

# IRGPH50MD2

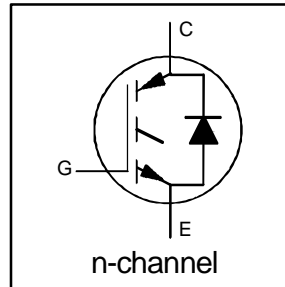
INSULATED GATE BIPOLAR TRANSISTOR  
WITH ULTRAFAST SOFT RECOVERY

Short Circuit Rated  
Fast CoPack IGBT

DIODE

**Features**

- Short circuit rated -10 $\mu$ s @125°C,  $V_{GE} = 15V$
- 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



$V_{CES} = 1200V$

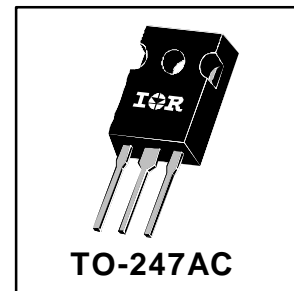
$V_{CE(sat)} \leq 2.9V$

@  $V_{GE} = 15V, I_C = 23A$

**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	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	42	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	23	
$I_{CM}$	Pulsed Collector Current ①	84	
$I_{LM}$	Clamped Inductive Load Current ②	84	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	16	
$I_{FM}$	Diode Maximum Forward Current	84	$\mu s$
$t_{sc}$	Short Circuit Withstand Time	10	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	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	$^\circ C$
$T_{STG}$			
	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	$^\circ C/W$
$R_{\theta JC}$	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)

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## 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	1200	—	—	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	—	1.1	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.3	2.9	V	I <sub>C</sub> = 23A
		—	3.0	—		I <sub>C</sub> = 42A
		—	2.8	—		I <sub>C</sub> = 23A, 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)/ΔT<sub>J</sub></sub>	Temperature Coeff. of Threshold Voltage	—	-13	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance ④	11	15	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 23A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V
		—	—	6500		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	2.5	3.0	V	I <sub>C</sub> = 16A
		—	2.1	2.5		I <sub>C</sub> = 16A, 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)	—	89	130	nC	I <sub>C</sub> = 23A V <sub>CC</sub> = 400V See Fig. 8
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	22	33		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	26	39		
t <sub>d(on)</sub>	Turn-On Delay Time	—	100	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 23A, V <sub>CC</sub> = 960V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω Energy losses include "tail" and diode reverse recovery.
t <sub>r</sub>	Rise Time	—	140	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	510	770		
t <sub>f</sub>	Fall Time	—	470	730		
E <sub>on</sub>	Turn-On Switching Loss	—	3.0	—		
E <sub>off</sub>	Turn-Off Switching Loss	—	8.0	—	mJ	See Fig. 9, 10, 11, 18
E <sub>ts</sub>	Total Switching Loss	—	11	17		
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—	μs	V <sub>CC</sub> = 720V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>d(on)</sub>	Turn-On Delay Time	—	86	—	ns	T <sub>J</sub> = 150°C, See Fig. 9, 10, 11, 18 I <sub>C</sub> = 23A, V <sub>CC</sub> = 960V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω Energy losses include "tail" and diode reverse recovery
t <sub>r</sub>	Rise Time	—	130	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	800	—		
t <sub>f</sub>	Fall Time	—	920	—		
E <sub>ts</sub>	Total Switching Loss	—	20	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	1900	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz See Fig. 7
C <sub>oes</sub>	Output Capacitance	—	140	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	24	—		
t <sub>rr</sub>	Diode Reverse Recovery Time	—	90	135	ns	T <sub>J</sub> = 25°C See Fig. 14
		—	164	245		T <sub>J</sub> = 125°C
I <sub>rr</sub>	Diode Peak Reverse Recovery Charge	—	5.8	10	A	T <sub>J</sub> = 25°C See Fig. 15
		—	8.3	15		T <sub>J</sub> = 125°C
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	260	675	nC	T <sub>J</sub> = 25°C See Fig. 16
		—	680	1838		T <sub>J</sub> = 125°C
di <sub>(rec)M/dt</sub>	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	120	—	A/μs	T <sub>J</sub> = 25°C See Fig. 17
		—	76	—		T <sub>J</sub> = 125°C

