# International Rectifier

IRGBC30UD2

INSULATED GATE BIPOLAR TRANSISTOR
WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast CoPack IGBT

Features

- Switching-loss rating includes all "tail" losses
- HEXFRED™ soft ultrafast diodes
- Optimized for high operating frequency (over 5kHz)
  See Fig. 1 for Current vs. Frequency curve

C

G

E

n-channel
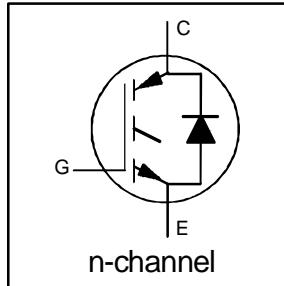
$V_{CES} = 600V$

$V_{CE(sat)} \leq 3.0V$

@ $V_{GE} = 15V$, $I_C = 12A$

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, motor control, UPS and power supply applications.

TO-220AB
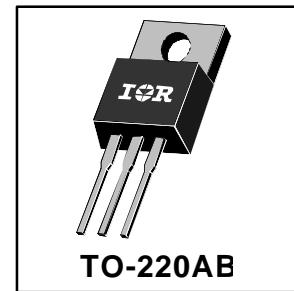
Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ $T_C = 25°C$	Continuous Collector Current	23	
I_C @ $T_C = 100°C$	Continuous Collector Current	12	
I_{CM}	Pulsed Collector Current ①	92	A
I_{LM}	Clamped Inductive Load Current ②	92	
I_F @ $T_C = 100°C$	Diode Continuous Forward Current	12	
I_{FM}	Diode Maximum Forward Current	92	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ $T_C = 25°C$	Maximum Power Dissipation	100	W
P_D @ $T_C = 100°C$	Maximum Power Dissipation	42	
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	Min.	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	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	80	
Wt	Weight	—	2 (0.07)	—	g (oz)

Revision 1

IRGBC30UD2

Electrical Characteristics @ T$_J$ = 25°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$_C$ = 250µA	
ΔV$_{(BR)CES}$/ΔT$_J$	Temperature Coeff. of Breakdown Voltage	—	0.63	—	V/°C	V$_{GE}$ = 0V, I$_C$ = 1.0mA	
V$_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.2	3.0		I$_C$ = 12A	V$_{GE}$ = 15V
		—	2.7	—	V	I$_C$ = 23A	See Fig. 2, 5
		—	2.4	—		I$_C$ = 12A, T$_J$ = 150°C	
V$_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5		V$_{CE}$ = V$_{GE}$, I$_C$ = 250µA	
ΔV$_{GE(th)}$/ΔT$_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V$_{CE}$ = V$_{GE}$, I$_C$ = 250µA	
g$_{fe}$	Forward Transconductance ④	3.1	8.6	—	S	V$_{CE}$ = 100V, I$_C$ = 12A	
I$_{CES}$	Zero Gate Voltage Collector Current	—	—	250	µA	V$_{GE}$ = 0V, V$_{CE}$ = 600V	
		—	—	2500		V$_{GE}$ = 0V, V$_{CE}$ = 600V, T$_J$ = 150°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°C	
I$_{GES}$	Gate-to-Emitter Leakage Current	—	—	±100	nA	V$_{GE}$ = ±20V	

