International
IOR Rectifier

PD -94904A

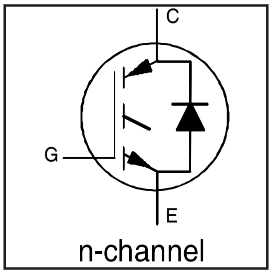
IRG4BC10SDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Standard Speed CoPack
IGBT

Features

- Extremely low voltage drop 1.1Vtyp. @ 2A
- S-Series: Minimizes power dissipation at up to 3 KHz PWM frequency in inverter drives, up to 4 KHz in brushless DC drives.
- Very Tight Vce(on) distribution
- IGBT co-packaged with HEXFRED^{TM} ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220AB package
- Lead-Free



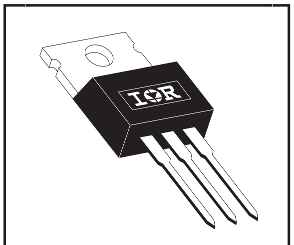
V_{CES} = 600V

$V_{CE(on)\ typ.}$ = 1.10V

@V_{GE} = 15V, I_C = 2.0A

Benefits

- Generation 4 IGBTs offer highest efficiencies available
- IGBTs optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBTs . Minimized recovery characteristics require less/no snubbing
- Lower losses than MOSFET's conduction and Diode losses


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	14	A
I_C @ T_C = 100°C	Continuous Collector Current	8.0	
I_{CM}	Pulsed Collector Current ①	18	
I_{LM}	Clamped Inductive Load Current ②	18	
I_F @ T_C = 100°C	Diode Continuous Forward Current	4.0	
I_{FM}	Diode Maximum Forward Current	18	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	38	W
P_D @ T_C = 100°C	Maximum Power Dissipation	15	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	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	----	----	3.3	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	----	----	7.0	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	----	0.50	----	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	----	----	80	
Wt	Weight	----	2.0(0.07)	----	g (oz)

07/04/07

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	600	—	—	V	V_{GE} = 0V, I_C = 250µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.64	—	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.58	1.8	V	I_C = 8.0A	V_{GE} = 15V
		—	2.05	—		I_C = 14.0A	See Fig. 2, 5
		—	1.68	—		I_C = 8.0A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-9.5	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance④	3.65	5.48	—	S	V_{CE} = 100V, I_C =8.0A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 600V	
		—	—	1000		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	1.5	1.8	V	I_C =4.0A	See Fig. 13
		—	1.4	1.7		I_C =4.0A, 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)	—	15	22	nC	I_C = 8.0A	
Qge	Gate - Emitter Charge (turn-on)	—	2.42	3.6		V_{CC} = 400V	See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	6.53	9.8		V_{GE} = 15V	
$t_{d(on)}$	Turn-On Delay Time	—	76	—	ns	T_J = 25°C	
t_r	Rise Time	—	32	—		I_C = 8.0A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	—	815	1200		V_{GE} = 15V, R_G = 100Ω	
t_f	Fall Time	—	720	1080		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	—	0.31	—	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	—	3.28	—		See Fig. 9, 10, 18	
E_{ts}	Total Switching Loss	—	3.60	10.9			
E_{ts}	Total Switching Loss	—	1.46	2.6	mJ	I_C = 5.0A	
$t_{d(on)}$	Turn-On Delay Time	—	70	—	ns	T_J = 150°C, See Fig. 10,11, 18	
t_r	Rise Time	—	36	—		I_C = 8.0A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	—	890	—		V_{GE} = 15V, R_G = 100Ω	
t_f	Fall Time	—	890	—		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	—	3.83	—	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	280	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	30	—		V_{CC} = 30V	See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	4.0	—		ƒ = 1.0MHz	
t_{rr}	Diode Reverse Recovery Time	—	28	42	ns	T_J = 25°C See Fig.	
		—	38	57		T_J = 125°C 14	I_F =4.0A
I_{rr}	Diode Peak Reverse Recovery Current	—	2.9	5.2	A	T_J = 25°C See Fig.	
		—	3.7	6.7		T_J = 125°C 15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	40	60	nC	T_J = 25°C See Fig.	
		—	70	105		T_J = 125°C 16	di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	—	280	—	A/µs	T_J = 25°C See Fig.	
	During t_b	—	235	—		T_J = 125°C 17	

