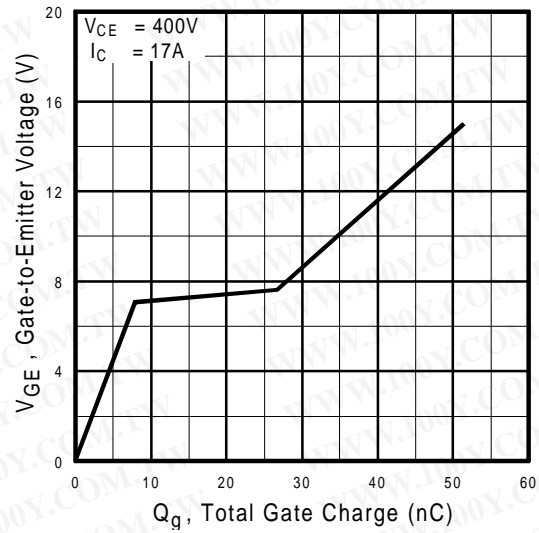
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

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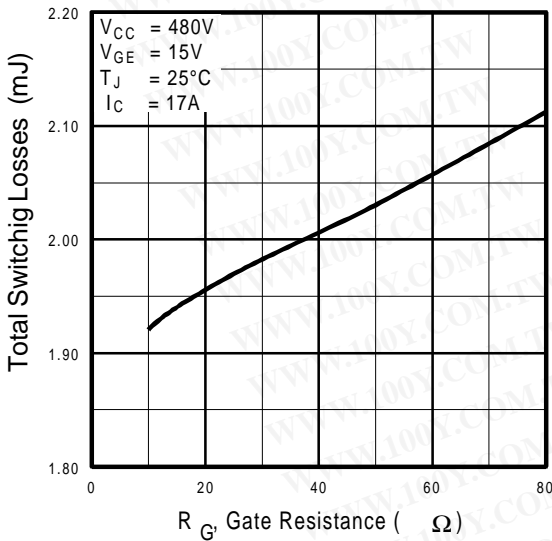
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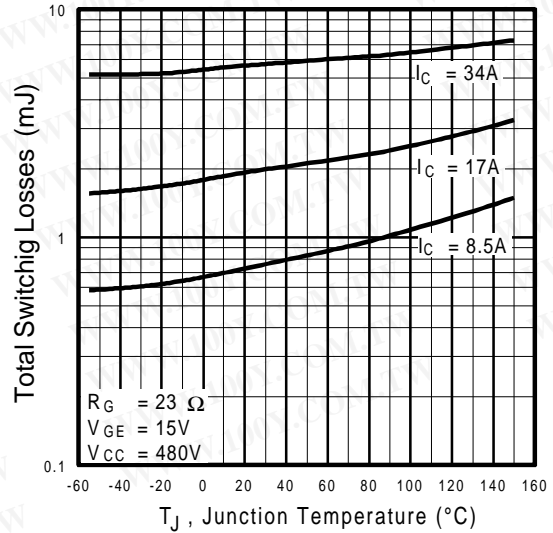
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



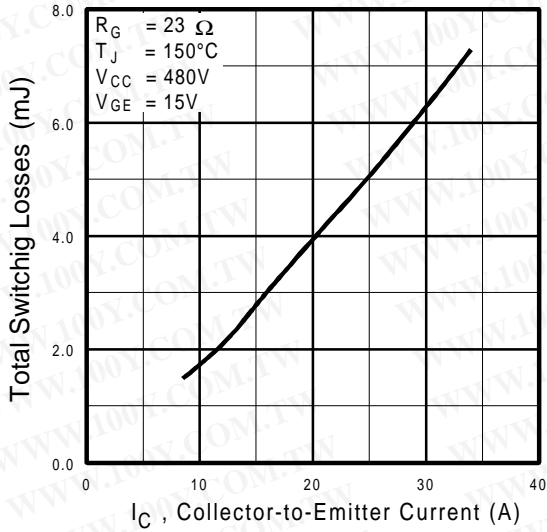
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