Switching Characteristics @ T$_J$ = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions		
Q$_g$	Total Gate Charge (turn-on)	—	29	36		I$_C$ = 12A		
Q$_{ge}$	Gate - Emitter Charge (turn-on)	—	4.8	6.8	nC	V$_{CC}$ = 400V		
Q$_{gc}$	Gate - Collector Charge (turn-on)	—	12	17		See Fig. 8		
t$_{d(on)}$	Turn-On Delay Time	—	67	—		T$_J$ = 25°C		
t$_r$	Rise Time	—	56	—	ns	I$_C$ = 12A, V$_{CC}$ = 480V		
t$_{d(off)}$	Turn-Off Delay Time	—	170	250		V$_{GE}$ = 15V, R$_G$ = 23Ω		
t$_f$	Fall Time	—	140	270		Energy losses include "tail" and		
E$_{on}$	Turn-On Switching Loss	—	0.70	—		diode reverse recovery.		
E$_{off}$	Turn-Off Switching Loss	—	0.80	—	mJ	See Fig. 9, 10, 11, 18		
E$_{ts}$	Total Switching Loss	—	1.5	2.5				
t$_{d(on)}$	Turn-On Delay Time	—	61	—		T$_J$ = 150°C, See Fig. 9, 10, 11, 18		
t$_r$	Rise Time	—	51	—	ns	I$_C$ = 12A, V$_{CC}$ = 480V		
t$_{d(off)}$	Turn-Off Delay Time	—	190	—		V$_{GE}$ = 15V, R$_G$ = 23Ω		
t$_f$	Fall Time	—	190	—		Energy losses include "tail" and		
E$_{ts}$	Total Switching Loss	—	1.9	—	mJ	diode reverse recovery.		
L$_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package		
C$_{ies}$	Input Capacitance	—	680	—		V$_{GE}$ = 0V		
C$_{oes}$	Output Capacitance	—	100	—	pF	V$_{CC}$ = 30V	See Fig. 7	
C$_{res}$	Reverse Transfer Capacitance	—	11	—		ƒ = 1.0MHz		
t$_{rr}$	Diode Reverse Recovery Time	—	42	60	ns	T$_J$ = 25°C	See Fig.	
		—	80	120		T$_J$ = 125°C	14	I$_F$ = 12A
I$_{rr}$	Diode Peak Reverse Recovery Current	—	3.5	6.0	A	T$_J$ = 25°C	See Fig.	
		—	5.6	10		T$_J$ = 125°C	15	V$_R$ = 200V
Q$_{rr}$	Diode Reverse Recovery Charge	—	80	180	nC	T$_J$ = 25°C	See Fig.	
		—	220	600		T$_J$ = 125°C	16	di/dt = 200A/µs
di$_{(rec)M}$/dt	Diode Peak Rate of Fall of Recovery	—	180	—	A/µs	T$_J$ = 25°C	See Fig.	
	During t$_b$	—	120	—		T$_J$ = 125°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=10µH, R$_G$=23Ω, (See fig. 19)

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

④ Pulse width 5.0µs, single shot.

Duty cycle: 50%
$T_J = 125°C$
$T_{sink} = 90°C$
Gate drive as specified
Turn-on losses include
effects of reverse recovery
Power Dissipation = 21W

60% of rated
voltage
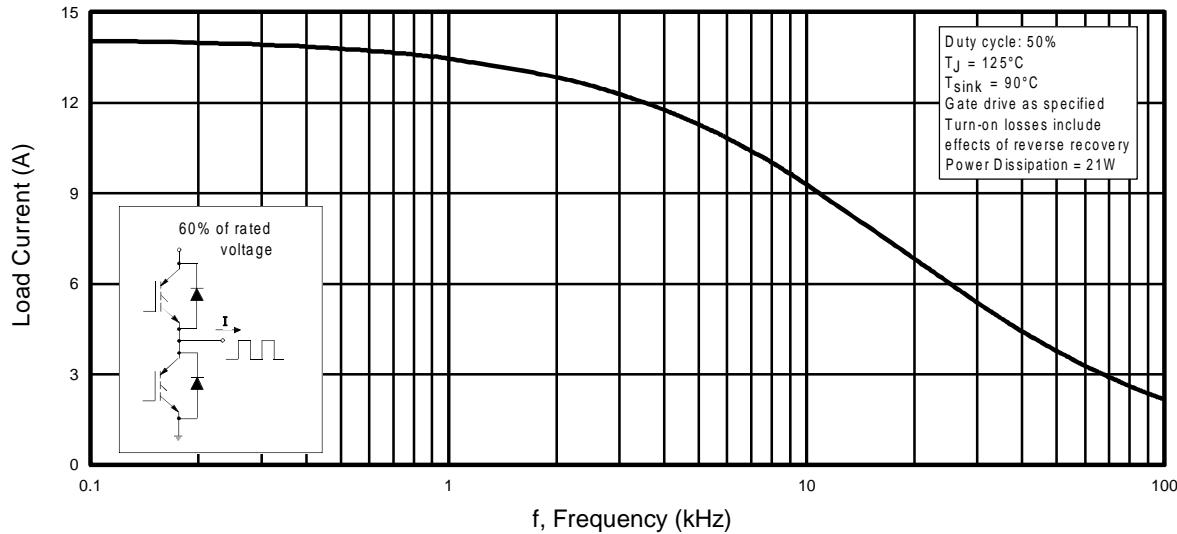
Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