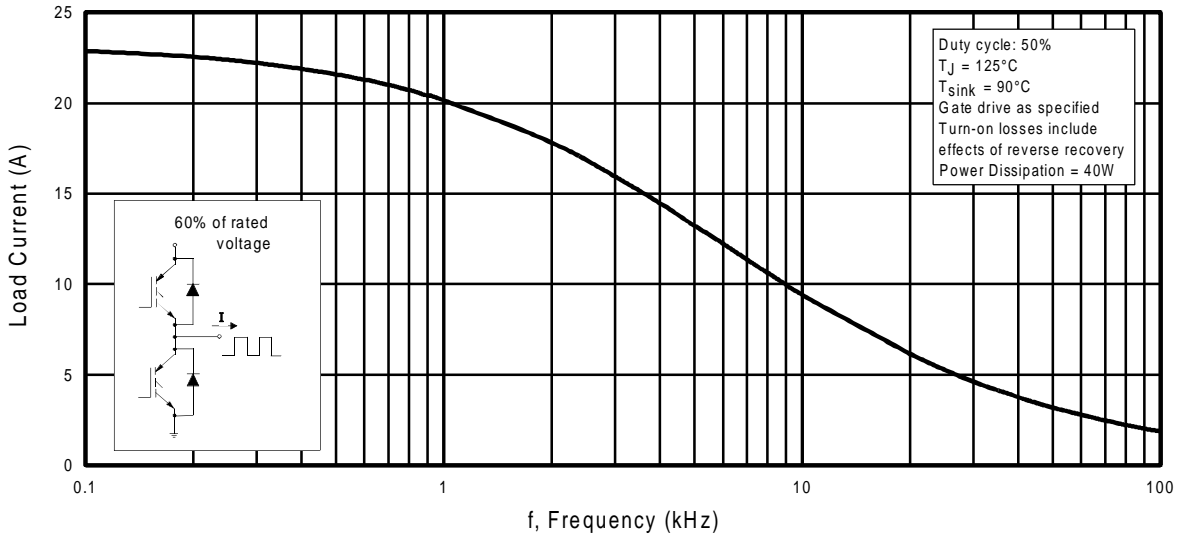
### Notes:

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

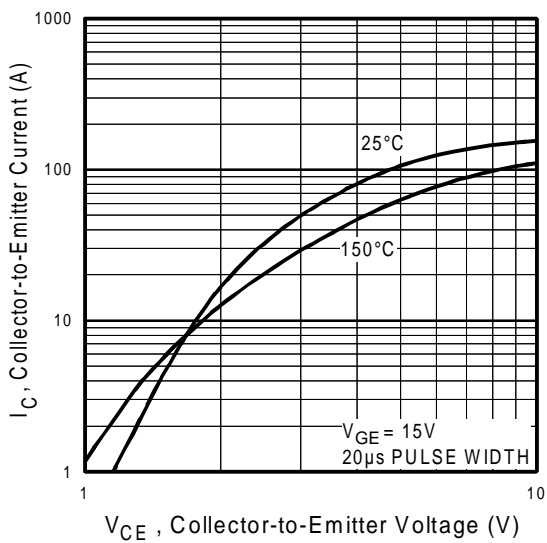
② V<sub>CC</sub>=80%(V<sub>CES</sub>), V<sub>GE</sub>=20V, L=10μH, R<sub>G</sub>= 5.0Ω, ( See fig. 19 )

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

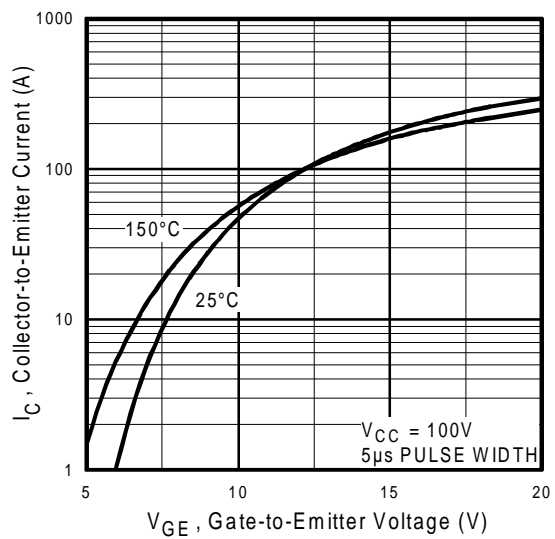
④ Pulse width 5.0μs, single shot.



