

# International Rectifier

PD - 9.1145A

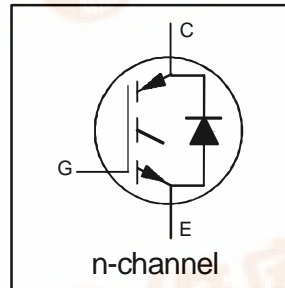
## IRGPC50MD2

INSULATED GATE BIPOLAR TRANSISTOR  
WITH ULTRAFAST SOFT RECOVERY

Short Circuit Rated  
Fast CoPack IGBT

### DIODE Features

- Short circuit rated  $-10\mu\text{s}$  @  $125^\circ\text{C}$ ,  $V_{GE} = 15\text{V}$
- Switching-loss rating includes all "tail" losses
- HEXFRED™ soft ultrafast diodes
- Optimized for medium operating frequency (1 to 10kHz) See Fig. 1 for Current vs. Frequency curve

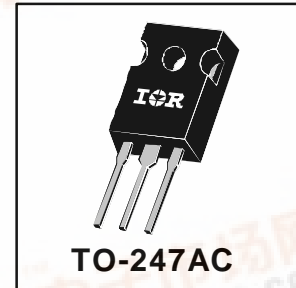


$V_{CES} = 600\text{V}$   
 $V_{CE(sat)} \leq 2.0\text{V}$   
@  $V_{GE} = 15\text{V}$ ,  $I_C = 35\text{A}$

### Description

Co-packaged IGBTs are a natural extension of International Rectifier's well known IGBT line. They provide the convenience of an IGBT and an ultrafast recovery diode in one package, resulting in substantial benefits to a host of high-voltage, high-current, applications.

These new short circuit rated devices are especially suited for motor control and other applications requiring short circuit withstand capability.



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ\text{C}$	Continuous Collector Current	60	A
$I_C @ T_C = 100^\circ\text{C}$	Continuous Collector Current	35	
$I_{CM}$	Pulsed Collector Current ①	120	
$I_{LM}$	Clamped Inductive Load Current ②	120	
$I_F @ T_C = 100^\circ\text{C}$	Diode Continuous Forward Current	25	
$I_{FM}$	Diode Maximum Forward Current	120	
$t_{sc}$	Short Circuit Withstand Time	10	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ\text{C}$	Maximum Power Dissipation	78	
$T_J$	Operating Junction and	-55 to +150	$^\circ\text{C}$
$T_{STG}$	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	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.64	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.83	
$R_{\theta CS}$	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)



# IRGPC50MD2



## 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 ③	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temp. Coeff. of Breakdown Voltage	—	0.62	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.8	2.0	V	I <sub>C</sub> = 35A
		—	2.3	—		I <sub>C</sub> = 60A
		—	2.0	—		I <sub>C</sub> = 35A, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	5.5		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Threshold Voltage	—	-14	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance ④	11	20	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 35A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	6500		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.3	1.7	V	I <sub>C</sub> = 25A
		—	1.2	1.5		I <sub>C</sub> = 25A, 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)	—	120	180	nC	I <sub>C</sub> = 35A
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	25	38		V <sub>CC</sub> = 400V
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	40	60		See Fig. 8
t <sub>d(on)</sub>	Turn-On Delay Time	—	78	—	ns	T <sub>J</sub> = 25°C
t <sub>r</sub>	Rise Time	—	110	—		I <sub>C</sub> = 35A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	340	510		V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>f</sub>	Fall Time	—	265	400		Energy losses include "tail" and diode reverse recovery.
E <sub>on</sub>	Turn-On Switching Loss	—	2.1	—		See Fig. 9, 10, 11, 18
E <sub>off</sub>	Turn-Off Switching Loss	—	4.0	—	mJ	
E <sub>ts</sub>	Total Switching Loss	—	6.1	9.5		
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—	μs	V <sub>CC</sub> = 360V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω, V <sub>Cpk</sub> < 500V
t <sub>d(on)</sub>	Turn-On Delay Time	—	80	—	ns	T <sub>J</sub> = 150°C, See Fig. 9, 10, 11, 18
t <sub>r</sub>	Rise Time	—	110	—		I <sub>C</sub> = 35A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	610	—		V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>f</sub>	Fall Time	—	440	—		Energy losses include "tail" and diode reverse recovery.
E <sub>ts</sub>	Total Switching Loss	—	9.4	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	2900	—	pF	V <sub>GE</sub> = 0V
C <sub>oes</sub>	Output Capacitance	—	230	—		V <sub>CC</sub> = 30V
C <sub>res</sub>	Reverse Transfer Capacitance	—	30	—		f = 1.0MHz
t <sub>rr</sub>	Diode Reverse Recovery Time	—	50	75	ns	T <sub>J</sub> = 25°C
		—	105	160		T <sub>J</sub> = 125°C
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	4.5	10	A	T <sub>J</sub> = 25°C
		—	8.0	15		T <sub>J</sub> = 125°C
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	112	375	nC	T <sub>J</sub> = 25°C
		—	420	1200		T <sub>J</sub> = 125°C
di <sub>(rec)</sub> M/dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	250	—	A/μs	T <sub>J</sub> = 25°C
		—	160	—		T <sub>J</sub> = 125°C