$T_J = 25°C$

$T_J = 150°C$

$V_{GE}= 15V$
20µs PULSE WIDTH

$T_J = 150°C$

$T_J = 25°C$

$V_{CC} = 100V$
5µs PULSE WIDTH
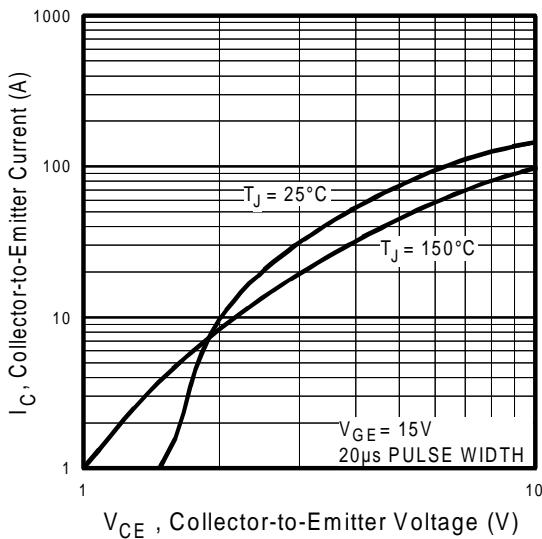
Fig. 2 - Typical Output Characteristics
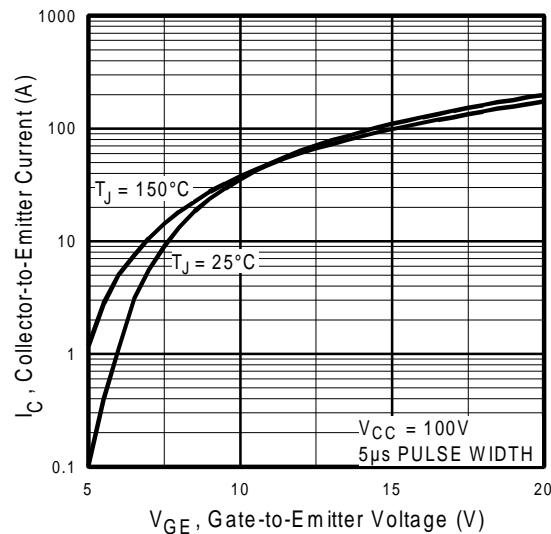
Fig. 3 - Typical Transfer Characteristics

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IOR
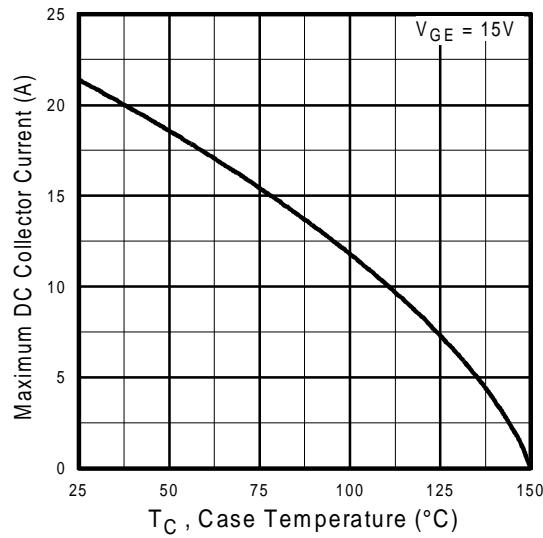
Fig. 4 - Maximum Collector Current vs.
Case Temperature
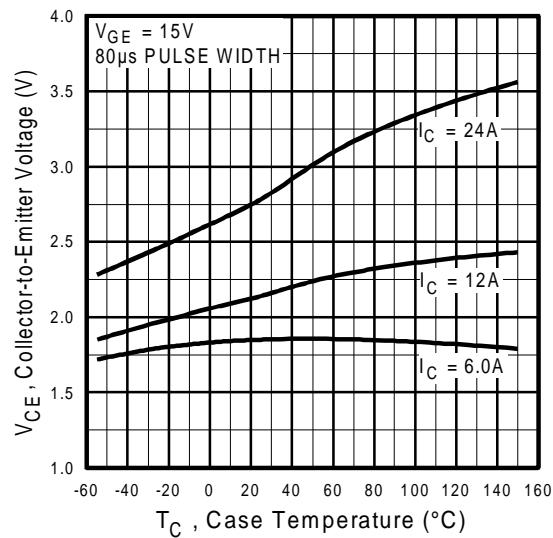
Fig. 5 - Collector-to-Emitter Voltage vs.
Case Temperature