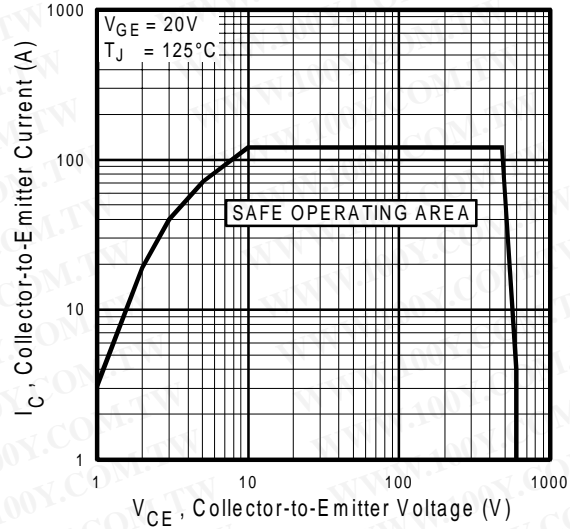
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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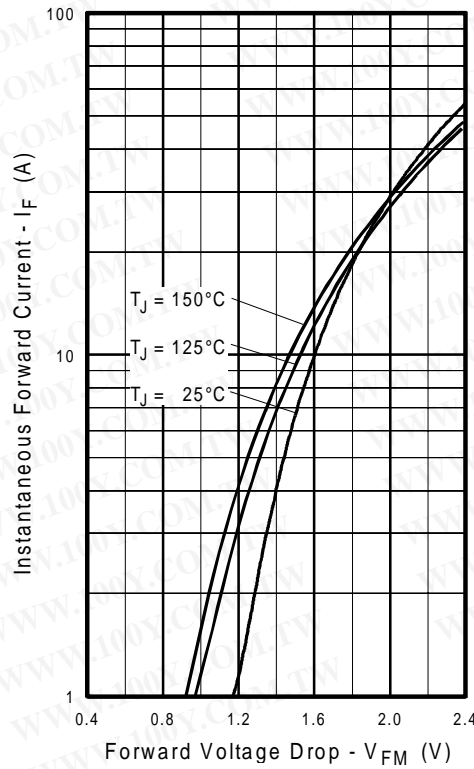
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**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



