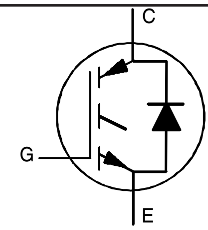
International
IOR Rectifier

IRG4BC20MDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
Fast IGBT

Features
- Rugged: 10µsec short circuit capable at V_{GS}=15V
- Low $V_{CE(on)}$ for 4 to 10kHz applications
- IGBT Co-packaged with ultra-soft-recovery antiparallel diode
- Industry standard TO-220AB package
- Lead-Free

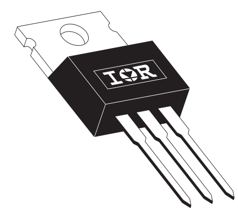


n-channel

V_{CES} = 600V

$V_{CE(on)\ typ.}$ = 1.85V

@V_{GE} = 15V, I_C = 11A


TO-220AB

Benefits
- Offers highest efficiency and short circuit capability for intermediate applications
- Provides best efficiency for the mid range frequency (4 to 10kHz)
- Optimized for Appliance Motor Drives, Industrial (Short Circuit Proof) Drives and Intermediate Frequency Range Drives
- High noise immune "Positive Only" gate drive- Negative bias gate drive not necessary
- For Low EMI designs- requires little or no snubbing
- Single Package switch for bridge circuit applications
- Compatible with high voltage Gate Driver IC's
- Allows simpler gate drive

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	18	A
I_C @ T_C = 100°C	Continuous Collector Current	11	
I_{CM}	Pulsed Collector Current ①	36	
I_{LM}	Clamped Inductive Load Current ②	36	
I_F @ T_C = 100°C	Diode Continuous Forward Current	7.0	
t_{sc}	Short Circuit Withstand Time	10	µs
I_{FM}	Diode Maximum Forward Current	36	A
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	60	W
P_D @ T_C = 100°C	Maximum Power Dissipation	24	
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	------	------	2.1	°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)

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	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.67	----	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	1.85	2.1	V	I_C = 11A	V_{GE} = 15V
		----	2.46	----		I_C = 18A	See Fig. 2, 5
		----	2.07	----		I_C = 11A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	----	6.5		$V_{CE} = V_{GE}$, I_C = 250µA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-11	----	mV/°C	$V_{CE} = V_{GE}$, I_C = 250µA	
g_{fe}	Forward Transconductance ④	3.0	3.6	----	S	V_{CE} = 100V, I_C = 11A	
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 = 8.0A	See Fig. 13
		----	1.3	1.6		I_C = 8.0A, 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)	----	39	59	nC	I_C = 11A		
Qge	Gate - Emitter Charge (turn-on)	----	5.3	8.0		V_{CC} = 400V See Fig. 8		
Q_{gc}	Gate - Collector Charge (turn-on)	----	20	30		V_{GE} = 15V		
$t_{d(on)}$	Turn-On Delay Time	----	21	----	ns	T_J = 25°C		
t_r	Rise Time	----	37	----		I_C = 11A, V_{CC} = 480V		
$t_{d(off)}$	Turn-Off Delay Time	----	463	690		V_{GE} = 15V, R_G = 50Ω		
t_f	Fall Time	----	340	510		Energy losses include "tail" and		
E_{on}	Turn-On Switching Loss	----	0.41	----	mJ	diode reverse recovery.		
E_{off}	Turn-Off Switching Loss	----	2.03	----		See Fig. 9, 10, 11, 18		
E_{ts}	Total Switching Loss	----	2.44	3.7				
$t_{d(on)}$	Turn-On Delay Time	----	19	----	ns	T_J = 150°C, See Fig. 9, 10, 11, 18		
t_r	Rise Time	----	41	----		I_C = 6.5A, V_{CC} = 480V		
$t_{d(off)}$	Turn-Off Delay Time	----	590	----		V_{GE} = 15V, R_G = 50Ω		
t_f	Fall Time	----	600	----		Energy losses include "tail" and		
E_{ts}	Total Switching Loss	----	3.49	----	mJ	diode reverse recovery.		
L_E	Internal Emitter Inductance	----	7.5	----	nH	Measured 5mm from package		
C_{ies}	Input Capacitance	----	460	----	pF	V_{GE} = 0V		
C_{oes}	Output Capacitance	----	54	----		V_{CC} = 30V See Fig. 7		
C_{res}	Reverse Transfer Capacitance	----	14	----		f = 1.0MHz		
t_{rr}	Diode Reverse Recovery Time	----	37	55	ns	T_J = 25°C	See Fig.	
		----	55	90		T_J = 125°C	14	I_F = 8.0A
I_{rr}	Diode Peak Reverse Recovery Current	----	3.5	5.0	A	T_J = 25°C	See Fig.	
		----	4.5	8.0		T_J = 125°C	15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	----	65	138	nC	T_J = 25°C	See Fig.	
		----	124	360		T_J = 125°C	16	di/dt 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	----	240	----	A/µs	T_J = 25°C	See Fig.	
	During t_b	----	210	----		T_J = 125°C	17	