Notes:
1. Duty factor $D = t_1 / t_2$

2. Peak $T_J = P_{DM} \times Z_{thJC} + T_C$
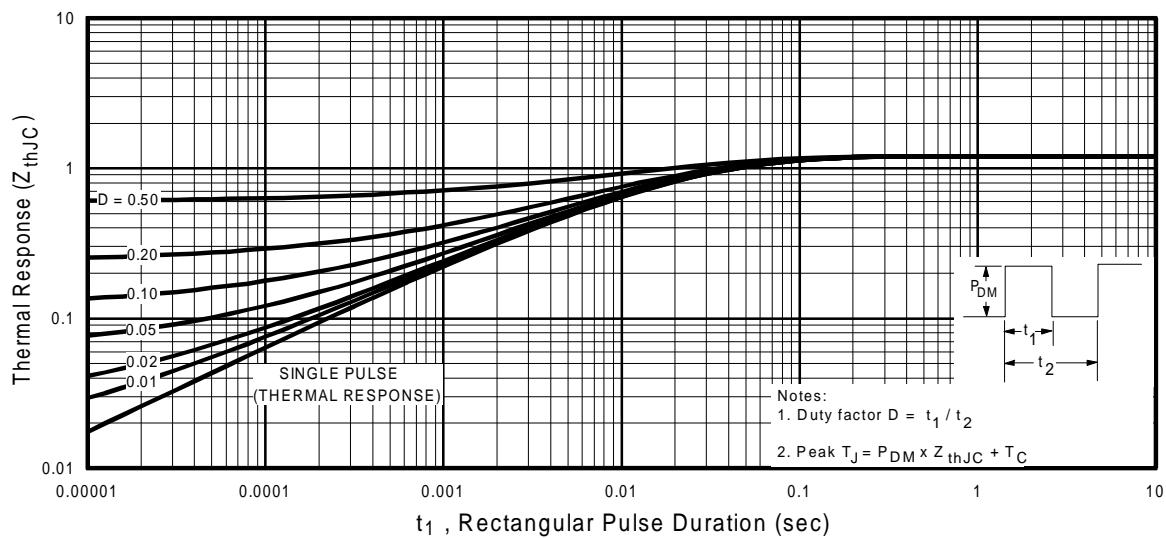
Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

Fig. 7 graph:
- Y-axis: C, Capacitance (pF), from 0 to 1400
- X-axis: V_{CE}, Collector-to-Emitter Voltage (V), from 1 to 100
- Legend: $V_{GE} = 0V$, $f = 1MHz$; $C_{ies} = C_{ge} + C_{gc}$, C_{ce} SHORTED; $C_{res} = C_{gc}$; $C_{oes} = C_{ce} + C_{gc}$
- Curves labeled: C_{ies}, C_{oes}, C_{res}
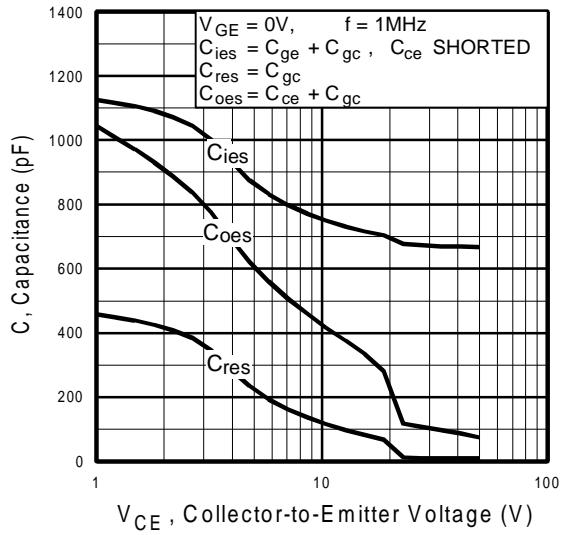
Fig. 7 - Typical Capacitance vs.
Collector-to-Emitter Voltage

