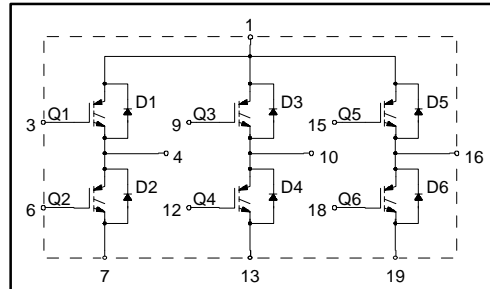


## IGBT SIP MODULE

## Short Circuit Rated Fast IGBT

### Features

- Short Circuit Rated -  $10\mu\text{s}$  @  $125^\circ\text{C}$ ,  $V_{GE} = 15\text{V}$
- Fully isolated printed circuit board mount package
- 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



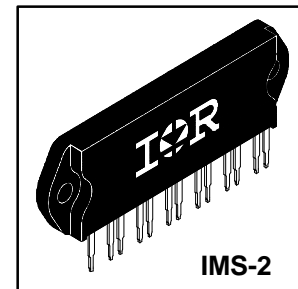
### Product Summary

#### Output Current in a Typical 5.0 kHz Motor Drive

7.65 A<sub>RMS</sub> per phase (2.4 kW total) with  $T_C = 90^\circ\text{C}$ ,  $T_J = 125^\circ\text{C}$ , Supply Voltage 360Vdc, Power Factor 0.8, Modulation Depth 80% (See Figure 1)

### Description

The IGBT technology is the key to International Rectifier's advanced line of IMS (Insulated Metal Substrate) Power Modules. These modules are more efficient than comparable bipolar transistor modules, while at the same time having the simpler gate-drive requirements of the familiar power MOSFET. This superior technology has now been coupled to a state of the art materials system that maximizes power throughput with low thermal resistance. This package is highly suited to power applications and where space is at a premium.



These new short circuit rated devices are especially suited for motor control and other totem-pole 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, each IGBT	13	A
$I_C @ T_C = 100^\circ\text{C}$	Continuous Collector Current, each IGBT	7.0	
$I_{CM}$	Pulsed Collector Current ①	26	
$I_{LM}$	Clamped Inductive Load Current ②	26	
$I_F @ T_C = 100^\circ\text{C}$	Diode Continuous Forward Current	6.1	
$I_{FM}$	Diode Maximum Forward Current	26	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu\text{s}$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$V_{ISOL}$	Isolation Voltage, any terminal to case, 1 min.	2500	V <sub>RMS</sub>
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation, each IGBT	36	W
$P_D @ T_C = 100^\circ\text{C}$	Maximum Power Dissipation, each IGBT	14	
$T_J$	Operating Junction and	-40 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.	5-7 lbf•in (0.55 - 0.8 N•m)	

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Junction-to-Case, each IGBT, one IGBT in conduction	—	3.5	°C/W
$R_{\theta JC}$ (DIODE)	Junction-to-Case, each diode, one diode in conduction	—	5.5	
$R_{\theta CS}$ (MODULE)	Case-to-Sink, flat, greased surface	0.1	—	
Wt	Weight of module	20 (0.7)	—	g (oz)

