

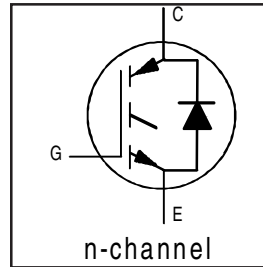
# IRG4IBC20FD

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT

## Features

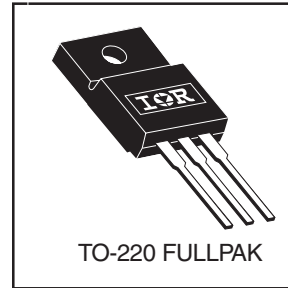
- Very Low 1.66V voltage drop
- 2.5kV, 60s insulation voltage ⑤
- 4.8 mm creepage distance to heatsink
- Fast: Optimized for medium operating frequencies ( 1-5 kHz in hard switching, >20 kHz in resonant mode).
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes
- Tighter parameter distribution
- Industry standard Isolated TO-220 Fullpak™ outline



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.66V$
@ $V_{GE} = 15V, I_C = 9.0A$

## Benefits

- Simplified assembly
- Highest efficiency and power density
- HEXFRED™ antiparallel Diode minimizes switching losses and EMI



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	14.3	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	7.7	
$I_{CM}$	Pulsed Collector Current ①	64	
$I_{LM}$	Clamped Inductive Load Current ②	64	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	6.5	
$I_{FM}$	Diode Maximum Forward Current	64	
Visol	RMS Isolation Voltage, Terminal to Case⑤	2500	V
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	34	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	14	
$T_J$	Operating Junction and	-55 to +150	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw.	10 lbf•in (1.1 N•m)	

## Thermal Resistance

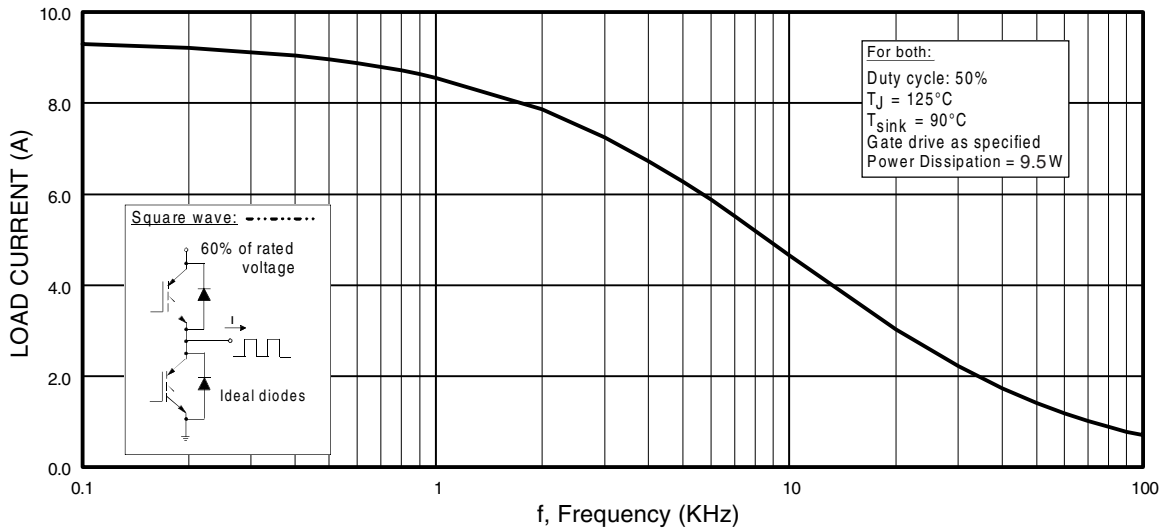
	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	3.7	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	5.1	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	65	
Wt	Weight	2.0 (0.07)	—	g (oz)

## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

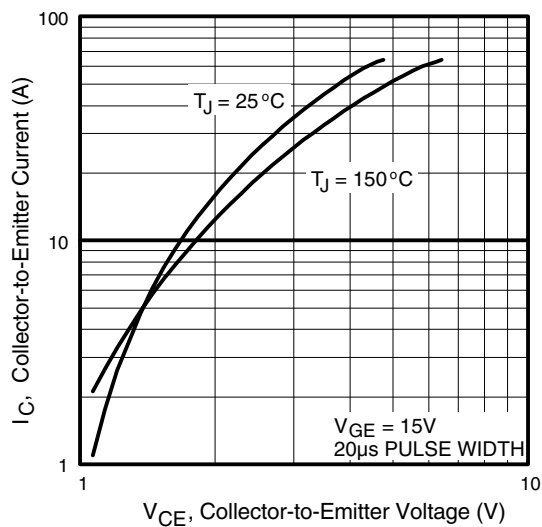
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES/ΔT<sub>J</sub></sub>	Temperature Coeff. of Breakdown Voltage	—	0.72	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.66	2.0	V	I <sub>C</sub> = 9.0A
		—	2.06	—		I <sub>C</sub> = 16A
		—	1.76	—		I <sub>C</sub> = 9.0A, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)/ΔT<sub>J</sub></sub>	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance <sup>④</sup>	2.9	5.1	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 9.0A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	1700		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.4	1.7	V	I <sub>C</sub> = 8.0A
		—	1.3	1.6		I <sub>C</sub> = 8.0A, T <sub>J</sub> = 150°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V

## Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

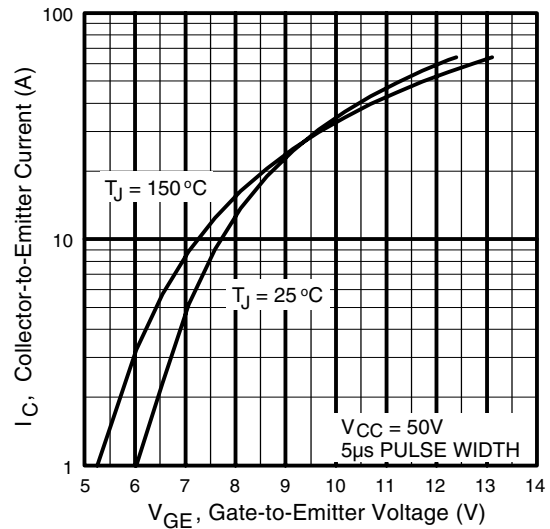
	Parameter	Min.	Typ.	Max.	Units	Conditions	
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	27	40	nC	I <sub>C</sub> = 9.0A	
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	4.2	6.2		V <sub>CC</sub> = 400V	
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	9.9	15		V <sub>GE</sub> = 15V	
t <sub>d(on)</sub>	Turn-On Delay Time	—	43	—	ns	T <sub>J</sub> = 25°C	
t <sub>r</sub>	Rise Time	—	20	—		I <sub>C</sub> = 9.0A, V <sub>CC</sub> = 480V	
t <sub>d(off)</sub>	Turn-Off Delay Time	—	240	360		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω	
t <sub>f</sub>	Fall Time	—	150	220		Energy losses include "tail" and diode reverse recovery.	
E <sub>on</sub>	Turn-On Switching Loss	—	0.25	—		mJ	See Fig. 9, 10, 18
E <sub>off</sub>	Turn-Off Switching Loss	—	0.64	—			
E <sub>ts</sub>	Total Switching Loss	—	0.89	1.3			
t <sub>d(on)</sub>	Turn-On Delay Time	—	41	—	ns	T <sub>J</sub> = 150°C, See Fig. 11, 18	
t <sub>r</sub>	Rise Time	—	22	—		I <sub>C</sub> = 9.0A, V <sub>CC</sub> = 480V	
t <sub>d(off)</sub>	Turn-Off Delay Time	—	320	—		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω	
t <sub>f</sub>	Fall Time	—	290	—		Energy losses include "tail" and diode reverse recovery.	
E <sub>ts</sub>	Total Switching Loss	—	1.35	—		mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package	
C <sub>ies</sub>	Input Capacitance	—	540	—	pF	V <sub>GE</sub> = 0V	
C <sub>oes</sub>	Output Capacitance	—	37	—		V <sub>CC</sub> = 30V	
C <sub>res</sub>	Reverse Transfer Capacitance	—	7.0	—		f = 1.0MHz	
t <sub>rr</sub>	Diode Reverse Recovery Time	—	37	55	ns	T <sub>J</sub> = 25°C See Fig. 14	
		—	55	90		T <sub>J</sub> = 125°C	
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	3.5	5.0	A	T <sub>J</sub> = 25°C See Fig. 15	
		—	4.5	8.0		T <sub>J</sub> = 125°C	
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	65	138	nC	T <sub>J</sub> = 25°C See Fig. 16	
		—	124	360		T <sub>J</sub> = 125°C	
di <sub>(rec)M/dt</sub>	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	240	—	A/μs	T <sub>J</sub> = 25°C See Fig. 17	
		—	210	—		T <sub>J</sub> = 125°C	