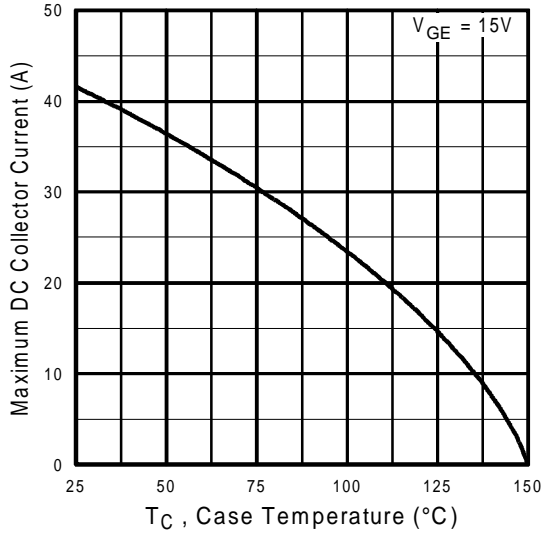
**Fig. 1 - Typical Load Current vs. Frequency**  
(Load Current =  $I_{RMS}$  of fundamental)



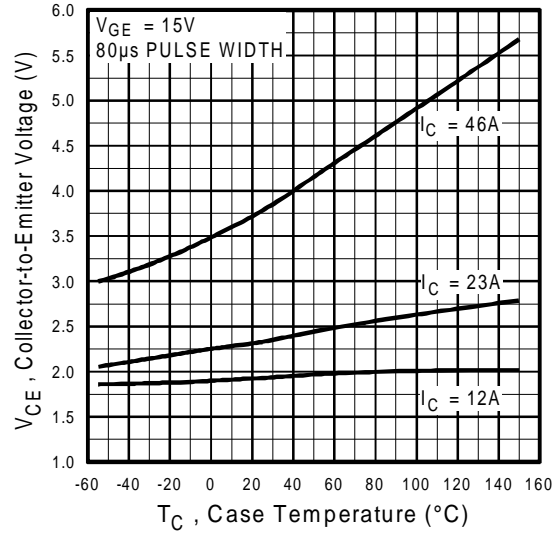
**Fig. 2 - Typical Output Characteristics**



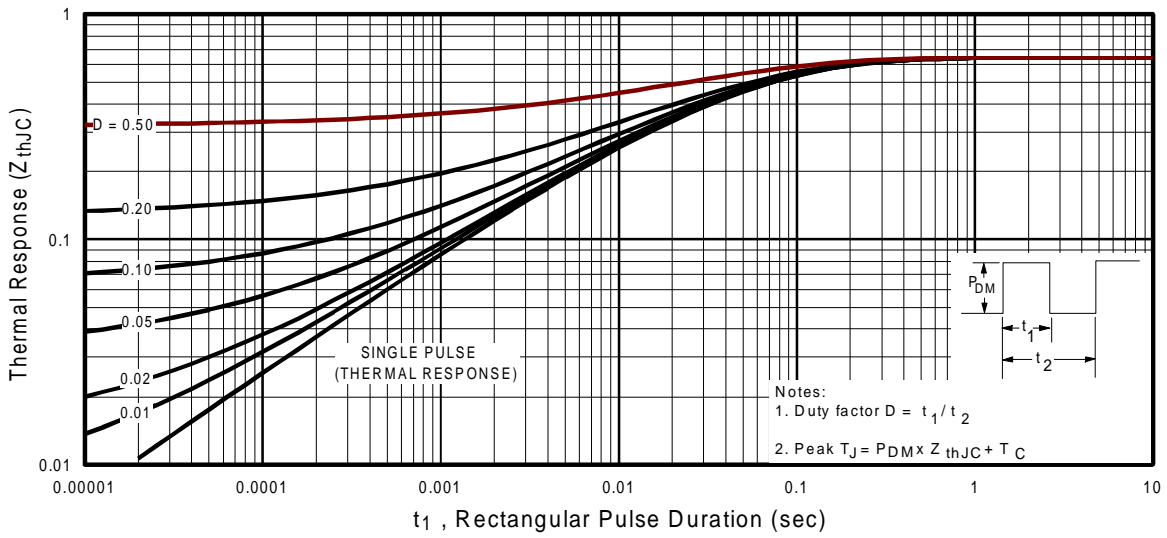
**Fig. 3 - Typical Transfer Characteristics**