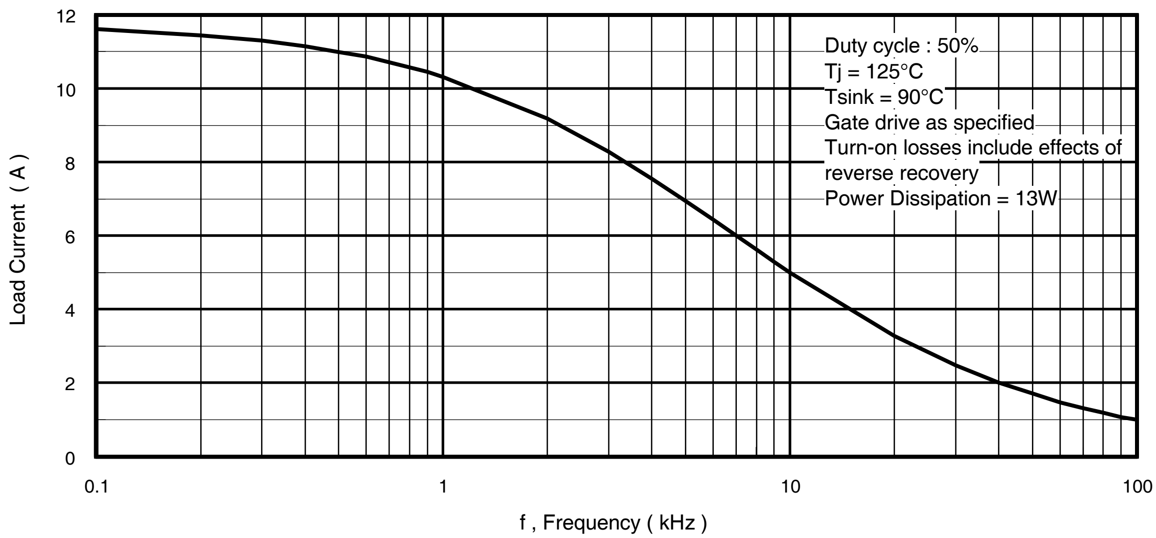


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

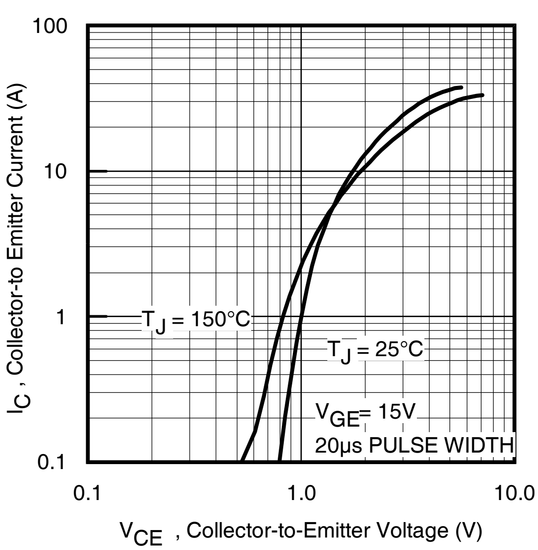


Fig. 2 - Typical Output Characteristics

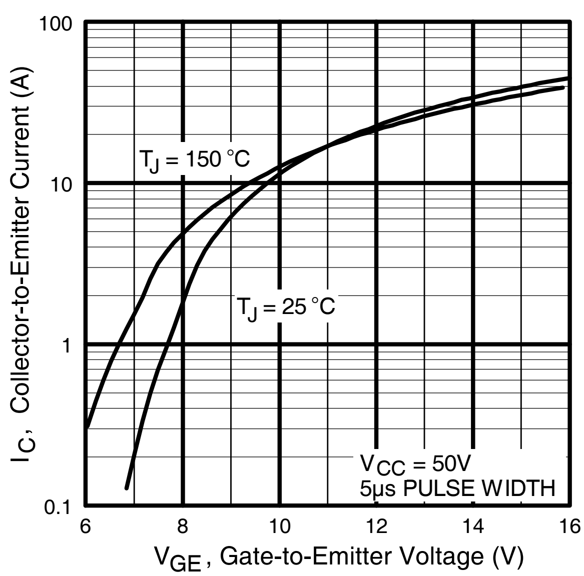


Fig. 3 - Typical Transfer Characteristics

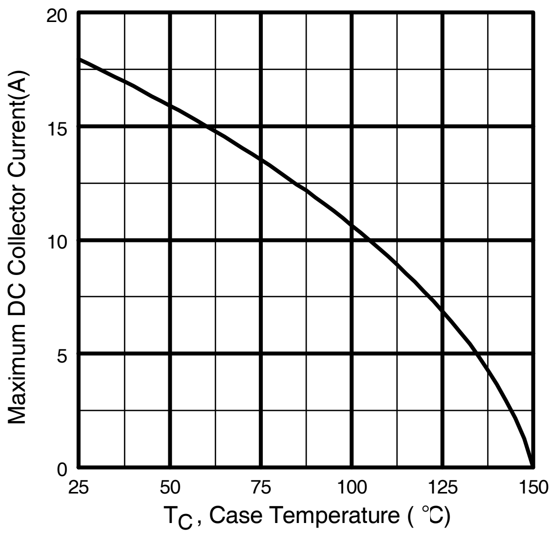


Fig. 4 - Maximum Collector Current vs. Case Temperature