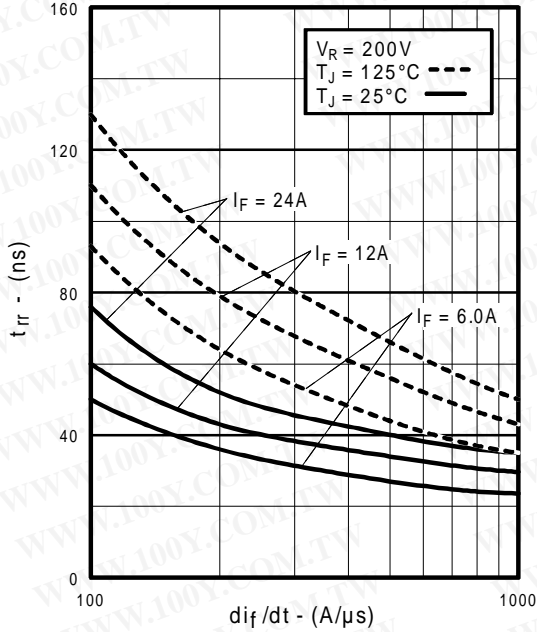
**Fig. 12** - Turn-Off SOA



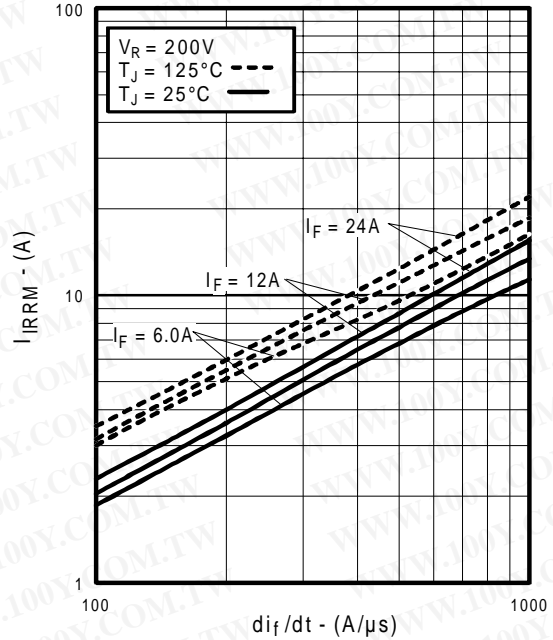
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

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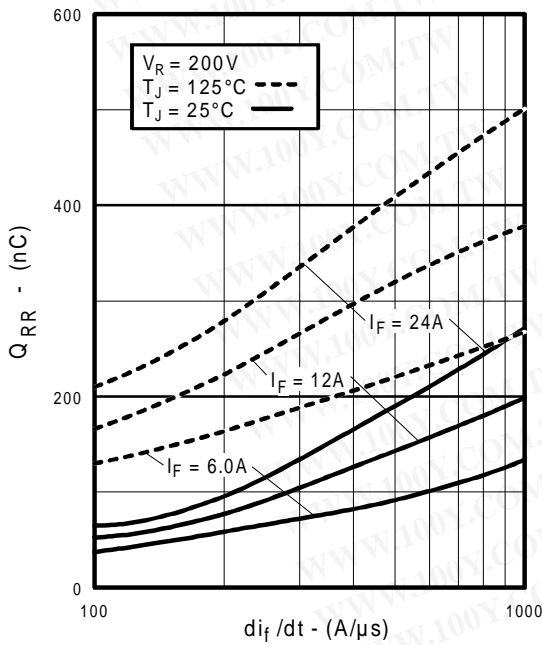
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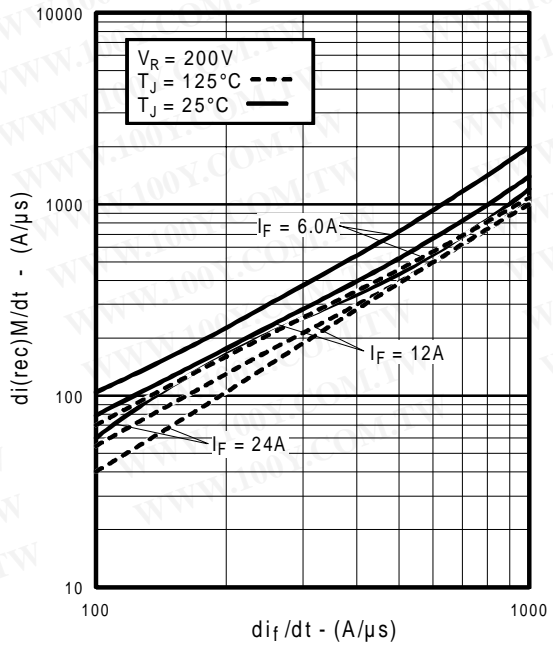
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



**Fig. 15** - Typical Recovery Current vs.  $di_f/dt$



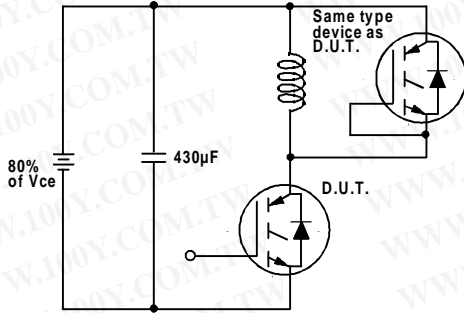
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