Details of note ① through ④ are on the last page

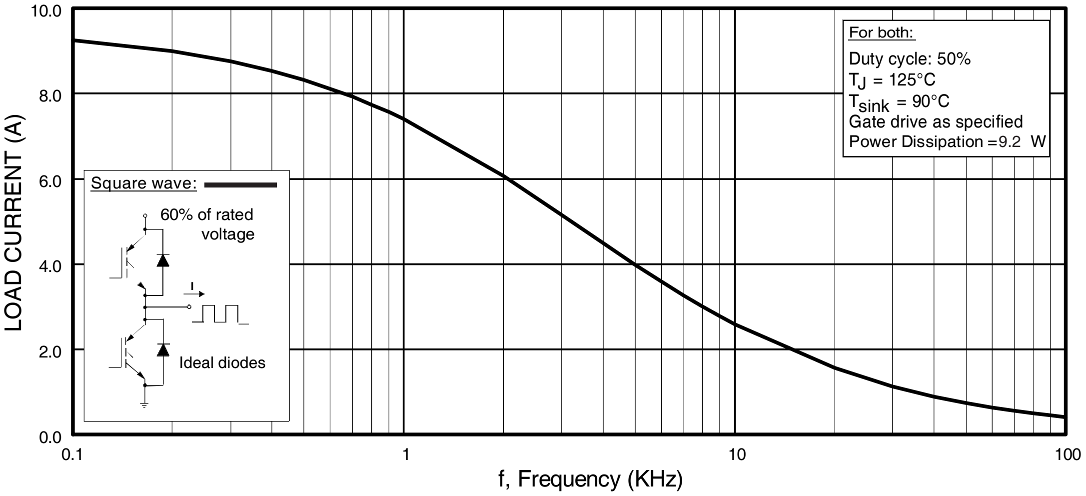
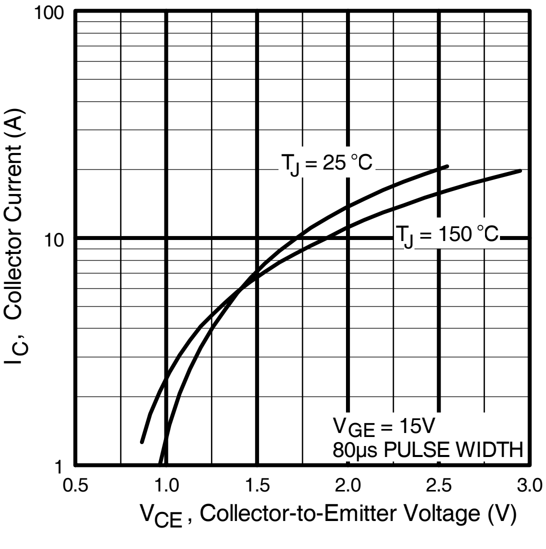


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)