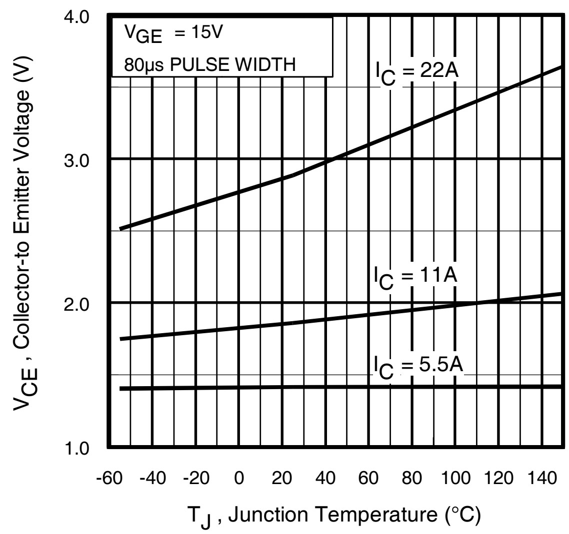


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

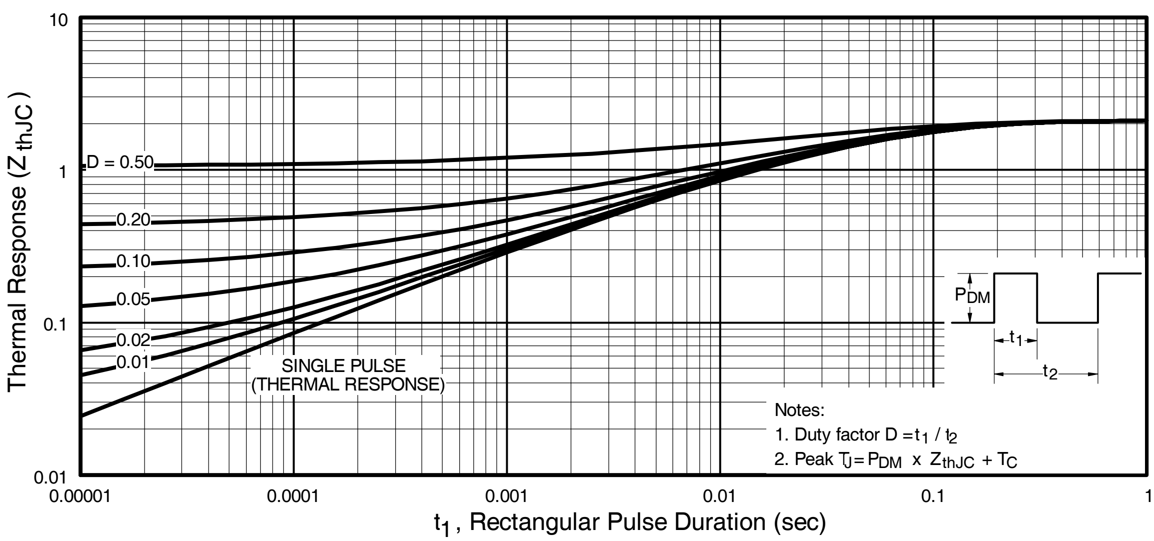


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

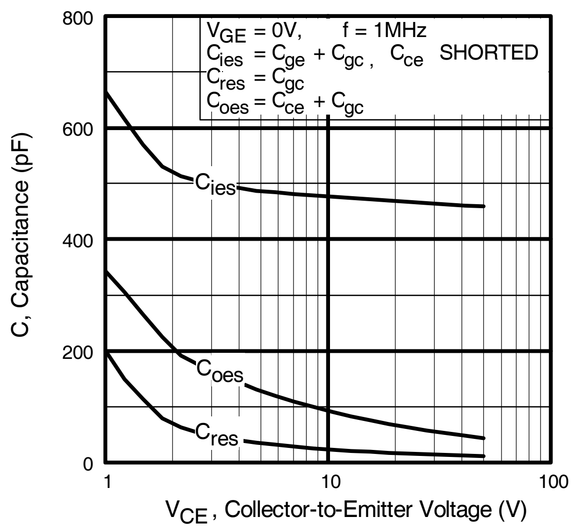


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

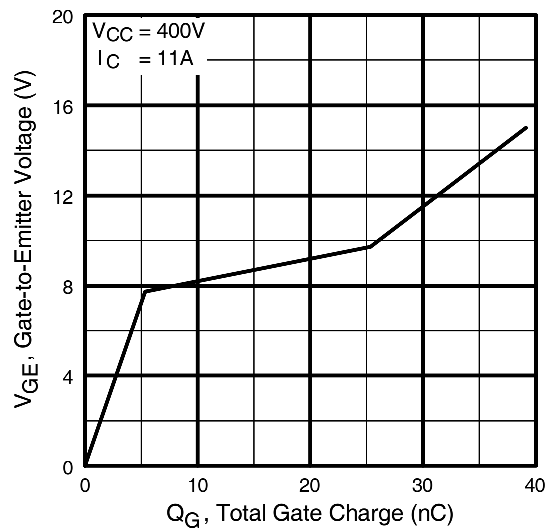