## 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 ③	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.68	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.6	2.4	V	$I_C = 7.0A, V_{GE} = 15V$
		—	2.0	—		$I_C = 13A$
		—	1.7	—		$I_C = 7.0A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-13	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ④	3.2	6.3	—	S	$V_{CE} = 100V, I_C = 14A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	2500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	1.4	1.7	V	$I_C = 12A$
		—	1.3	1.6		$I_C = 12A, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 500$	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)	—	32	49	nC	$I_C = 14A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	6.7	10		$V_{CC} = 400V$
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	13	21		See Fig. 8
$t_{d(on)}$	Turn-On Delay Time	—	64	—	ns	$T_J = 25^\circ\text{C}$
$t_r$	Rise Time	—	29	—		$I_C = 7.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	340	500		$V_{GE} = 15V, R_G = 23\Omega$
$t_f$	Fall Time	—	240	350		Energy losses include "tail" and diode reverse recovery.
$E_{on}$	Turn-On Switching Loss	—	0.28	—	mJ	See Fig. 9, 10, 11, 18
$E_{off}$	Turn-Off Switching Loss	—	0.70	—		
$E_{ts}$	Total Switching Loss	—	0.98	1.5		
$t_{sc}$	Short Circuit Withstand Time	10	—	—	$\mu s$	$V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 23\Omega, V_{CPK} < 500V$
$t_{d(on)}$	Turn-On Delay Time	—	62	—	ns	$T_J = 150^\circ\text{C},$ See Fig. 9, 10, 11, 18
$t_r$	Rise Time	—	28	—		$I_C = 7.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	620	—		$V_{GE} = 15V, R_G = 23\Omega$
$t_f$	Fall Time	—	420	—		Energy losses include "tail" and diode reverse recovery.
$E_{ts}$	Total Switching Loss	—	1.8	—	mJ	
$C_{ies}$	Input Capacitance	—	750	—	pF	$V_{GE} = 0V$
$C_{oes}$	Output Capacitance	—	100	—		$V_{CC} = 30V$
$C_{res}$	Reverse Transfer Capacitance	—	9.3	—		$f = 1.0MHz$
$t_{rr}$	Diode Reverse Recovery Time	—	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig.
		—	80	120		$T_J = 125^\circ\text{C}$ 14
$I_{rr}$	Diode Peak Reverse Recovery Current	—	3.5	6.0	A	$T_J = 25^\circ\text{C}$ See Fig.
		—	5.6	10		$T_J = 125^\circ\text{C}$ 15
$Q_{rr}$	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig.
		—	220	600		$T_J = 125^\circ\text{C}$ 16
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	180	—	A/ $\mu s$	$T_J = 25^\circ\text{C}$ See Fig.
		—	120	—		$T_J = 125^\circ\text{C}$ 17

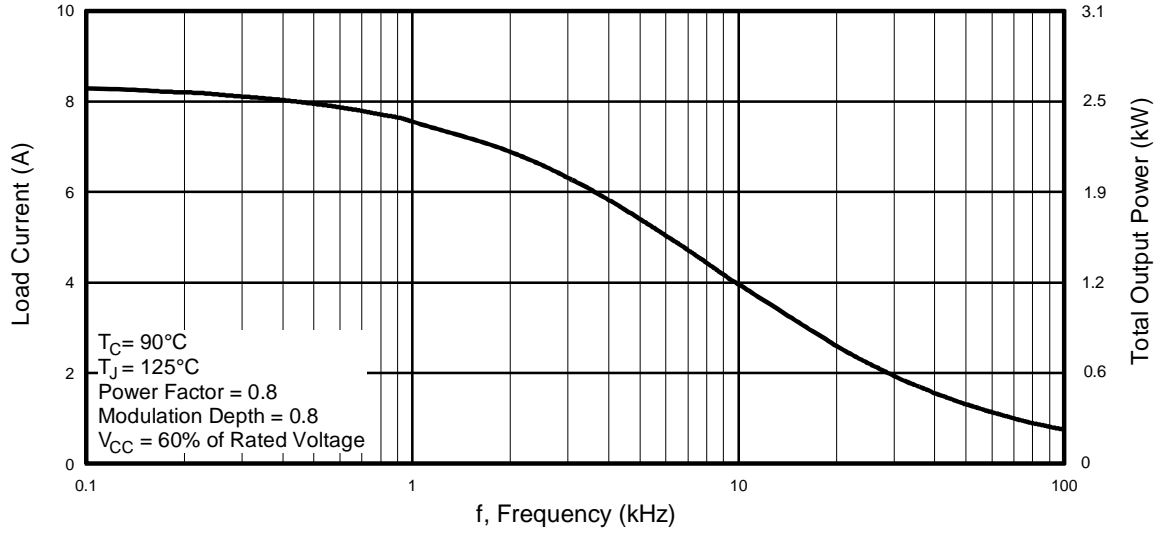
### Notes:

① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature. ( See fig. 20)

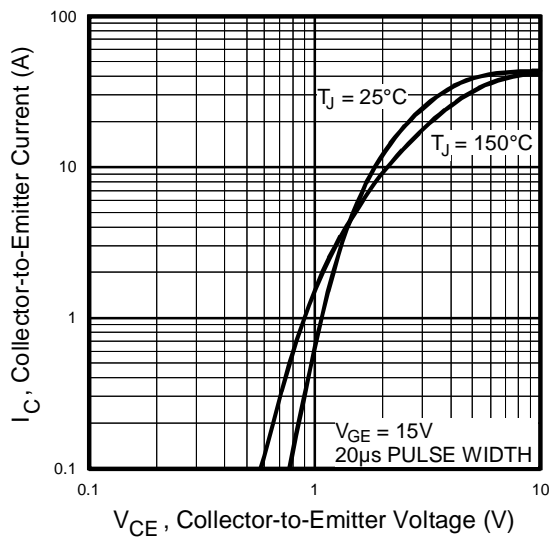
②  $V_{CC}=80\%(V_{CES}), V_{GE}=20V, L=10\mu H, R_G=23\Omega,$  ( See fig. 19)

③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .

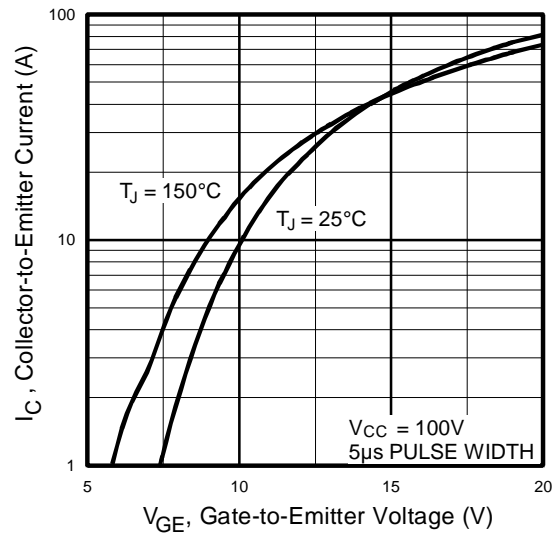
④ Pulse width 5.0 $\mu s$ , single shot.



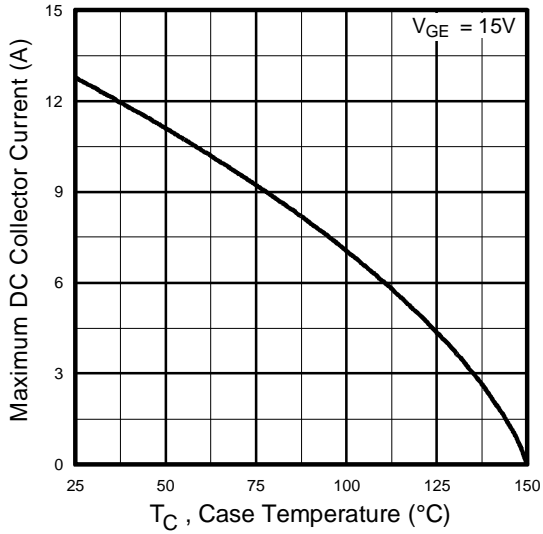
**Fig. 1 - RMS Current and Output Power, Synthesized Sine Wave**



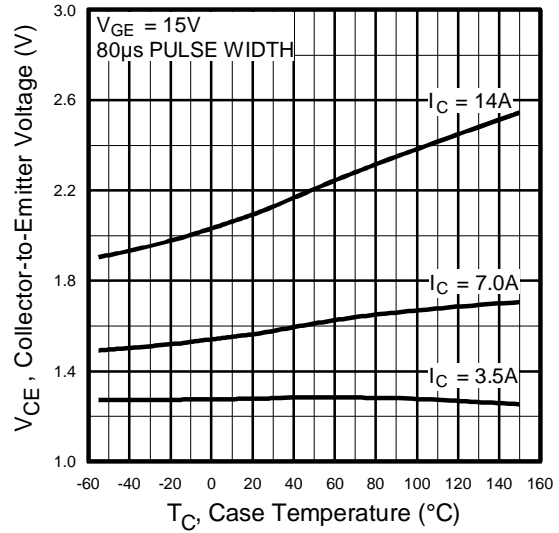
**Fig. 2 - Typical Output Characteristics**