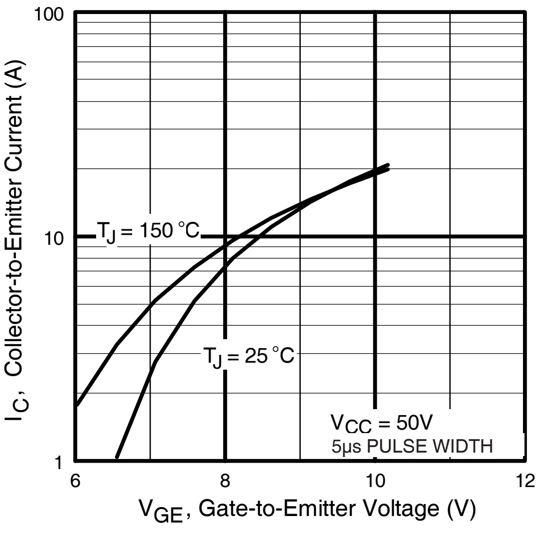


Fig. 2 - Typical Output Characteristics

Fig. 3 - Typical Transfer Characteristics

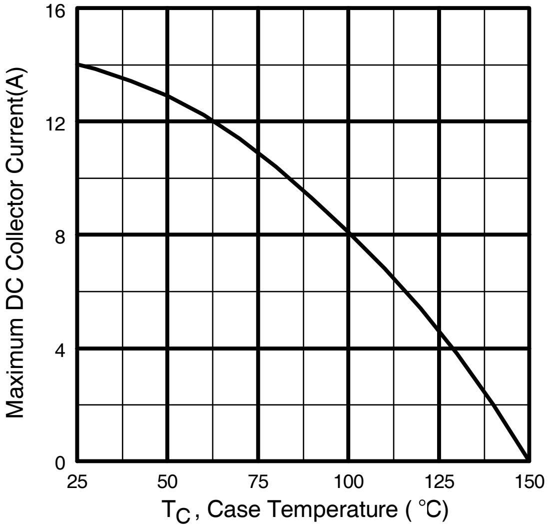


Fig. 4 - Maximum Collector Current vs. Case Temperature

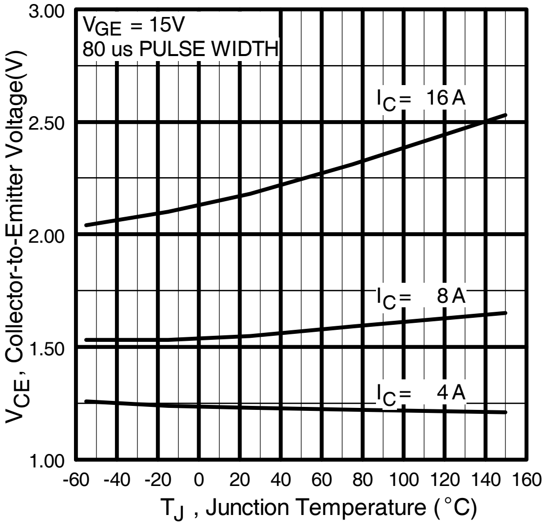


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

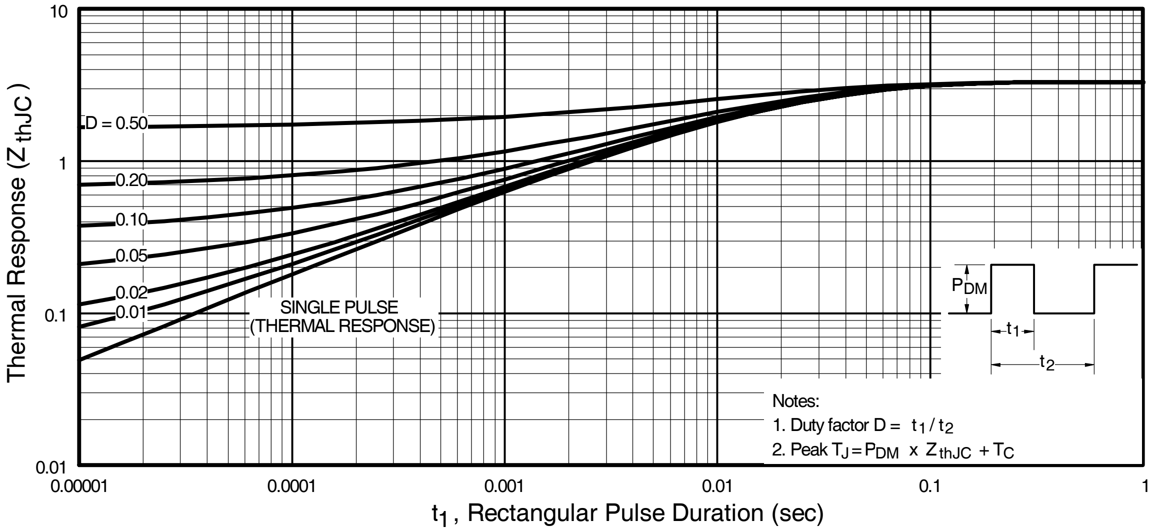


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

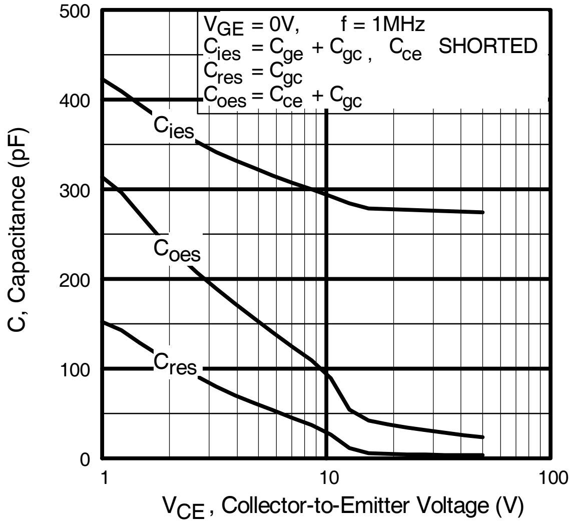


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

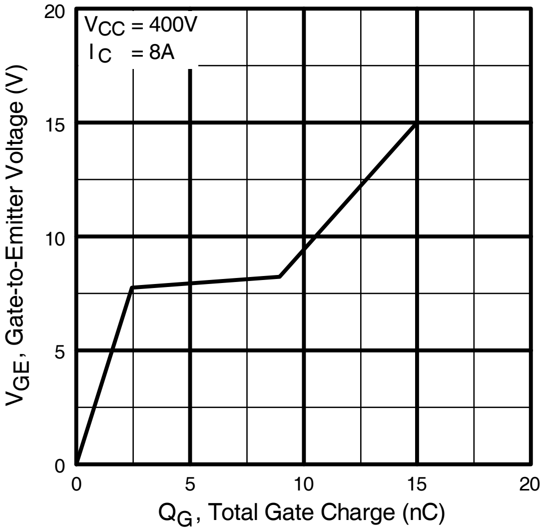


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