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

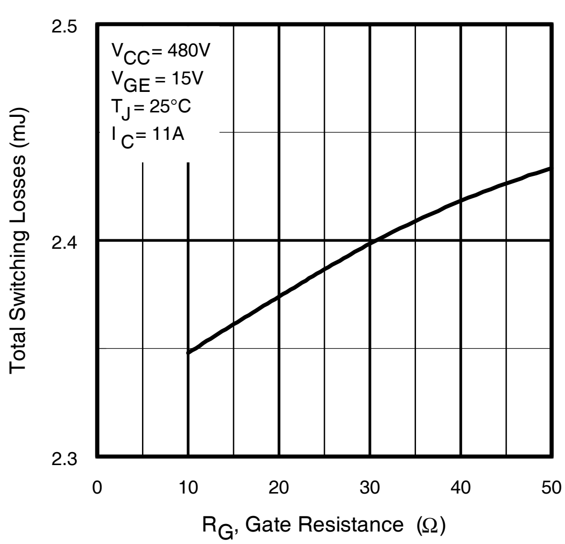


Fig. 9 - Typical Switching Losses vs. Gate Resistance

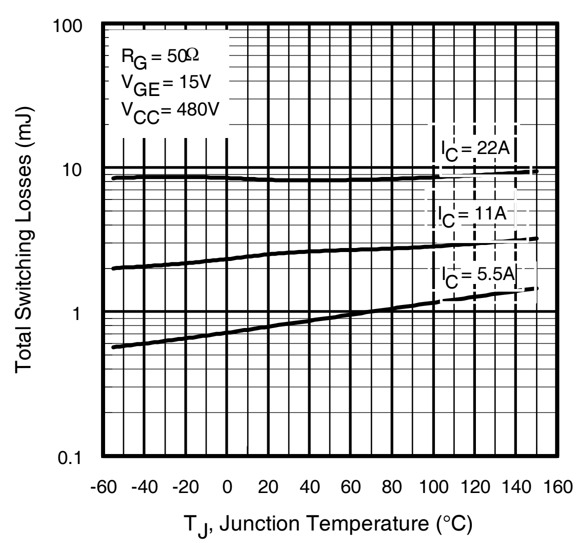


Fig. 10 - Typical Switching Losses vs. Junction Temperature

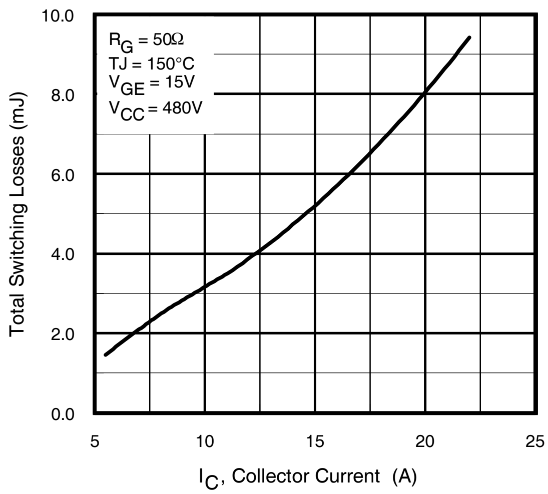


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

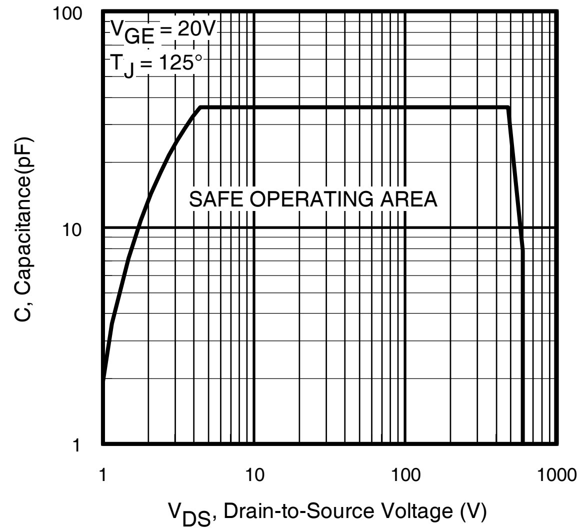