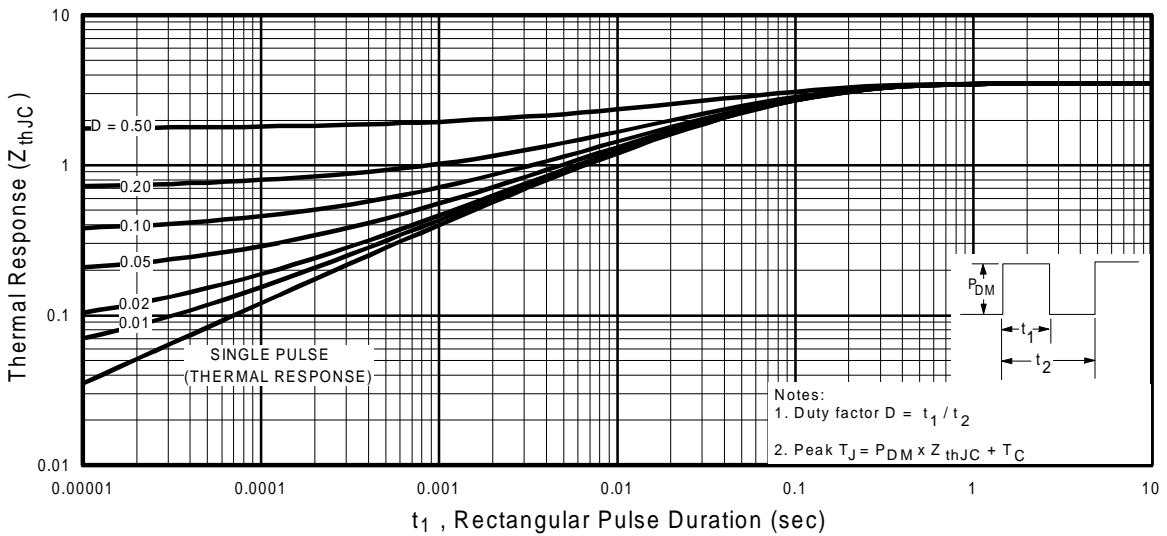
**Fig. 3 - Typical Transfer Characteristics**



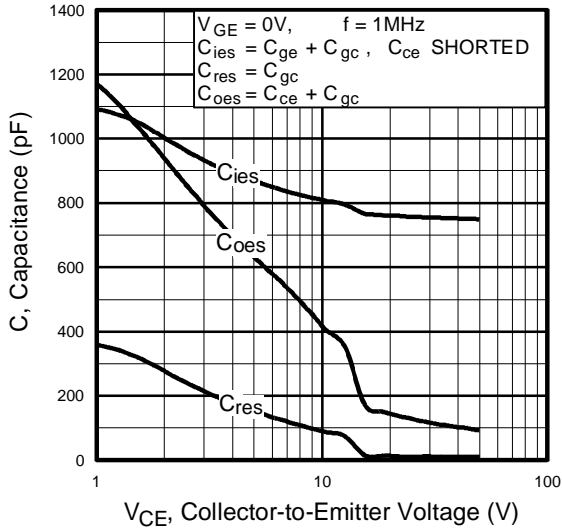
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



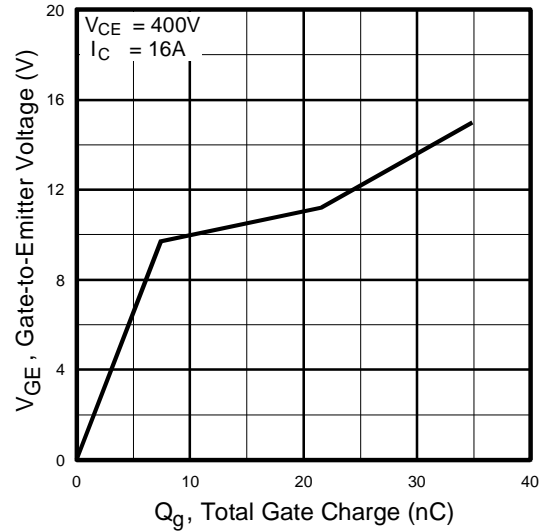
**Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature**



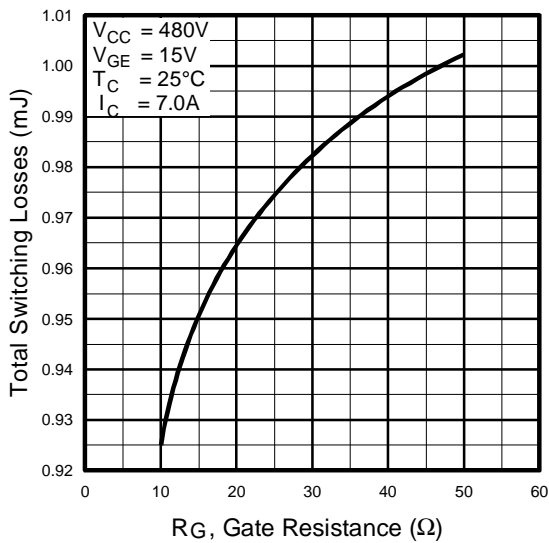
**Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case**