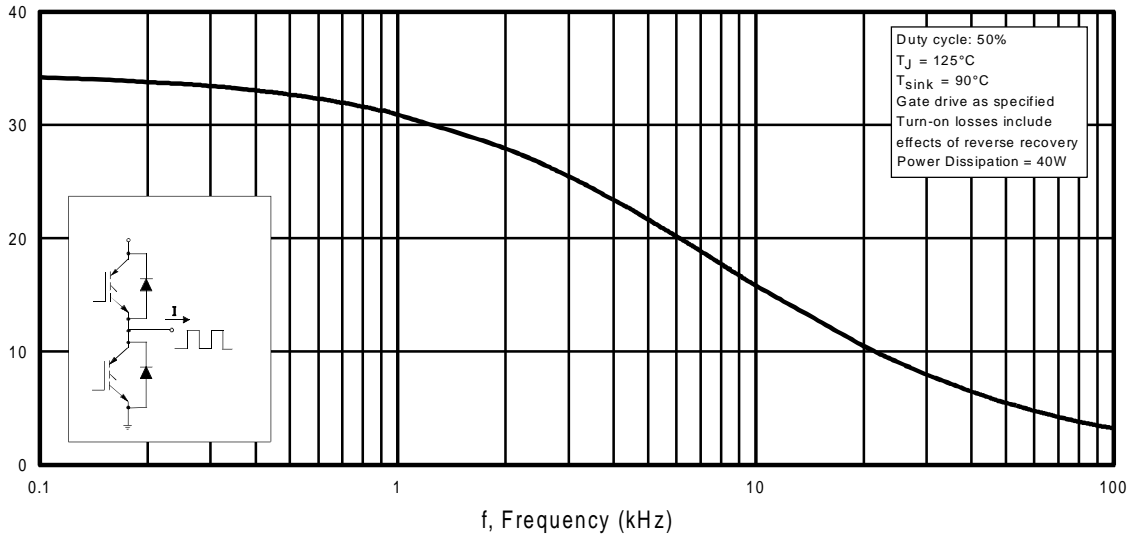
### Notes:

① Repetitive rating; V<sub>GE</sub>=20V, pulse width limited by max. junction temperature. ( See fig. 20 )

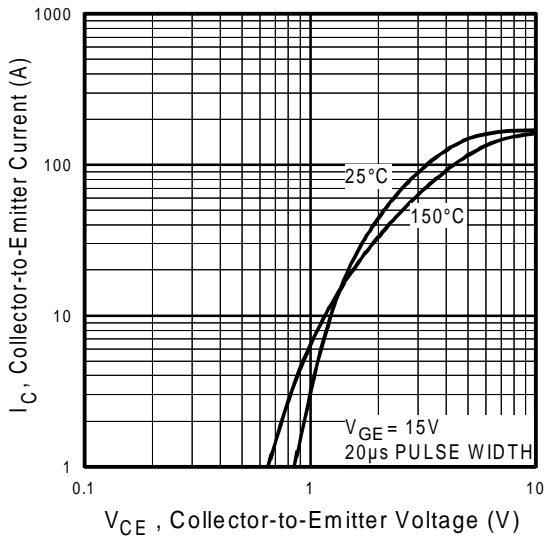
② V<sub>CC</sub>=80%(V<sub>CES</sub>), V<sub>GE</sub>=20V, L=10μH, R<sub>G</sub>= 5.0Ω, ( See fig. 19 )

③ Pulse width ≤ 80μs; duty factor ≤ 0.1%.