Fig. 12 - Turn-Off SOA

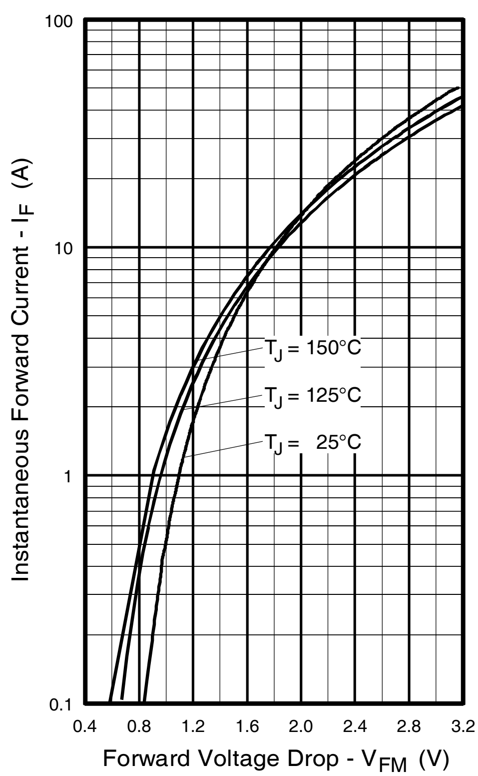


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

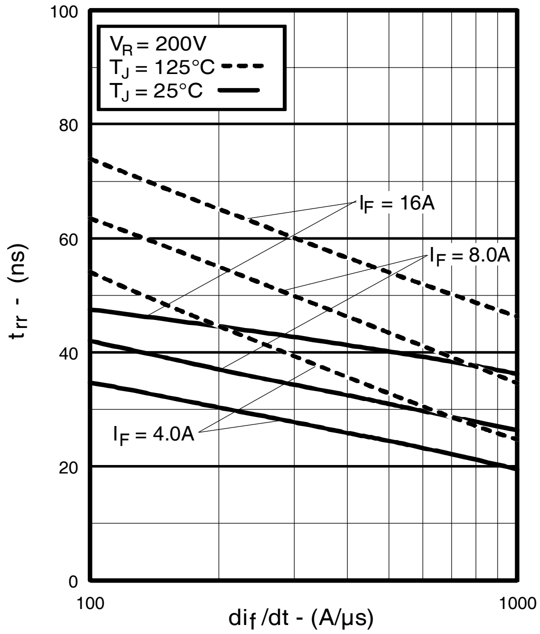


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

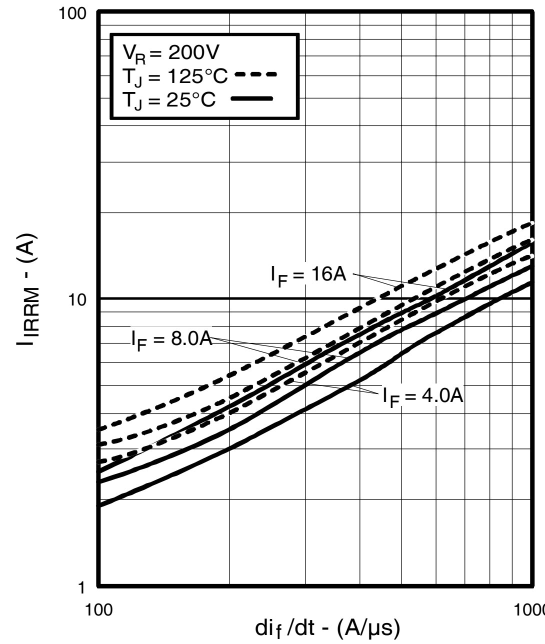


Fig. 15 - Typical Recovery Current vs. di_f/dt

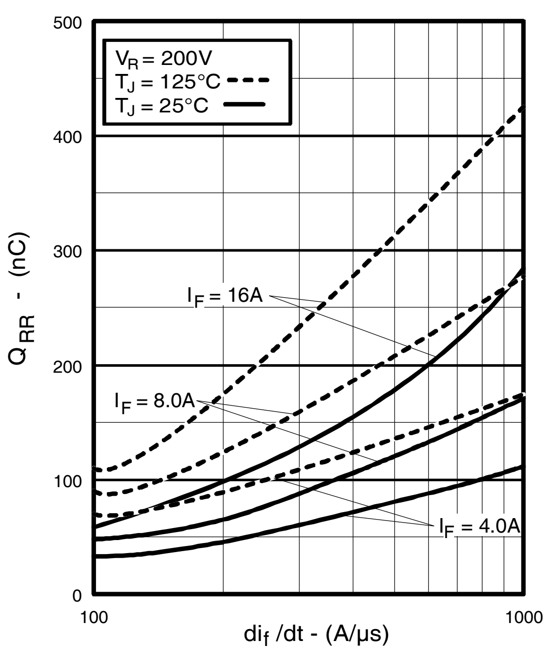