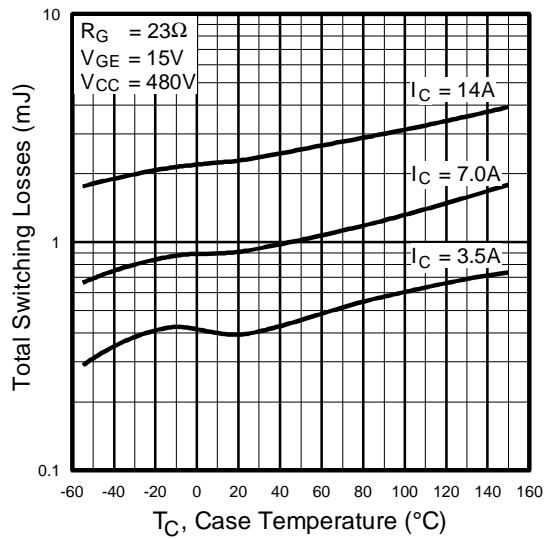
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



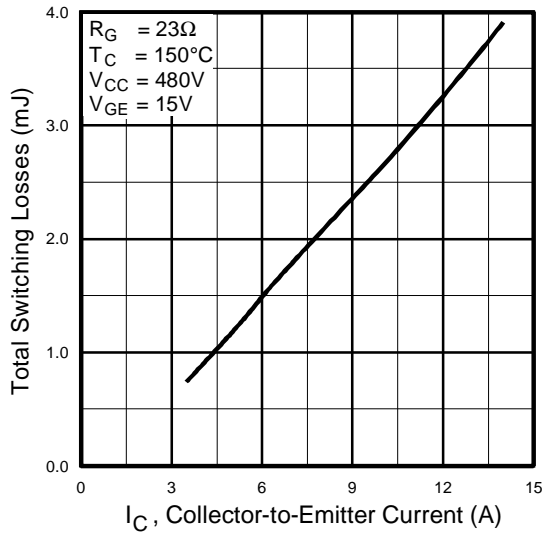
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



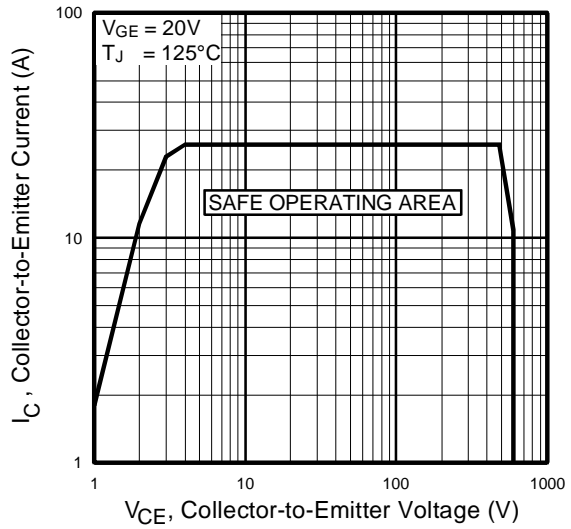
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



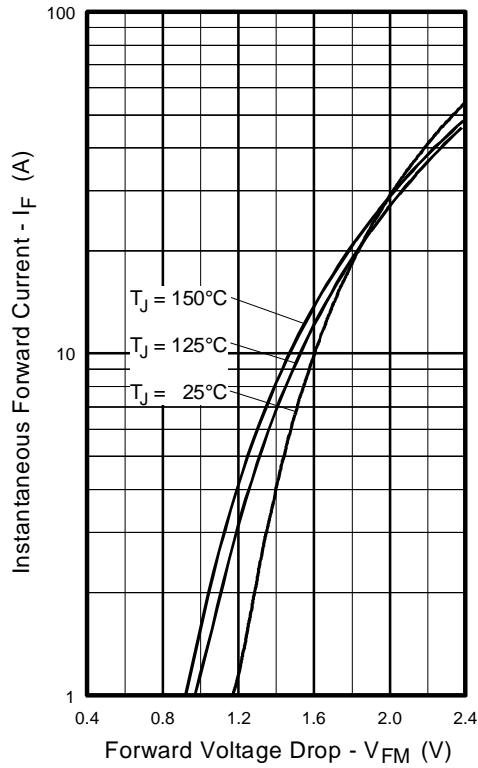
**Fig. 10** - Typical Switching Losses vs. Case Temperature