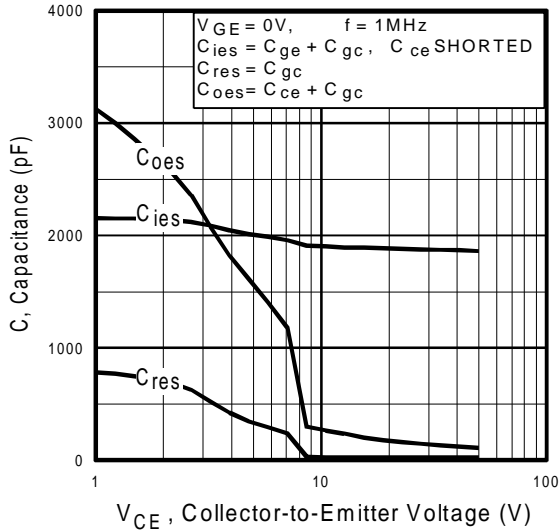
**Fig. 4** - Maximum Collector Current vs. Case Temperature



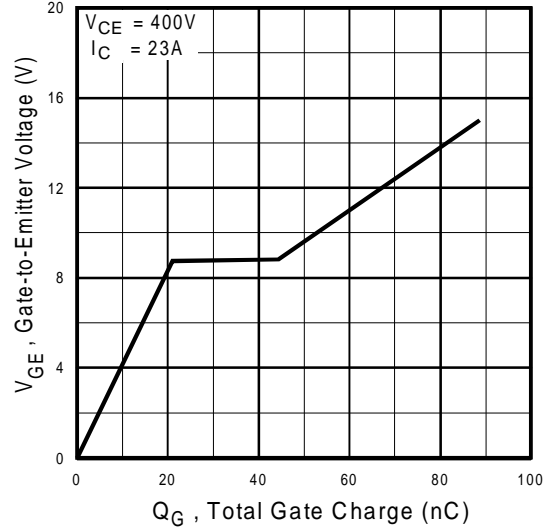
**Fig. 5** - Collector-to-Emitter Voltage vs. Case Temperature



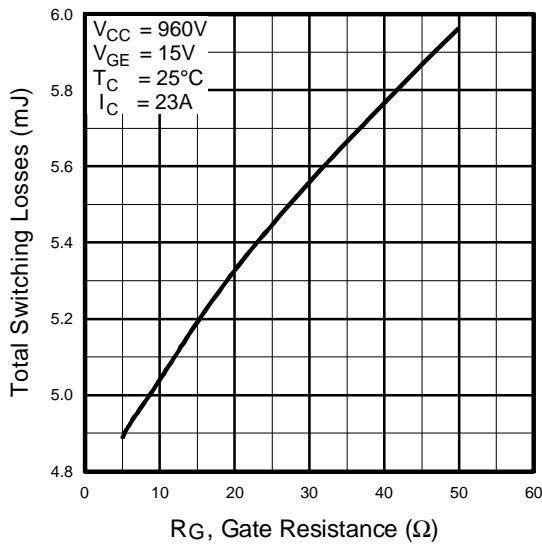
**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case



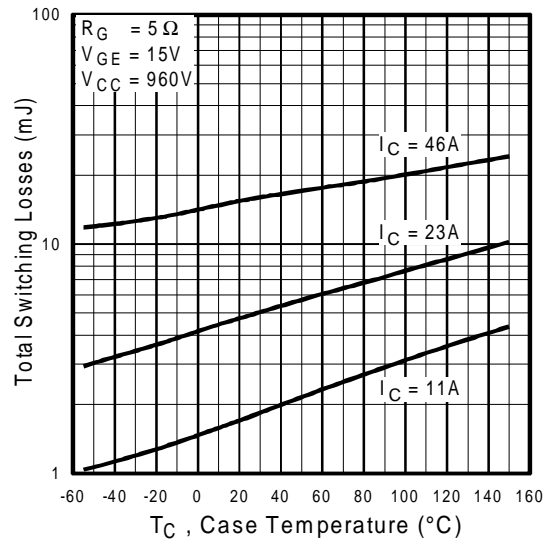
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