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

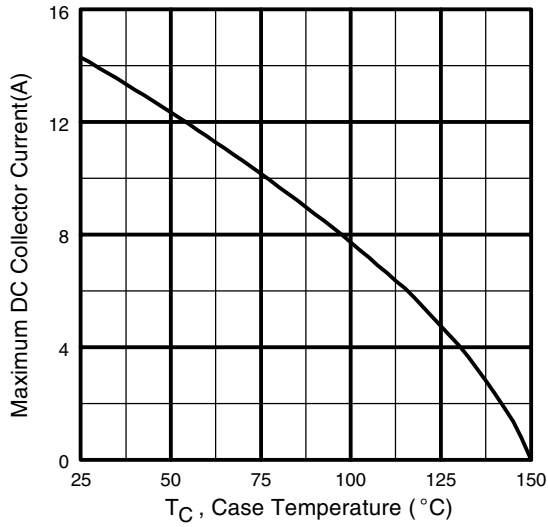


**Fig. 2 - Typical Output Characteristics**  
[www.irf.com](http://www.irf.com)

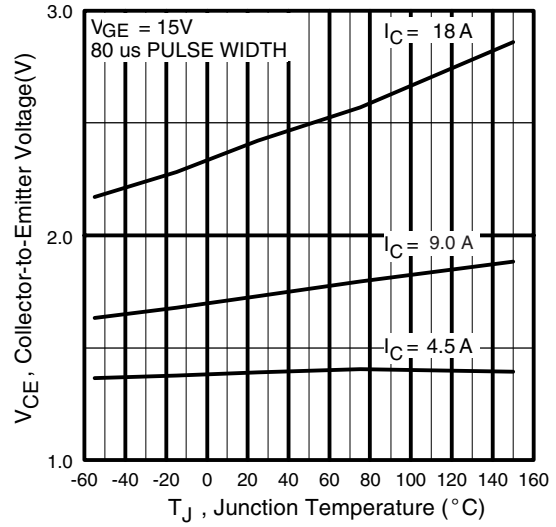


**Fig. 3 - Typical Transfer Characteristics**

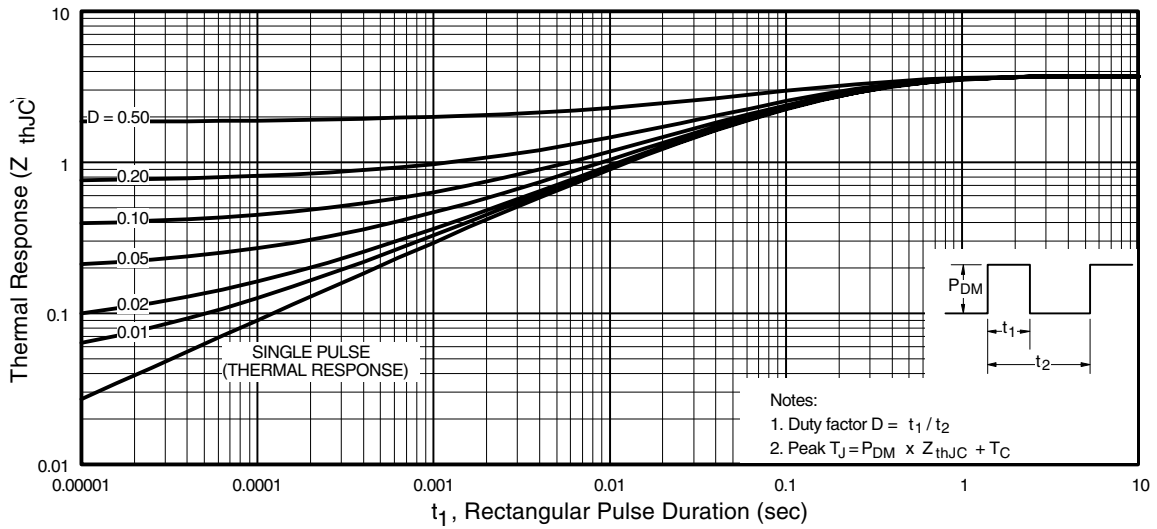