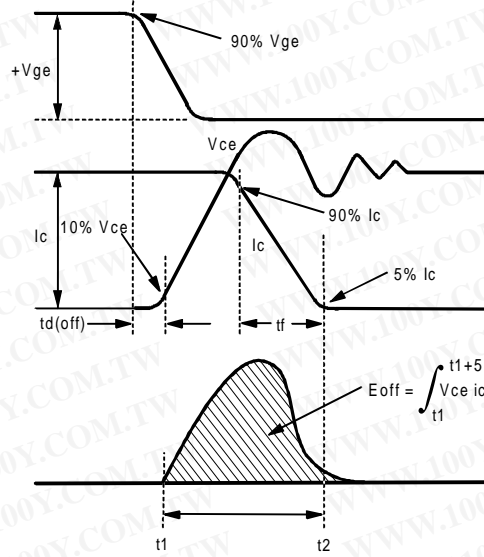
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

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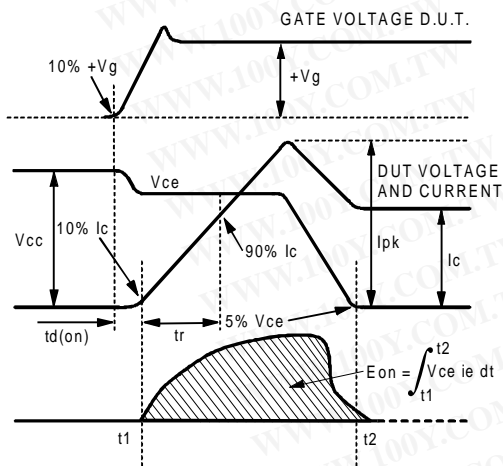
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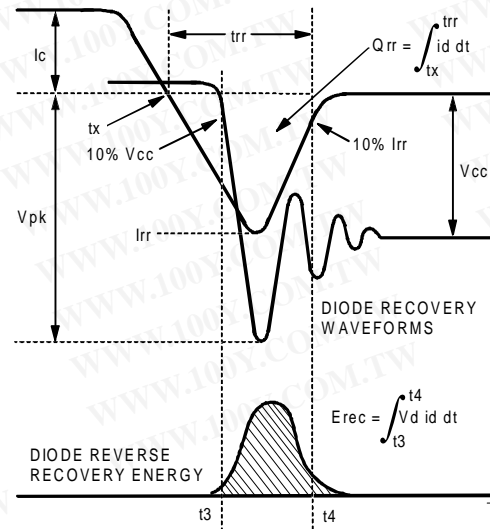
**Fig. 18a** - Test Circuit for Measurement of I<sub>LM</sub>, E<sub>on</sub>, E<sub>off</sub>(diode), t<sub>rr</sub>, Q<sub>rr</sub>, I<sub>rr</sub>, t<sub>d</sub>(on), t<sub>r</sub>, t<sub>d</sub>(off), t<sub>f</sub>



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining E<sub>off</sub>, t<sub>d</sub>(off), t<sub>f</sub>



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining E<sub>on</sub>, t<sub>d</sub>(on), t<sub>r</sub>



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining E<sub>rec</sub>, t<sub>rr</sub>, Q<sub>rr</sub>, I<sub>rr</sub>



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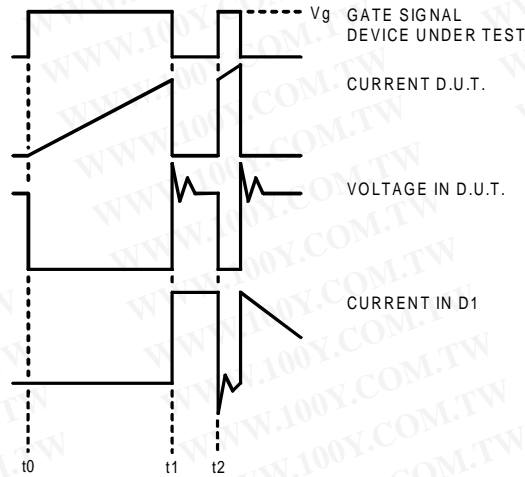