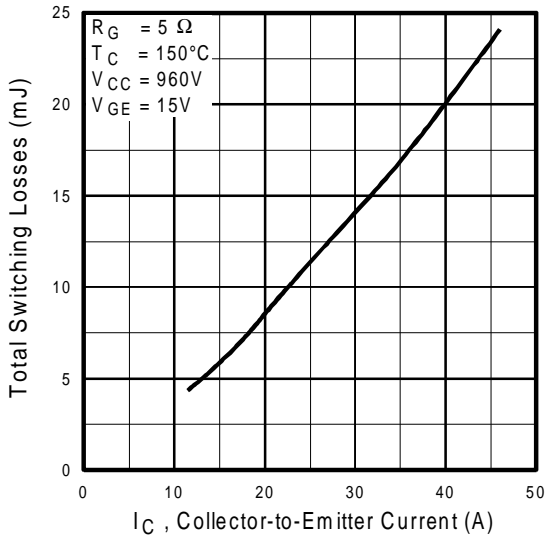
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



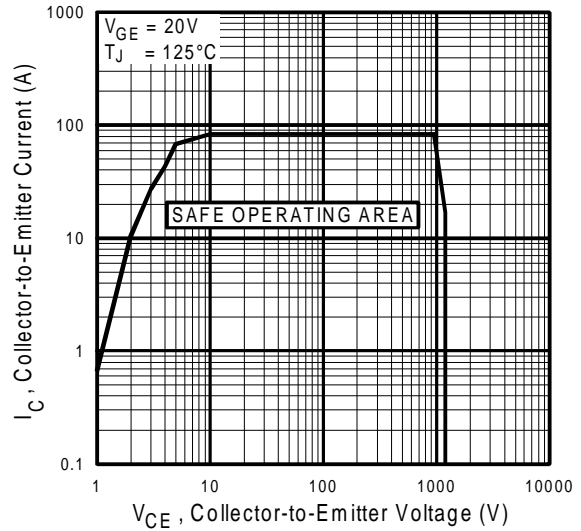
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



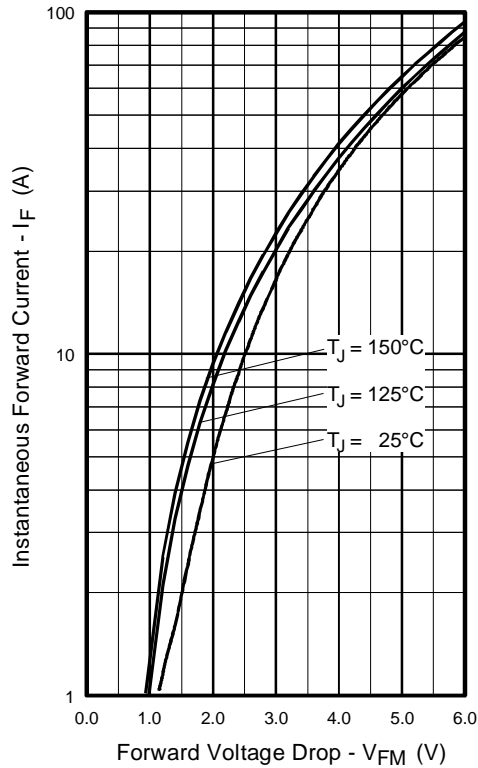
**Fig. 10** - Typical Switching Losses vs. Case Temperature