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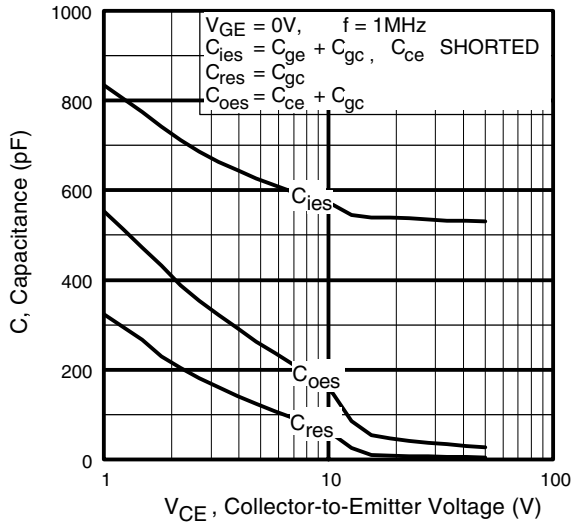
**Fig. 4** - Maximum Collector Current vs. Case Temperature



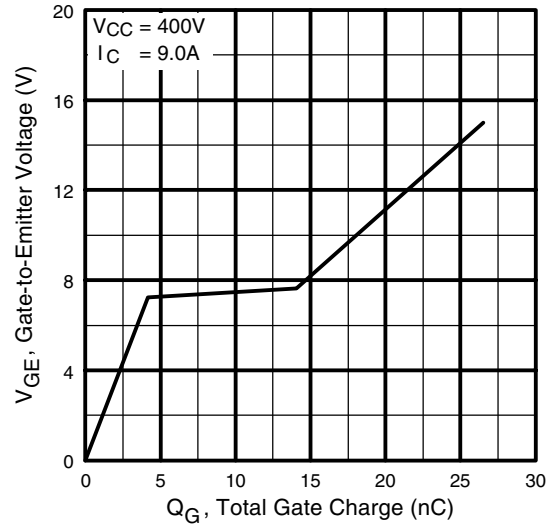
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



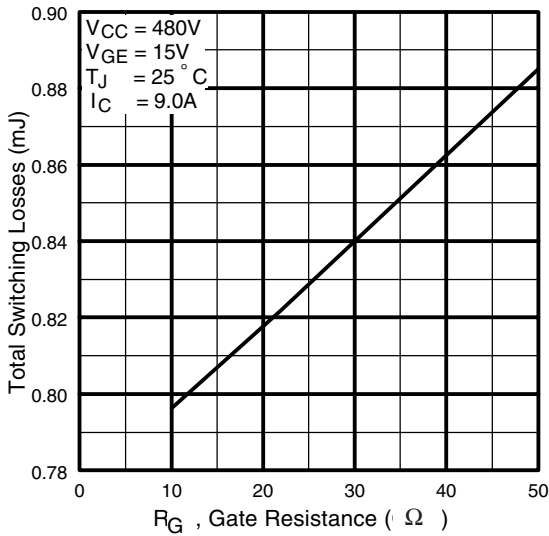
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