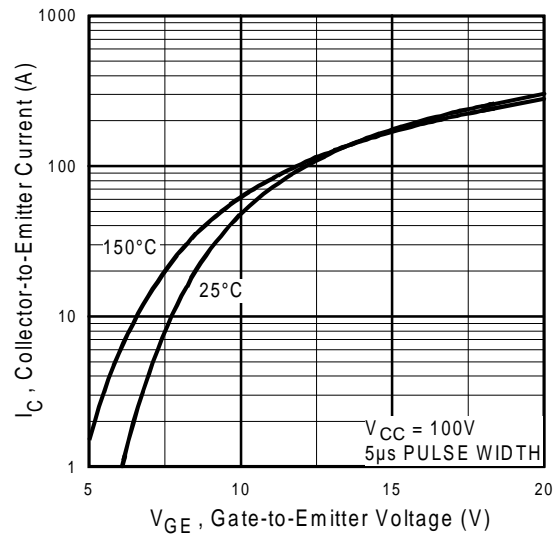
④ Pulse width 5.0μs, single shot.



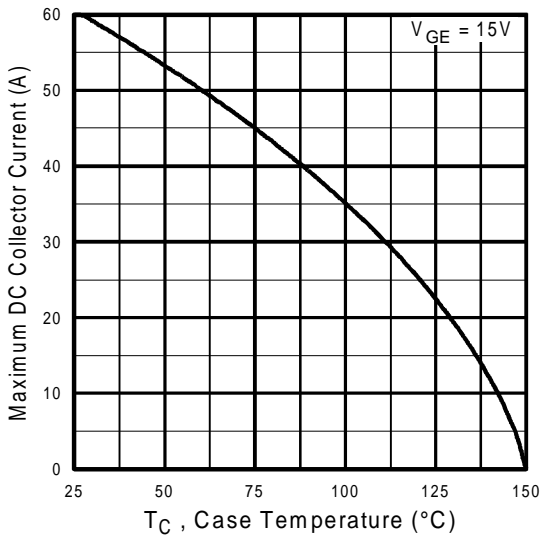
**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)



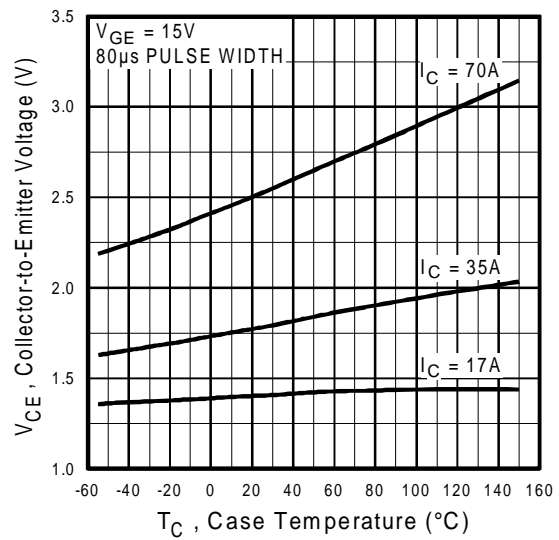
**Fig. 2 - Typical Output Characteristics**