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

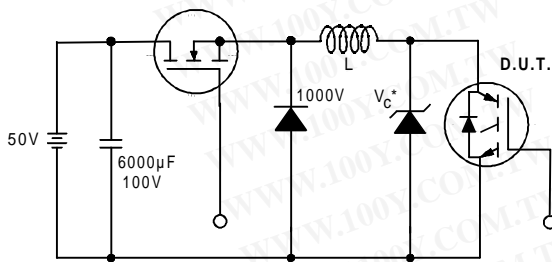


Figure 19. Clamped Inductive Load Test Circuit

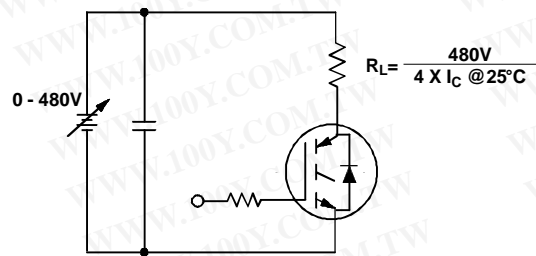


Figure 20. Pulsed Collector Current Test Circuit

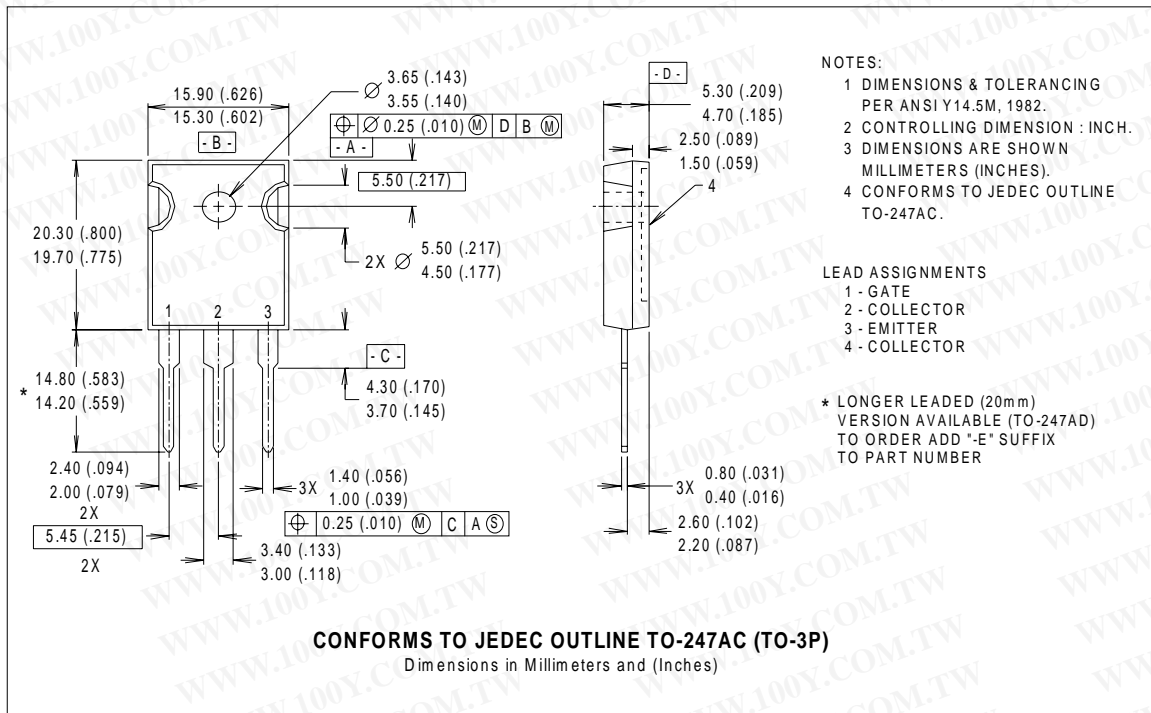
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### Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G = 23\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

### Case Outline — TO-247AC



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Data and specifications subject to change without notice. 12/00