Fig. 8 graph:
- Y-axis: V_{GE}, Gate-to-Emitter Voltage (V), from 0 to 20
- X-axis: Q_g, Total Gate Charge (nC), from 0 to 30
- $V_{CE} = 400V$; $I_C = 12A$
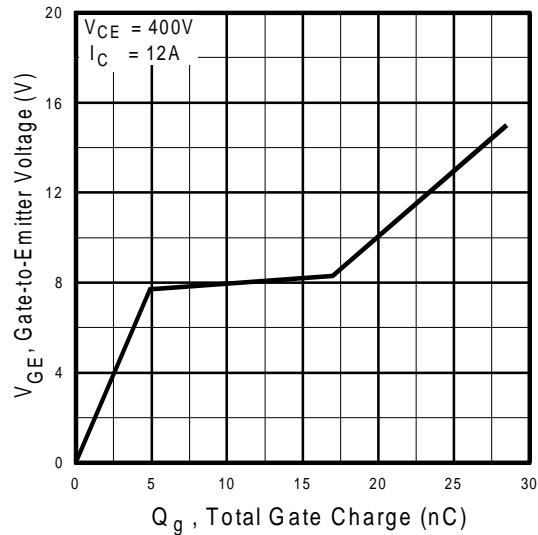
Fig. 8 - Typical Gate Charge vs.
Gate-to-Emitter Voltage

Fig. 9 graph:
- Y-axis: Total Switching Losses (mJ), from 1.4 to 1.7
- X-axis: R_G, Gate Resistance (Ω), from 0 to 60
- $V_{CC} = 480V$; $V_{GE} = 15V$; $T_C = 25°C$; $I_C = 12A$
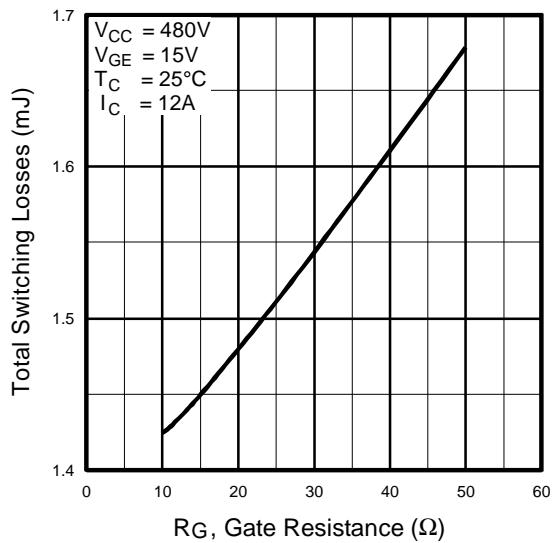
Fig. 9 - Typical Switching Losses vs. Gate
Resistance

Fig. 10 graph:
- Y-axis: Total Switching Losses (mJ), from 0.1 to 10
- X-axis: T_C, Case Temperature (°C), from -60 to 160
- Curves labeled: $I_C = 24A$, $I_C = 12A$, $I_C = 6.0A$
- $R_G = 23\Omega$; $V_{GE} = 15V$; $V_{CC} = 480V$
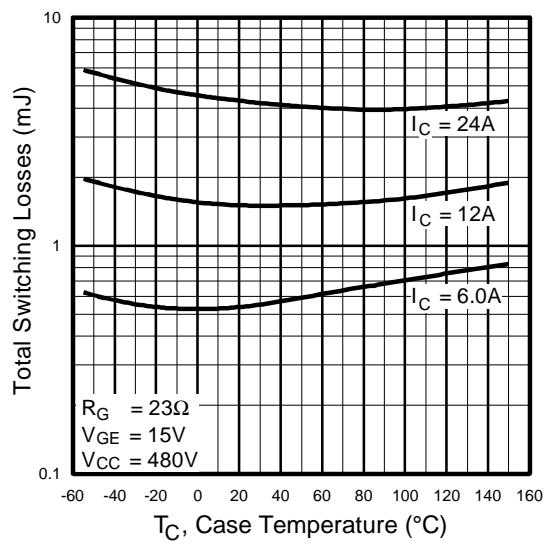
Fig. 10 - Typical Switching Losses vs.
Case Temperature