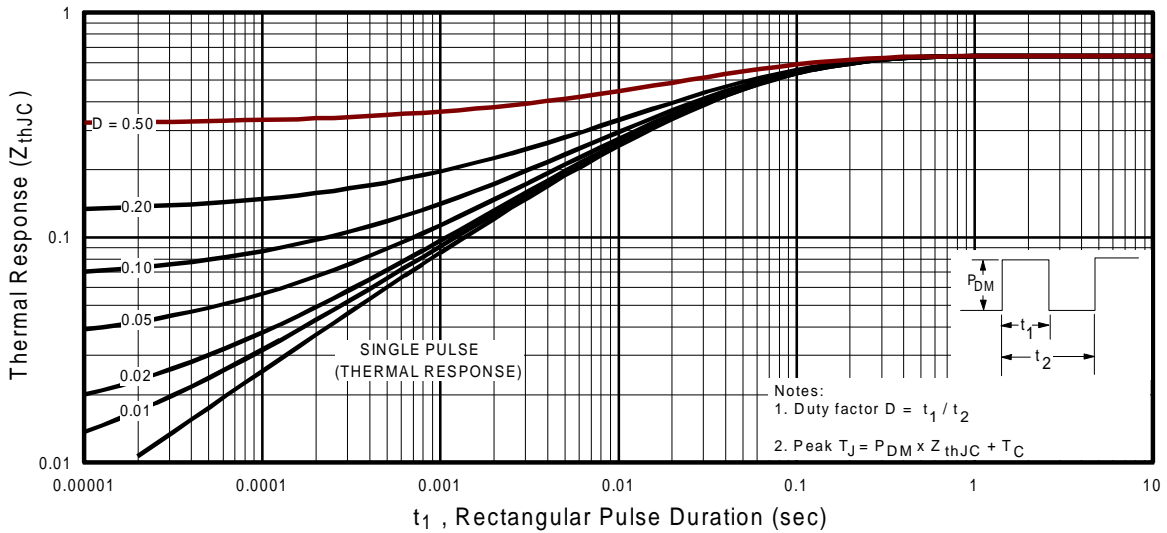
**Fig. 3 - Typical Transfer Characteristics**



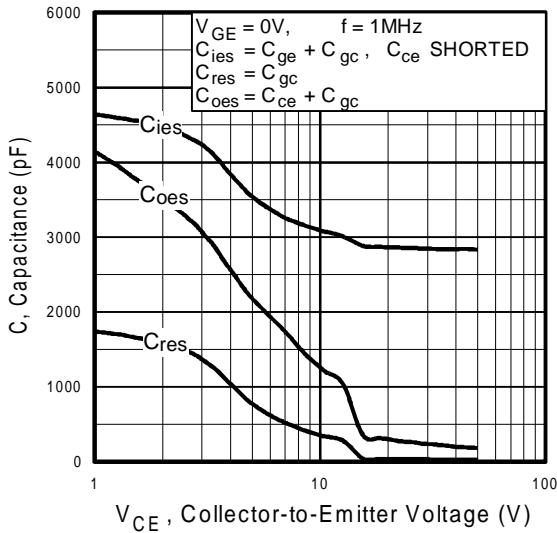
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



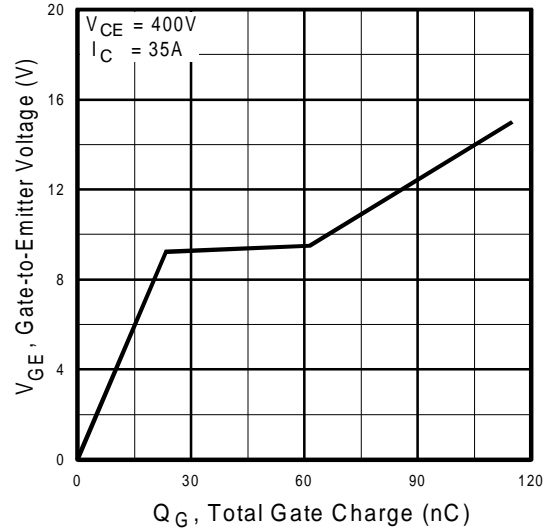
**Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature**



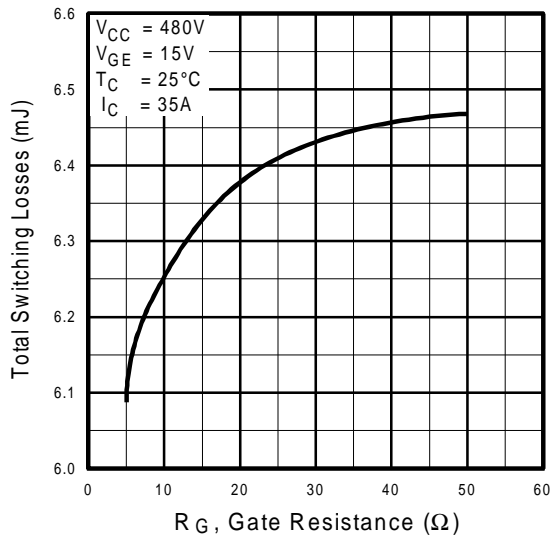
**Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case**