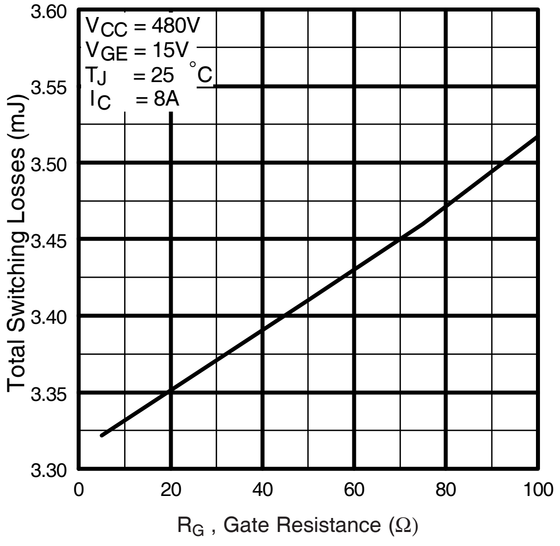


Fig. 9 - Typical Switching Losses vs. Gate Resistance

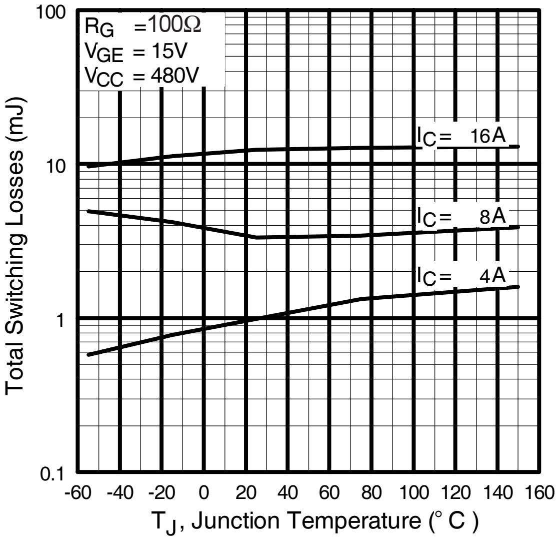


Fig. 10 - Typical Switching Losses vs. Junction Temperature

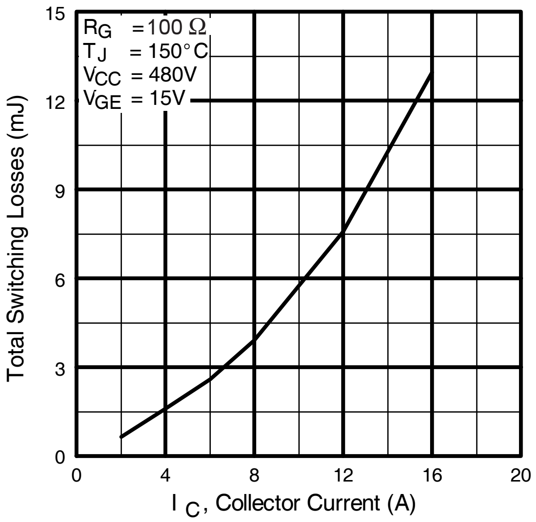


Fig. 11 - Typical Switching Losses vs. Collector Current

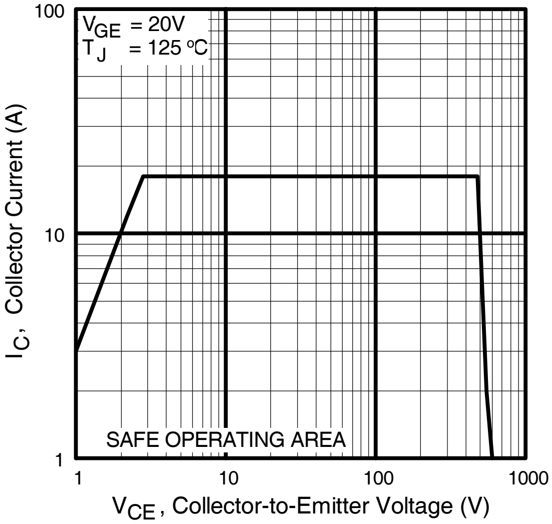


Fig. 12 - Turn-Off SOA

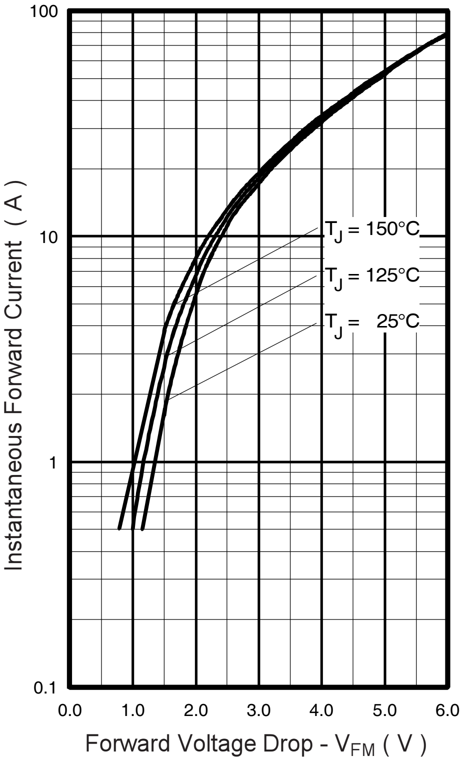


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

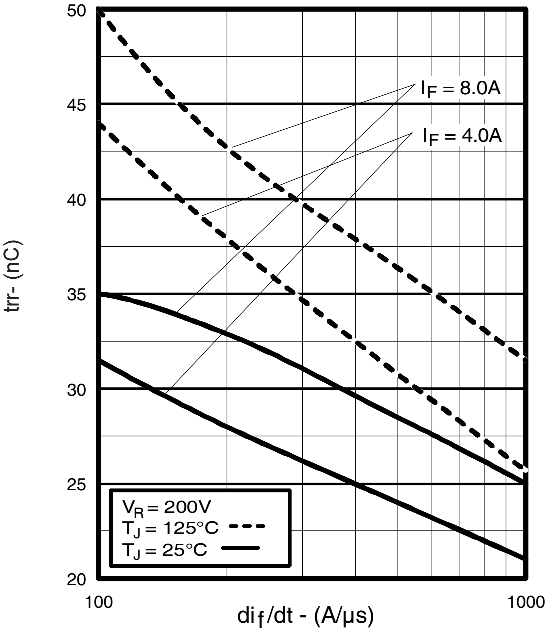


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