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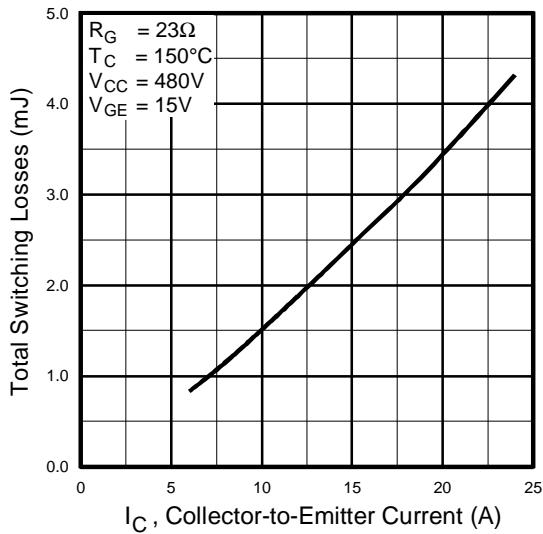
Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current
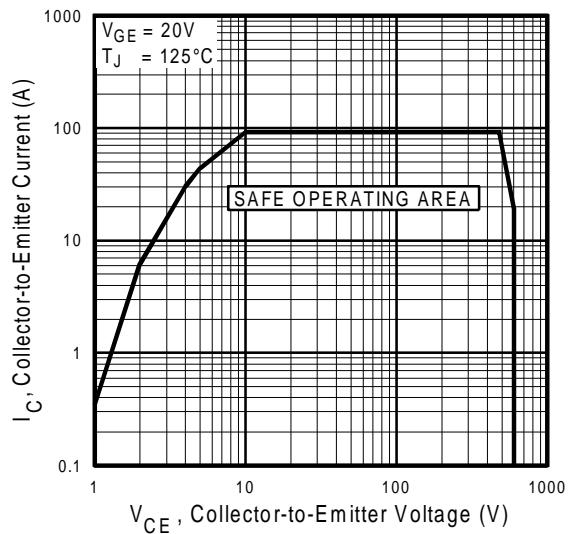