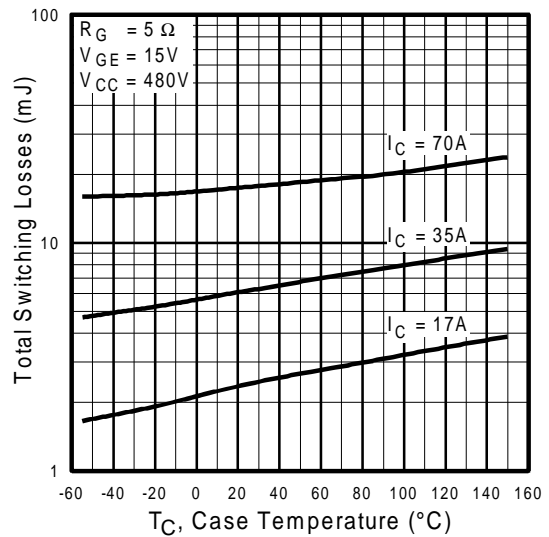
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



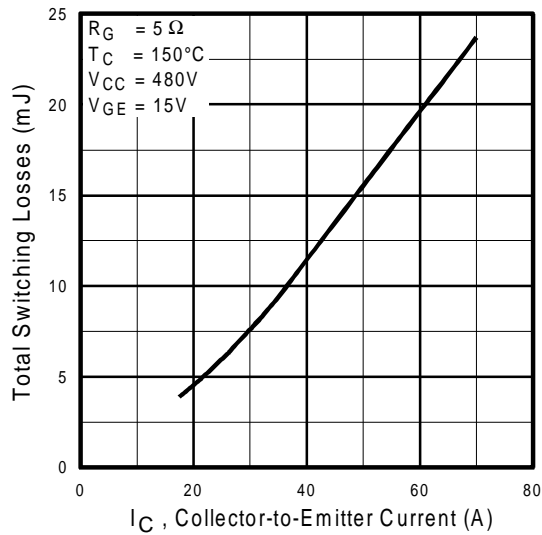
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



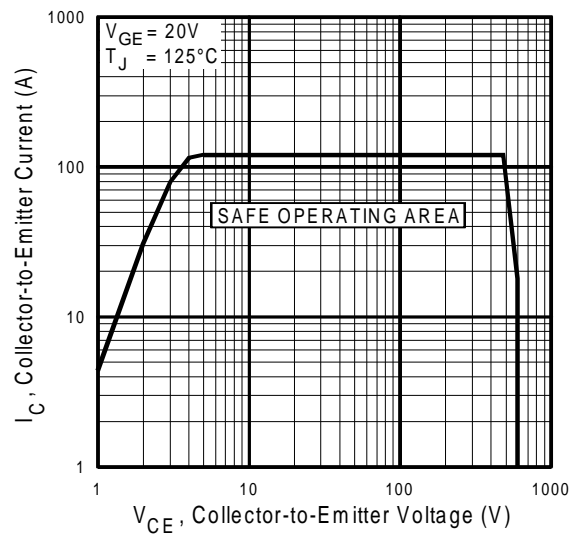
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



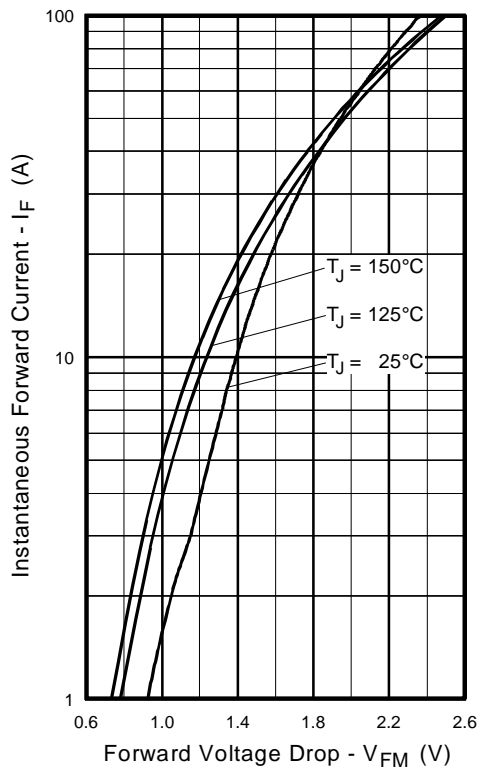
**Fig. 10** - Typical Switching Losses vs. Case Temperature