Fig. 16 - Typical Stored Charge vs. di_f/dt

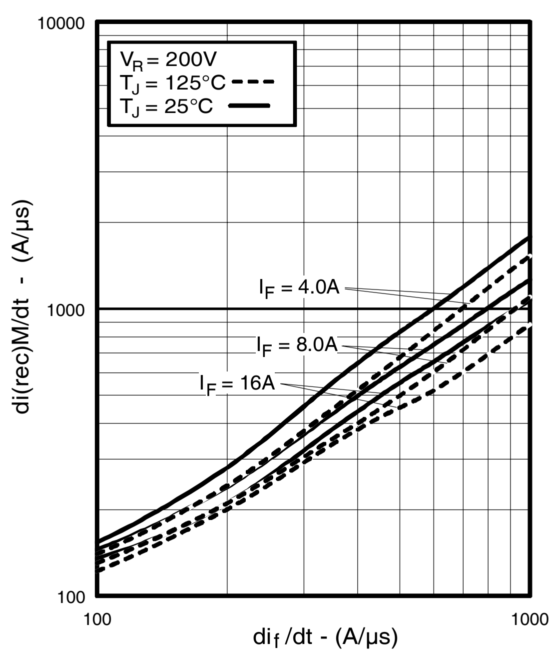


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

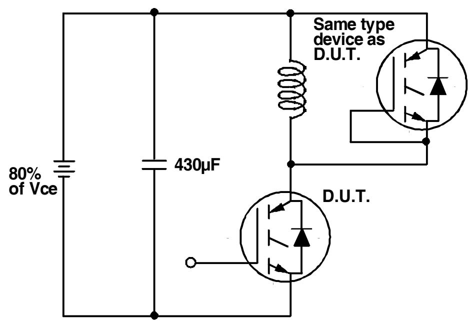


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

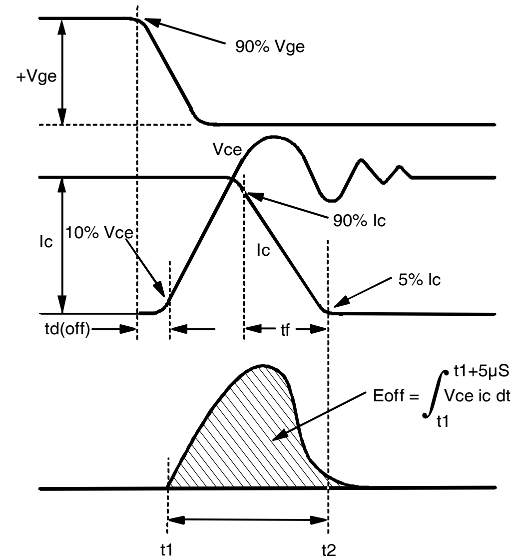


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