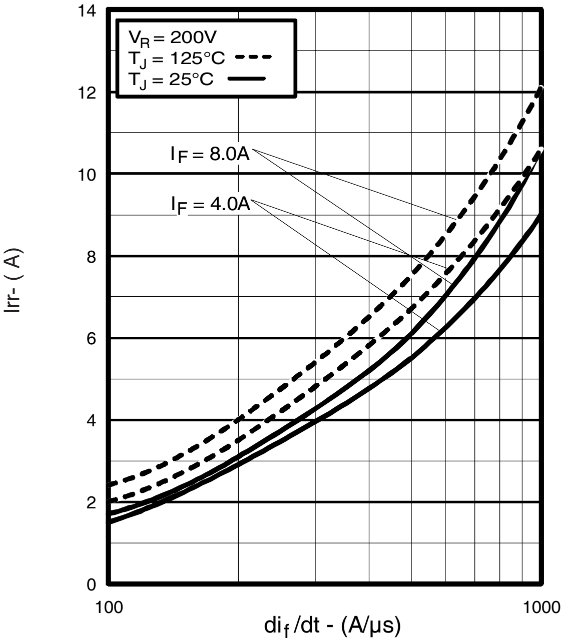


Fig. 15 - Typical Recovery Current vs. di_f/dt

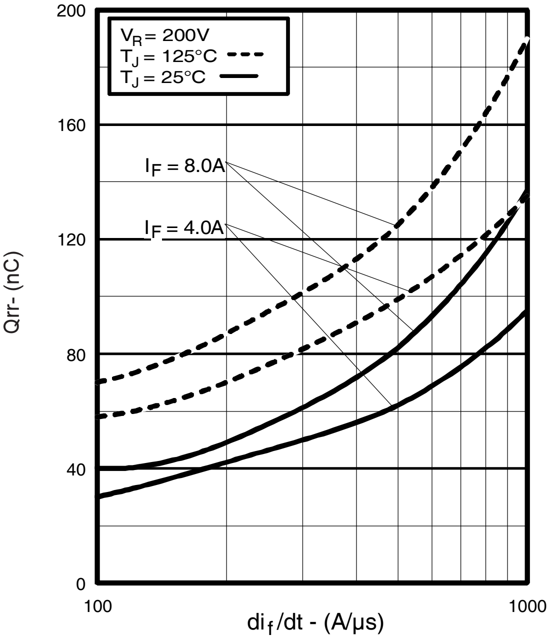


Fig. 16 - Typical Stored Charge vs. di_f/dt

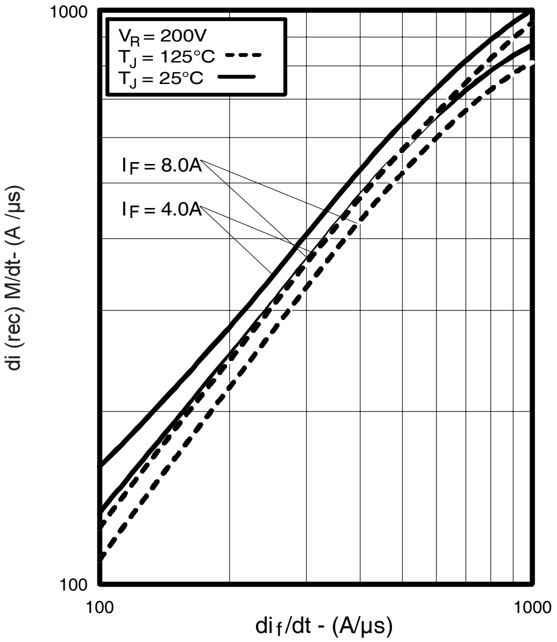


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt,

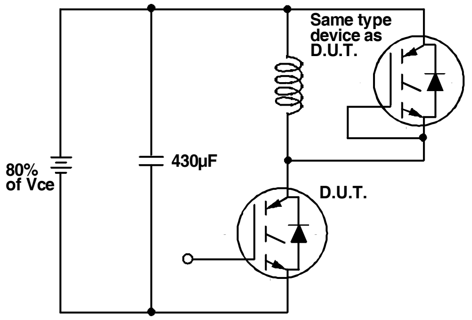


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

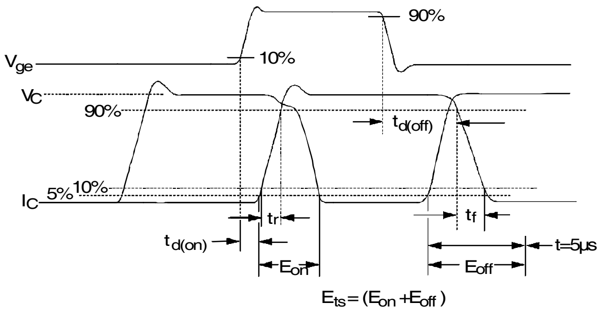


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

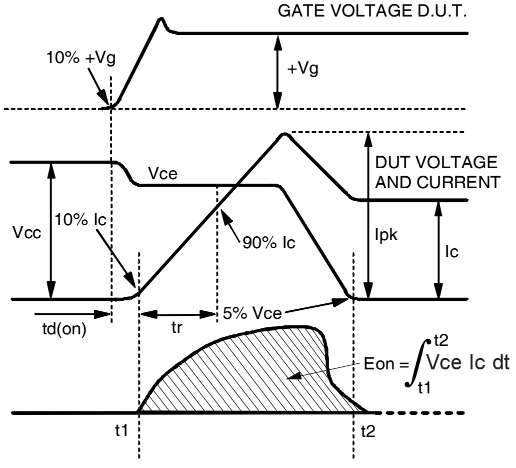


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

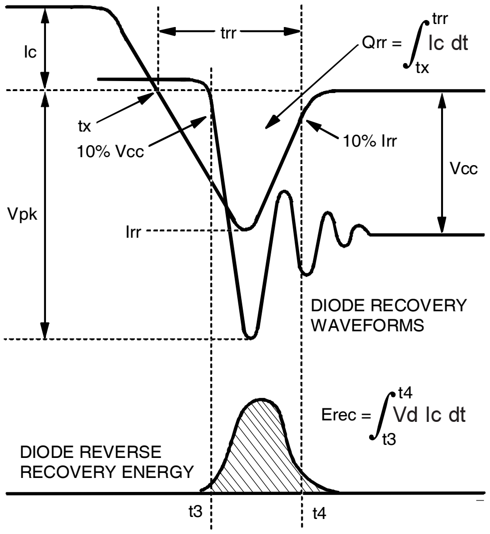