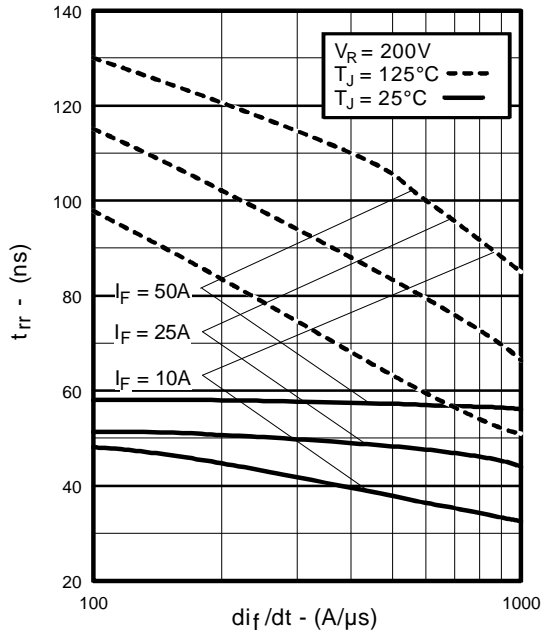
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



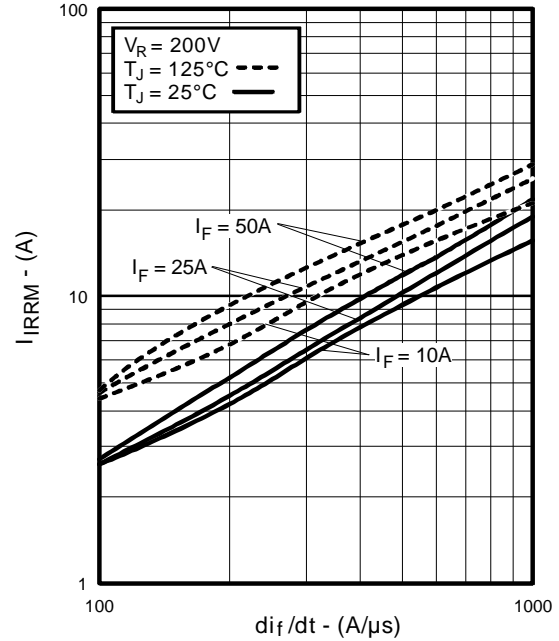
**Fig. 12** - Turn-Off SOA



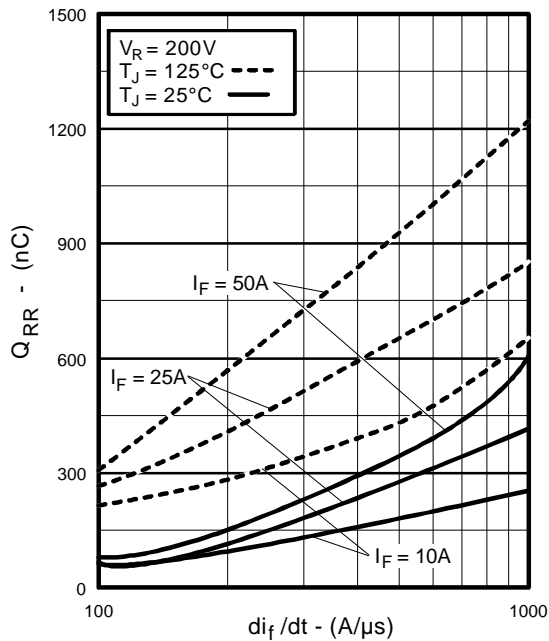
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