Fig. 12 - Turn-Off SOA
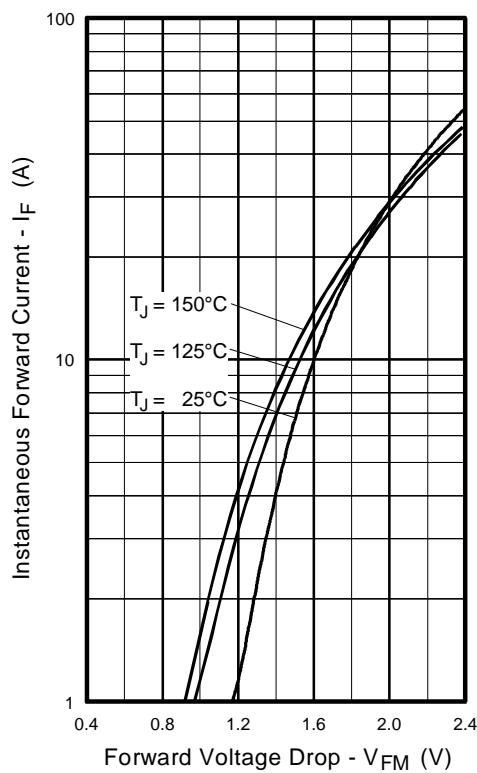
Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current
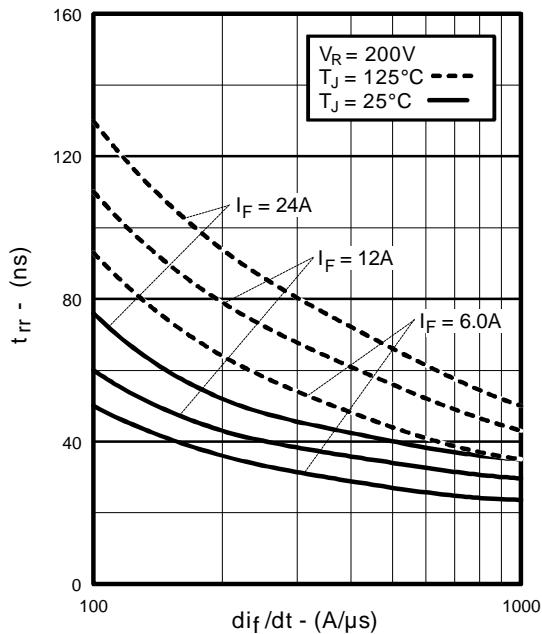
Fig. 14 - Typical Reverse Recovery vs. di$_f$/dt
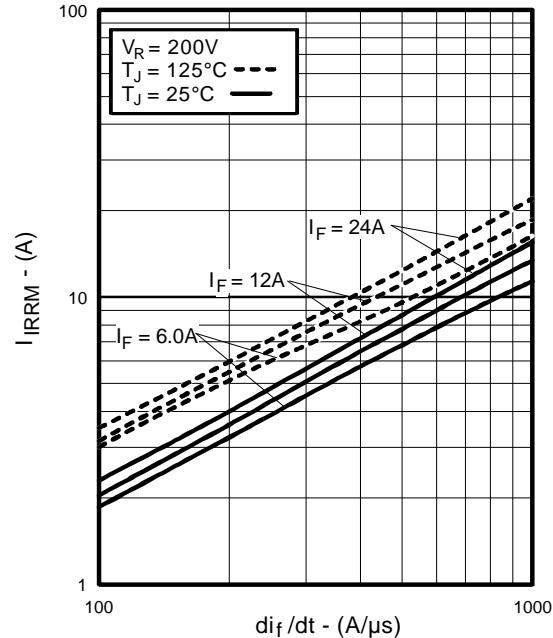

Fig. 15 - Typical Recovery Current vs. di$_f$/dt
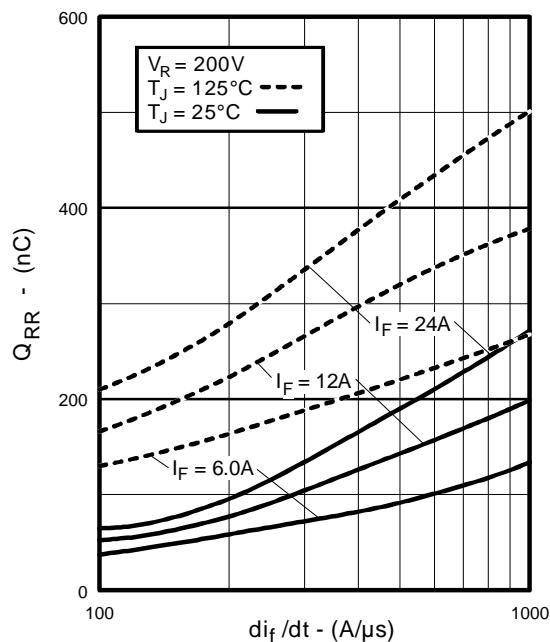

Fig. 16 - Typical Stored Charge vs. di$_f$/dt
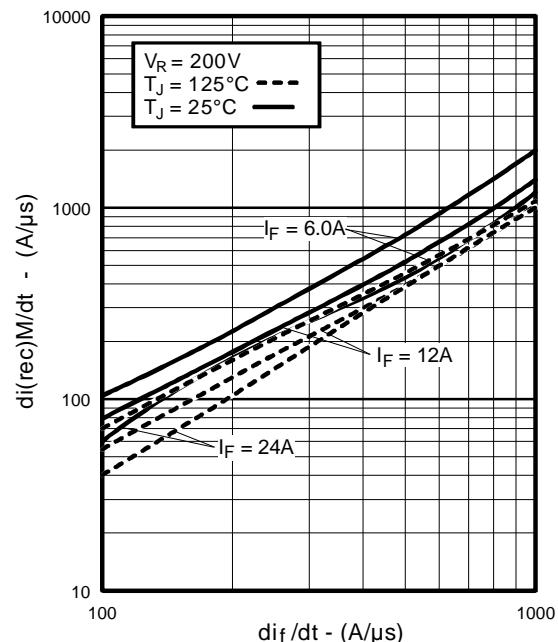