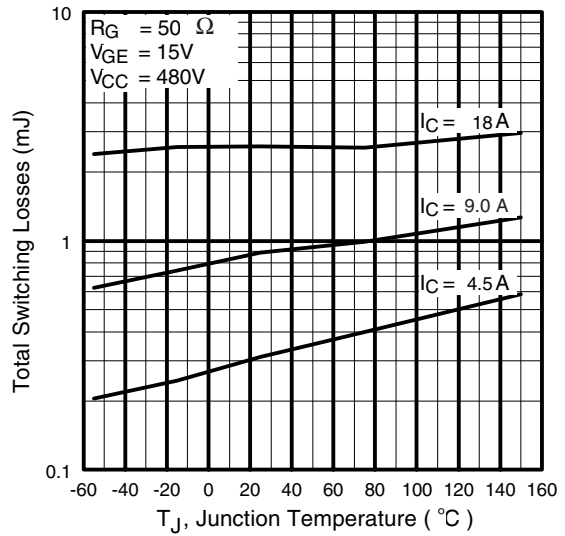
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

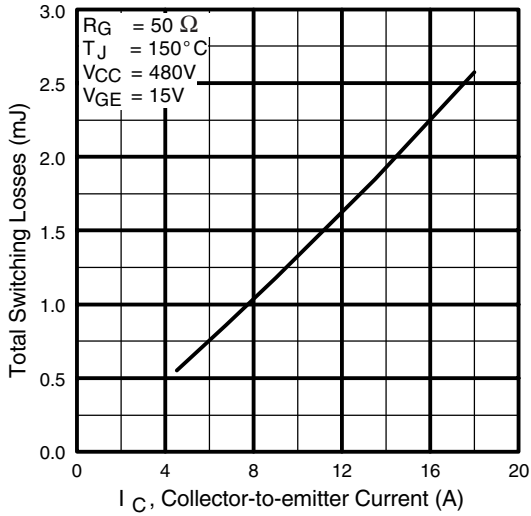


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

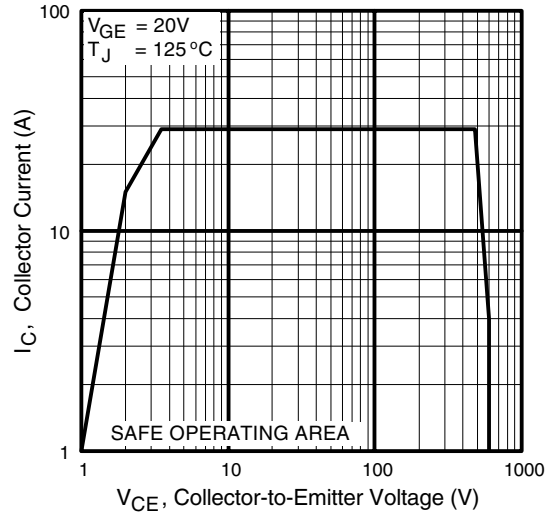


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

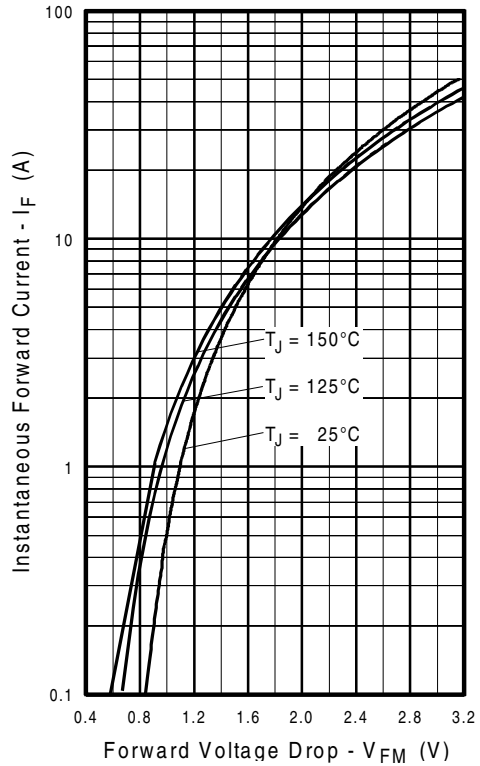
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**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