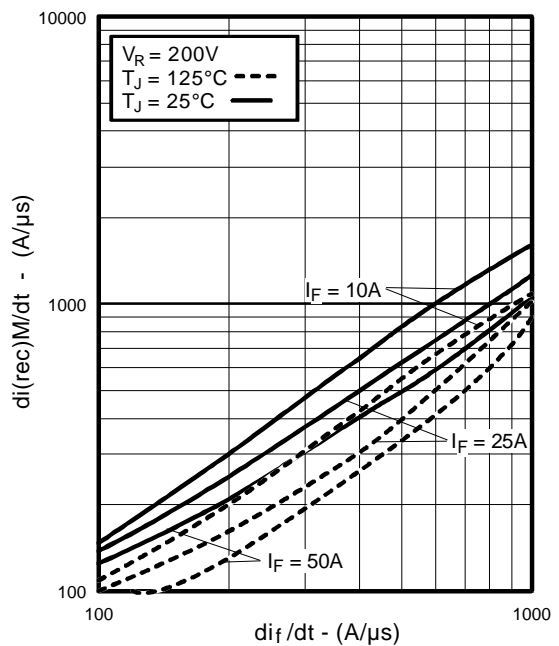
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



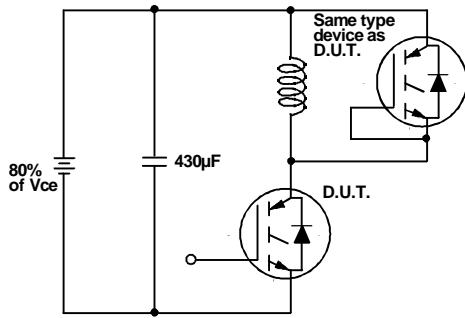
**Fig. 15** - Typical Recovery Current vs.  $di_f/dt$



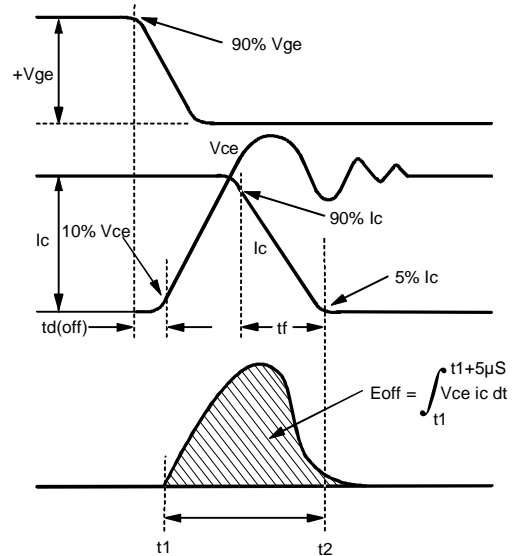
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



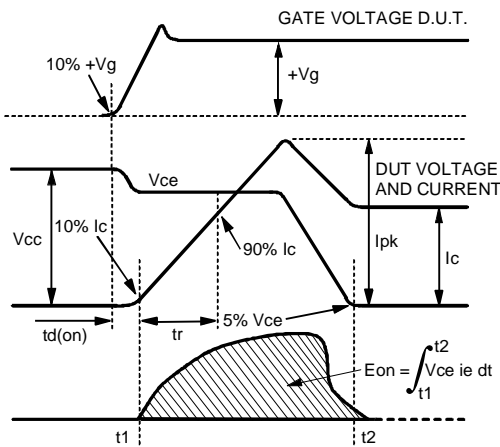
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$



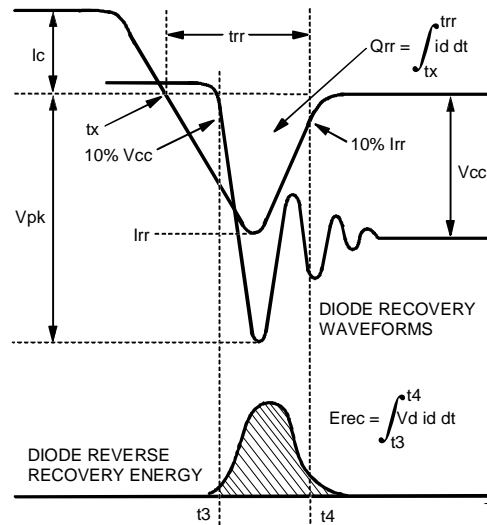
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

Refer to Section D for the following:

**Appendix D: Section D - page D-6**

- Fig. 18e - Macro Waveforms for Test Circuit of Fig. 18a
- Fig. 19 - Clamped Inductive Load Test Circuit
- Fig. 20 - Pulsed Collector Current Test Circuit