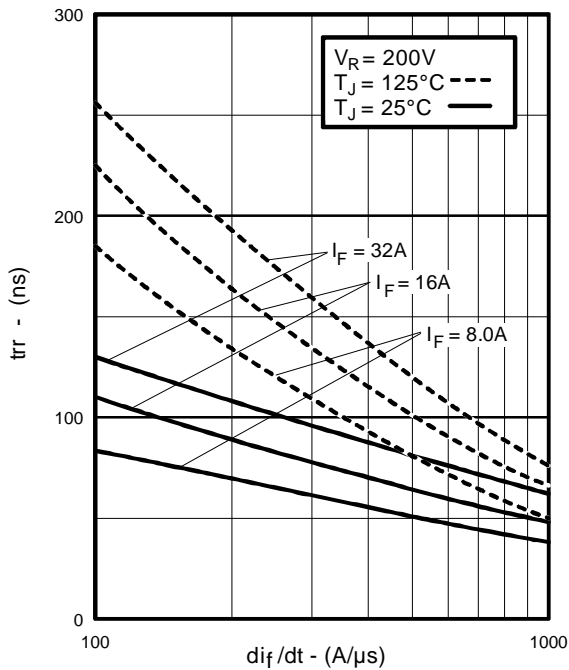
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



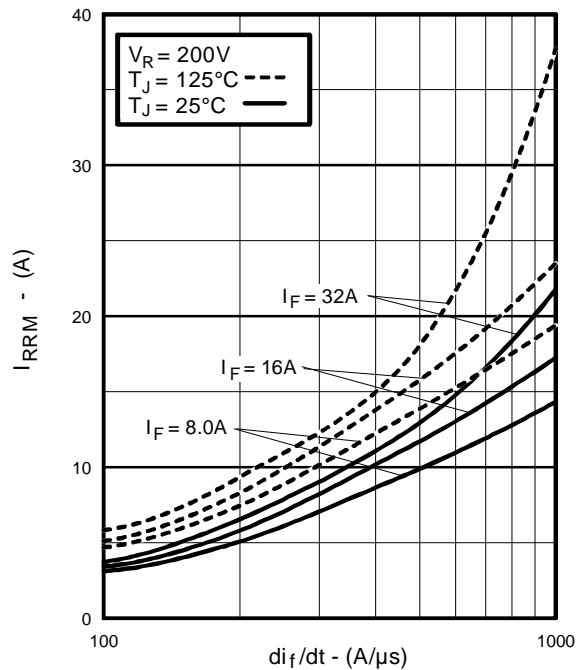
**Fig. 12** - Turn-Off SOA



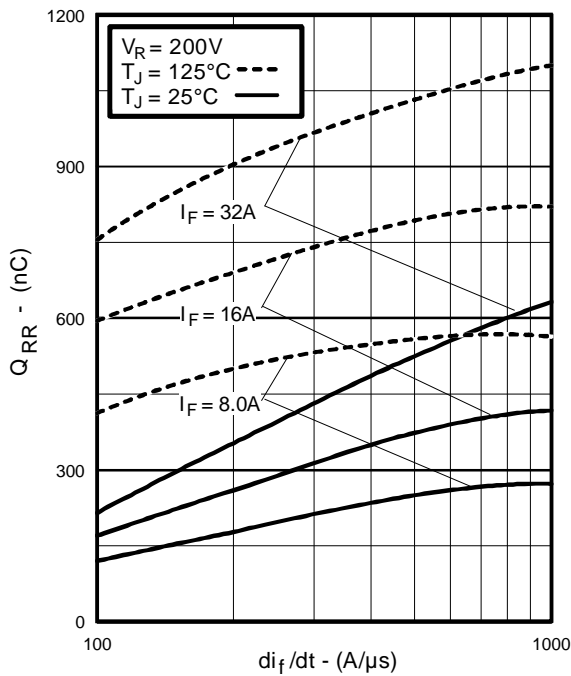
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