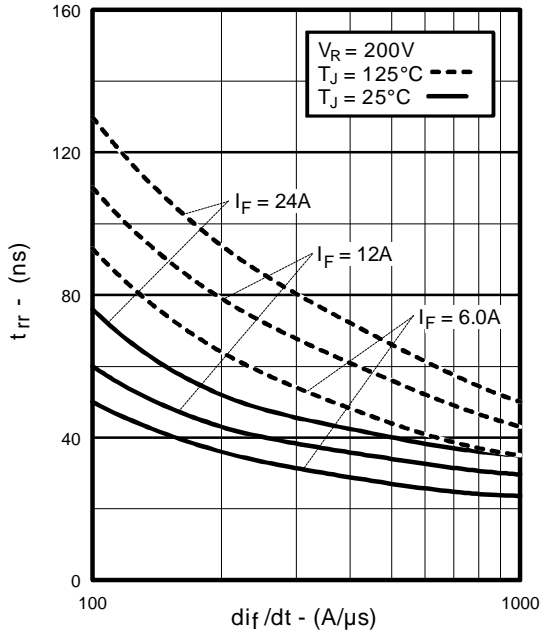
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



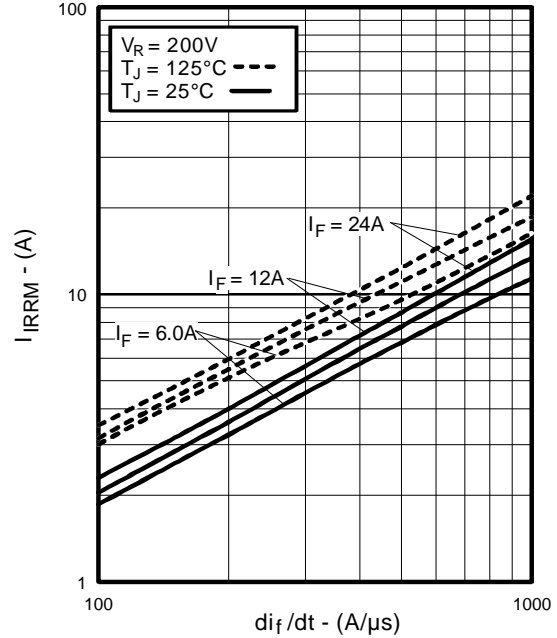
**Fig. 12** - Turn-Off SOA



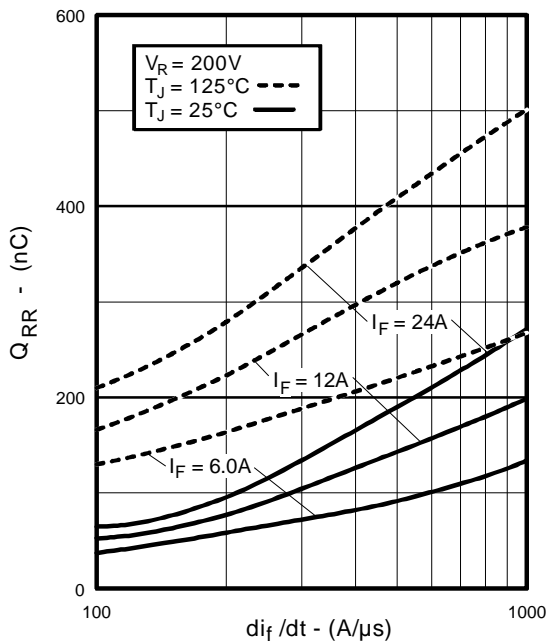
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