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

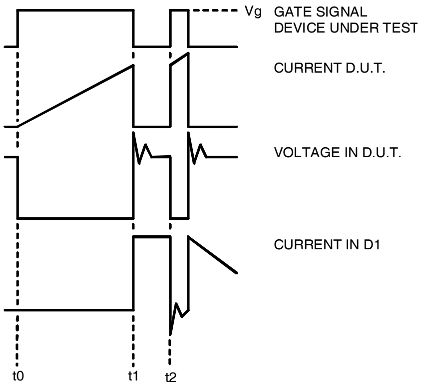


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

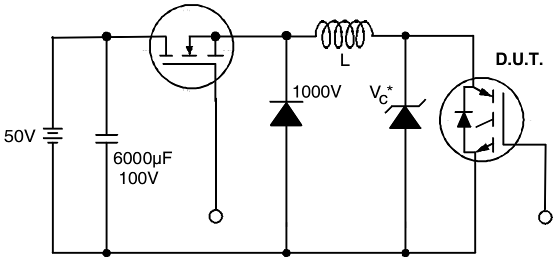


Figure 19. Clamped Inductive Load Test Circuit

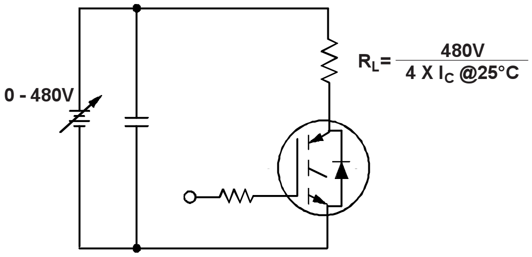


Figure 20. Pulsed Collector Current Test Circuit

Notes:

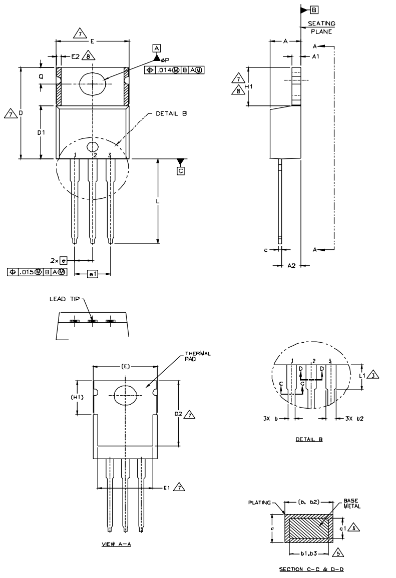
① Repetitive rating: V_{GE}=20V; pulse width limited by maximum junction temperature (figure 20)

② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G = 100W (figure 19)

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

④ Pulse width 5.0µs, single shot.

TO-220AB Package Outline (Dimensions are shown in millimeters (inches))



NOTES:

1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5.- DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.- CONTROLLING DIMENSION : INCHES.
7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.03	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.97	.015	.038	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	–	0.76	–	.030	8
e	2.54 BSC		.100 BSC		
e1	5.08 BSC		.200 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	–	6.35	–	.250	3
ØP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

LEAD ASSIGNMENTS

HEXFET

1.- GATE
2.- DRAIN
3.- SOURCE

IGBTs, CoPACK

1 - GATE
2.- COLLECTOR
3.- EMITTER

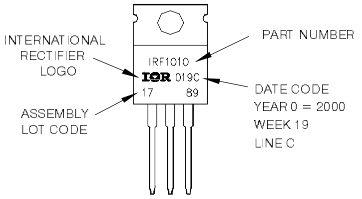
DIODES

1.- ANODE/OPEN
2.- CATHODE
3.- ANODE

TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 2000
IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position
indicates "Lead - Free"



Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

Data and specifications subject to change without notice.

International
IOR Rectifier

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