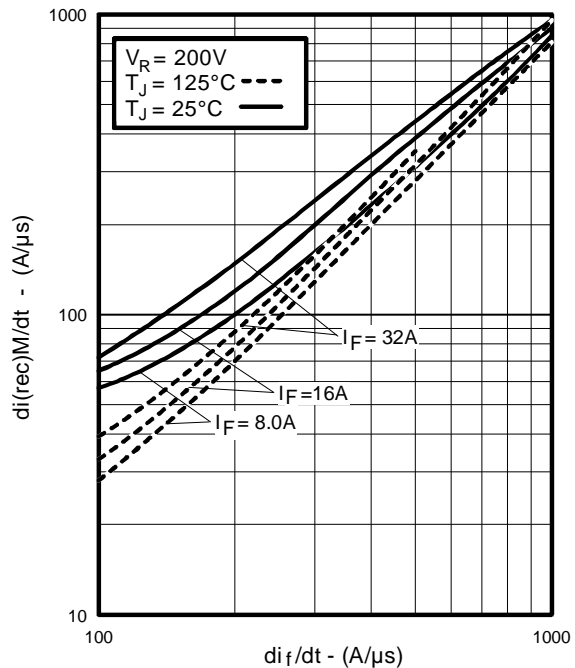
**Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$**



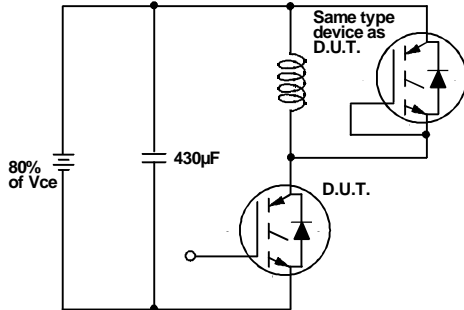
**Fig. 15 - Typical Recovery Current vs.  $di_f/dt$**



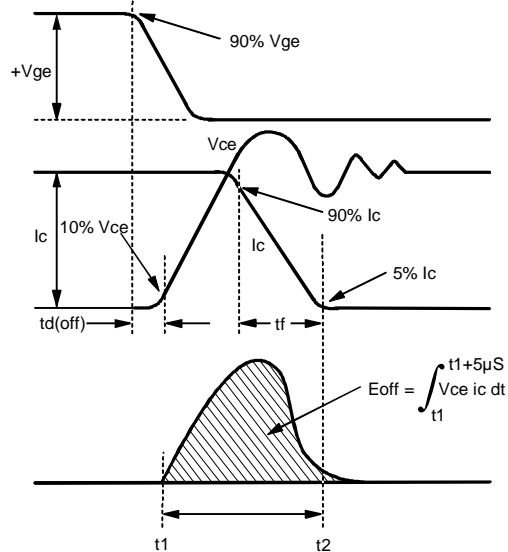
**Fig. 16 - Typical Stored Charge vs.  $di_f/dt$**



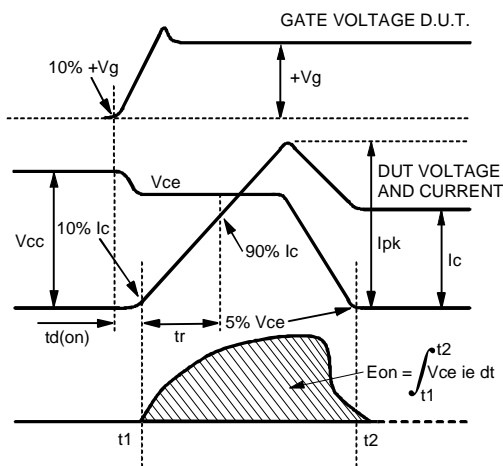
**Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$**



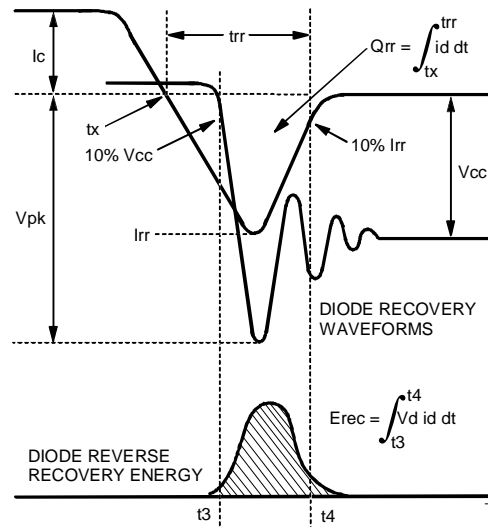
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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 H: Section D - page D-10**

Fig. 18e - Macro Waveforms for Test Circuit Fig. 18a

Fig. 19 - Clamped Inductive Load Test Circuit

Fig. 20 - Pulsed Collector Current Test Circuit