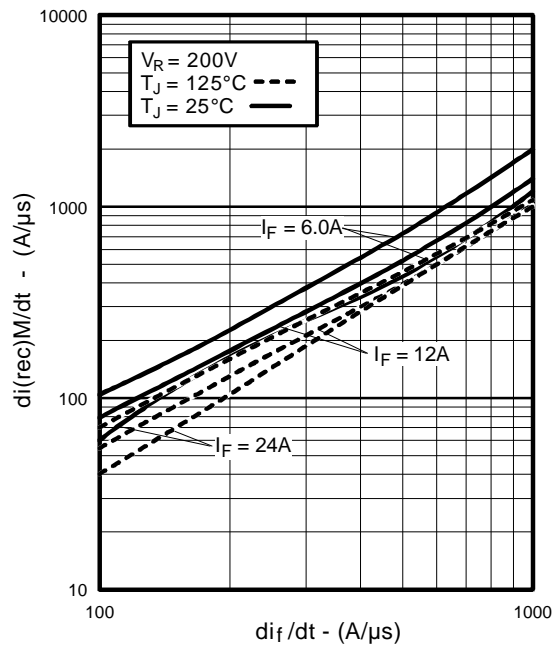
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



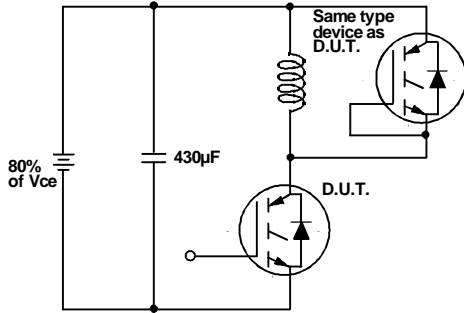
**Fig. 15** - Typical Recovery Current vs.  $di_f/dt$



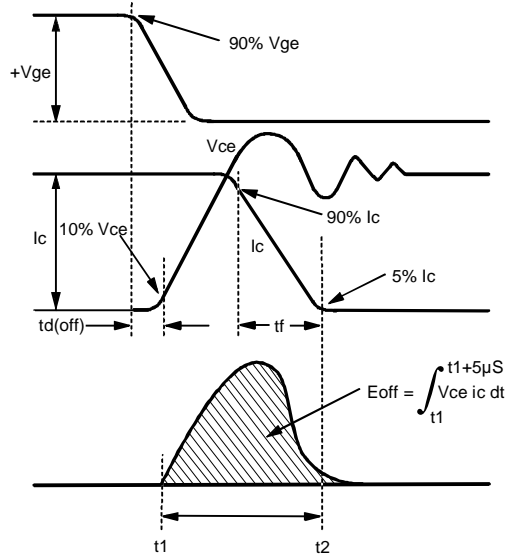
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



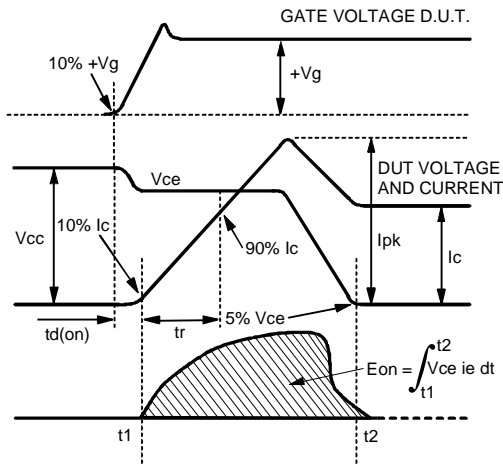
**Fig. 17** - Typical  $di_{(rec)}M/dt$  vs.  $di_f/dt$



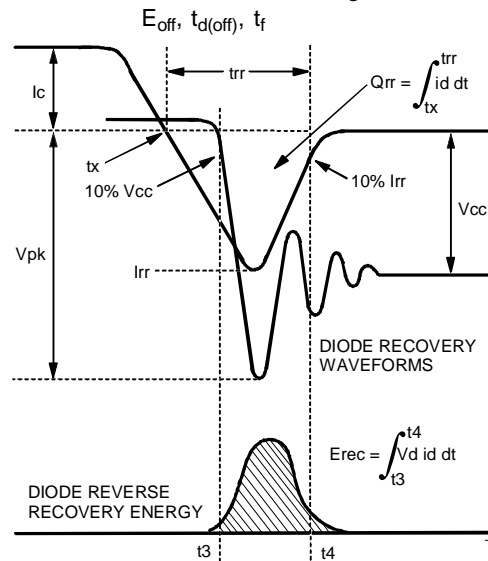
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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