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



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

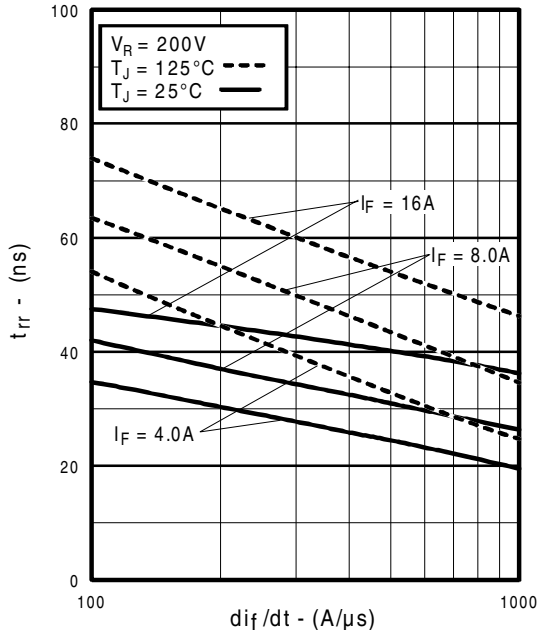


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

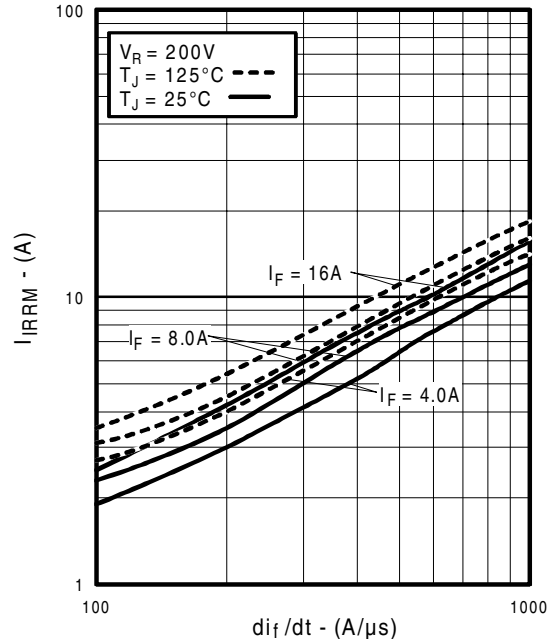


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

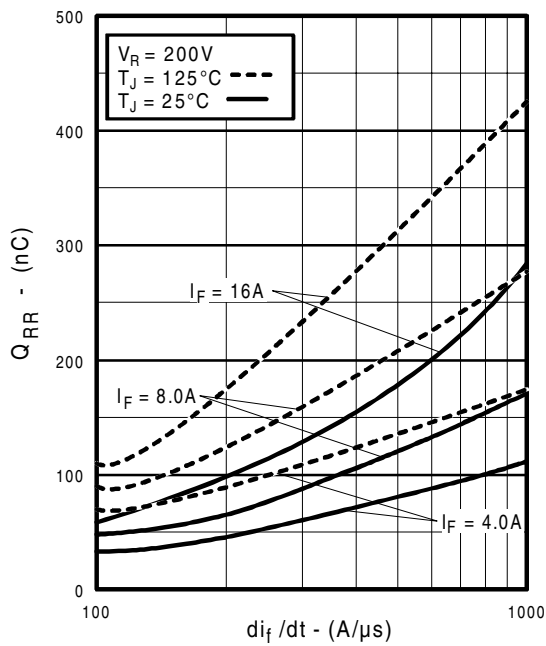


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