Fig. 17 - Typical di$_{(rec)M}$/dt vs. di$_f$/dt
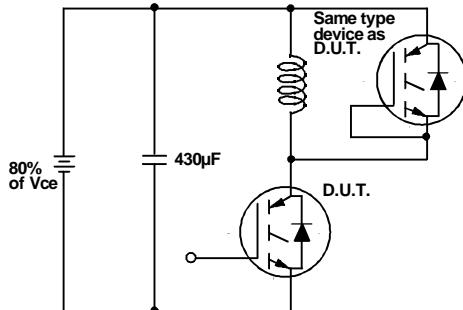
Fig. 18a - Test Circuit for Measurement of
I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f
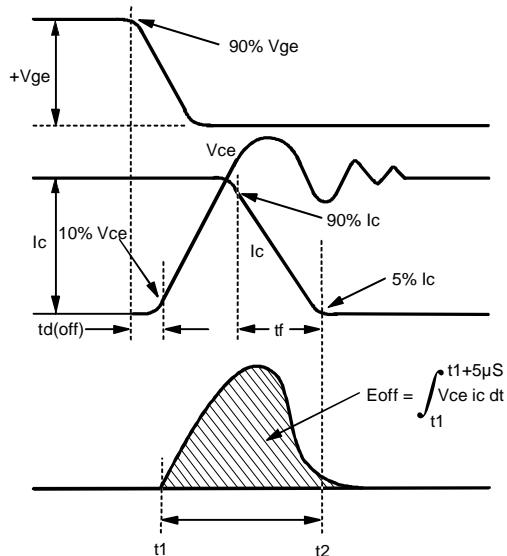

Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining
E_{off}, $t_{d(off)}$, t_f
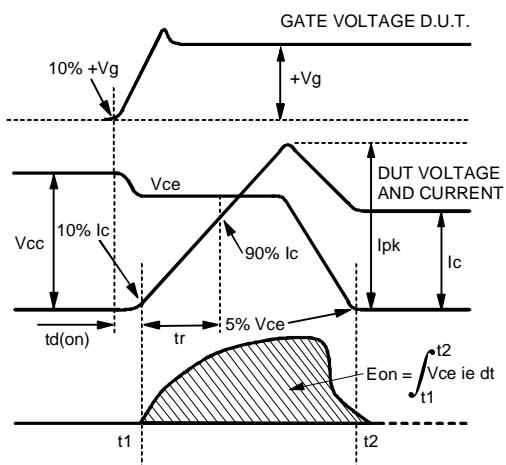
Fig. 18c - Test Waveforms for Circuit of Fig. 18a,
Defining E_{on}, $t_{d(on)}$, t_r
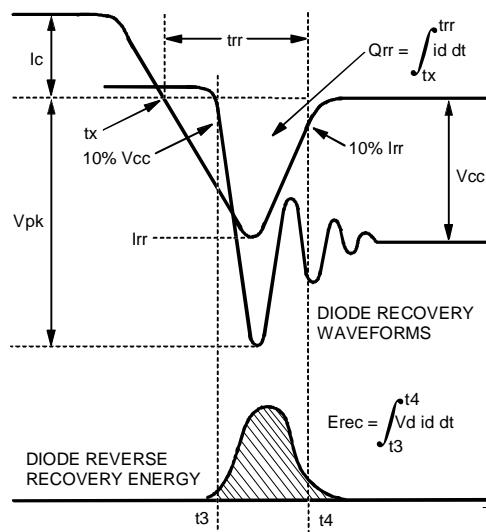
Fig. 18d - Test Waveforms for Circuit of Fig. 18a,
Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

Refer to Section D for the following:
Appendix D: Section D - page D-6
Fig. 18e - Macro Waveforms for Test Circuit Fig. 18a
Fig. 19 - Clamped Inductive Load Test Circuit
Fig. 20 - Pulsed Collector Current Test Circuit

Package Outline 1 - JEDEC Outline TO-220AB   **Section D - page D-12**