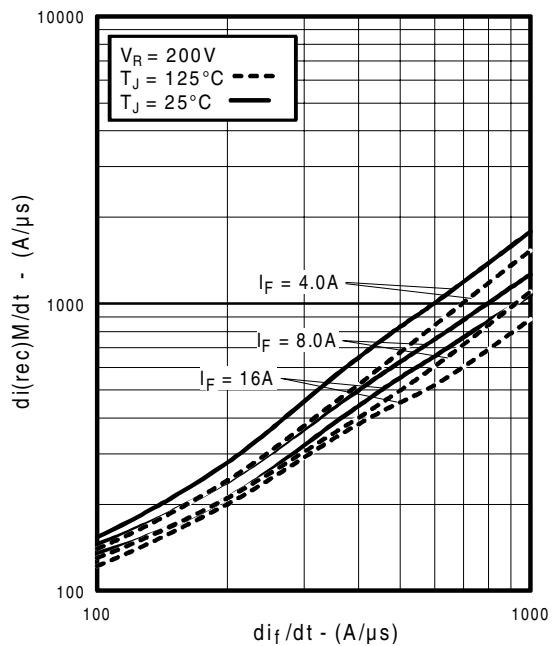
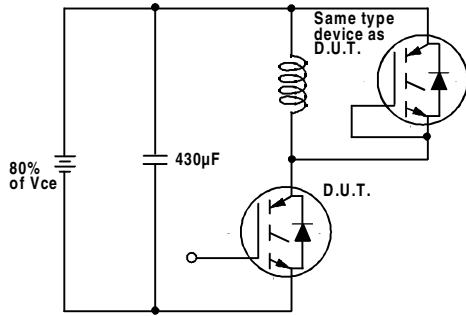
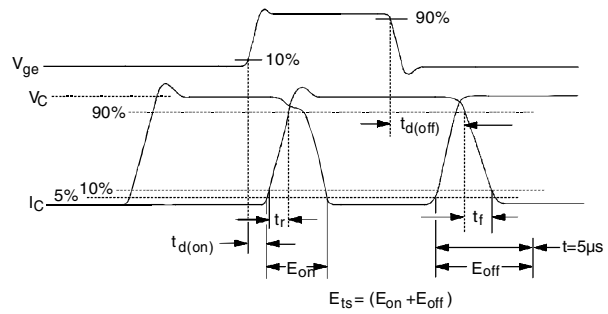


Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

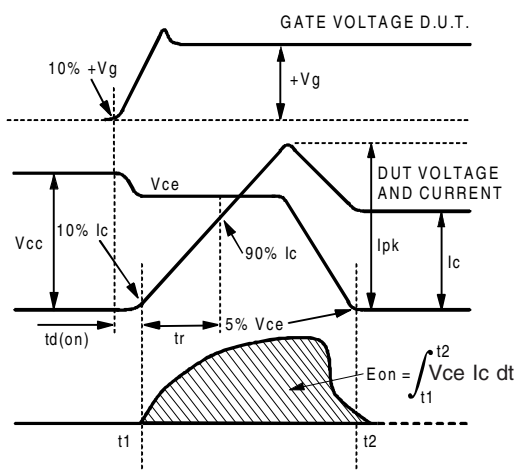
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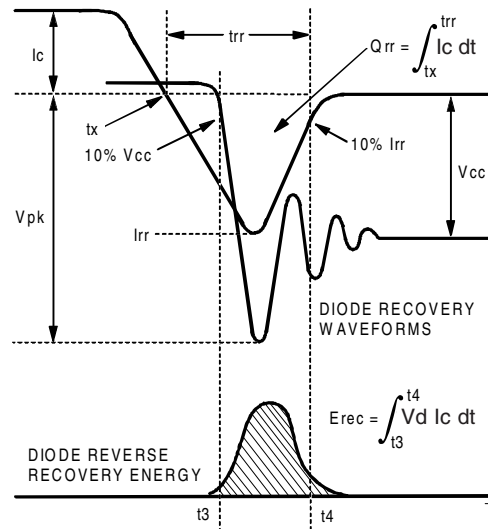
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



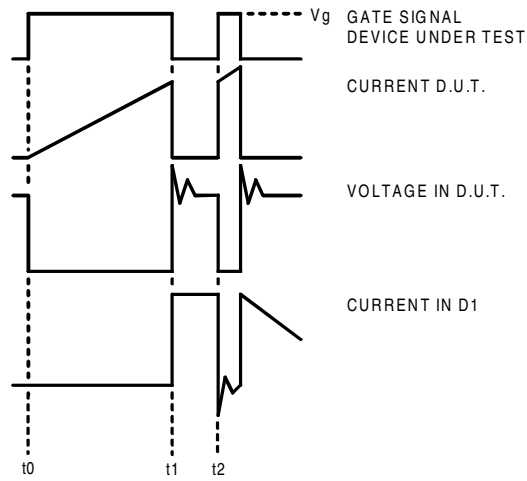


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

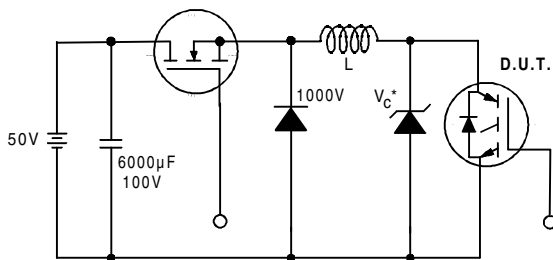


Figure 19. Clamped Inductive Load Test Circuit

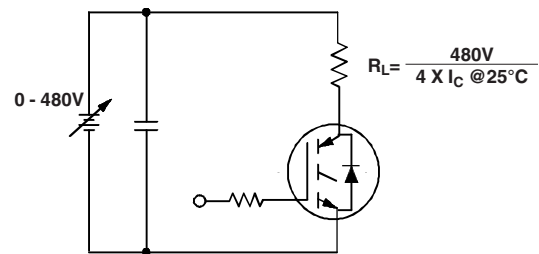


Figure 20. Pulsed Collector Current Test Circuit

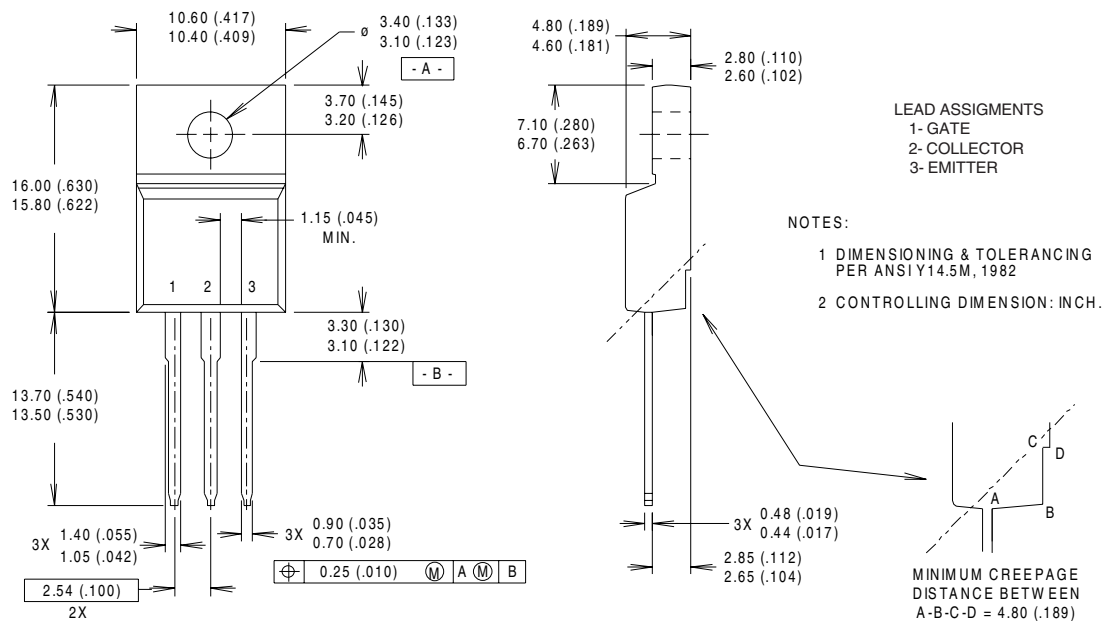
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International  
**IR** Rectifier

## Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G = 50\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.
- ⑤  $t = 60s$ ,  $f = 60Hz$

## Case Outline — TO-220 FULLPAK



International  
**IR** Rectifier

**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 0BL, 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. 4/00*