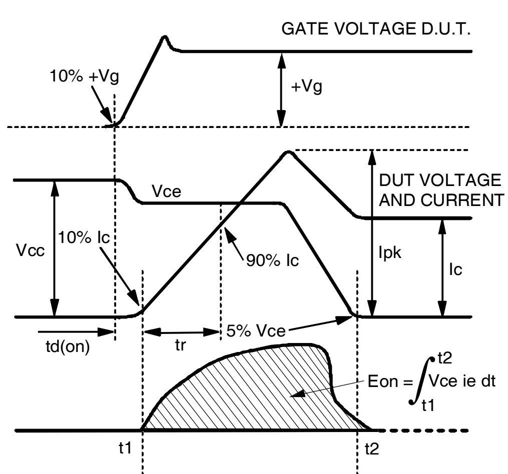


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

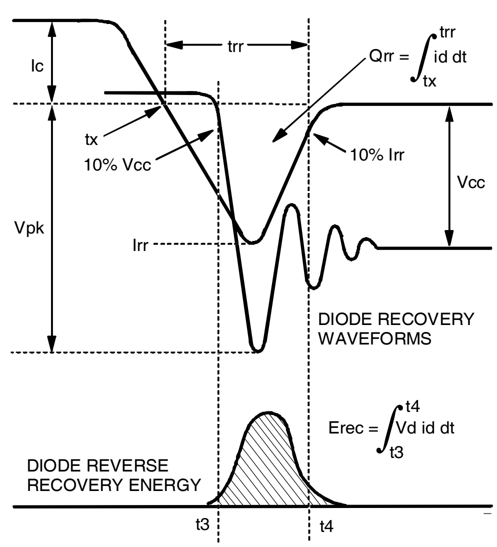


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

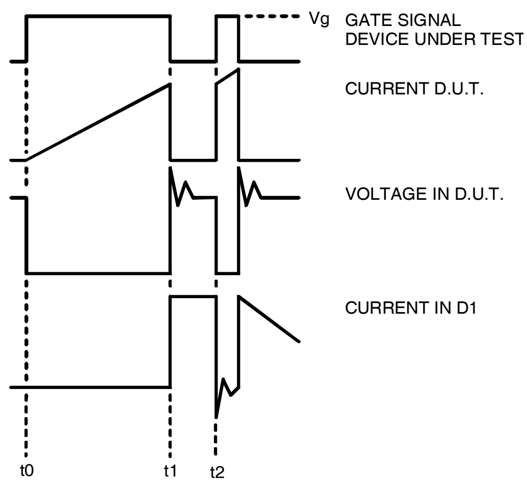


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

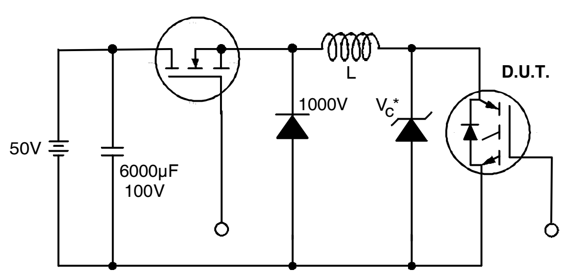


Figure 19. Clamped Inductive Load Test Circuit

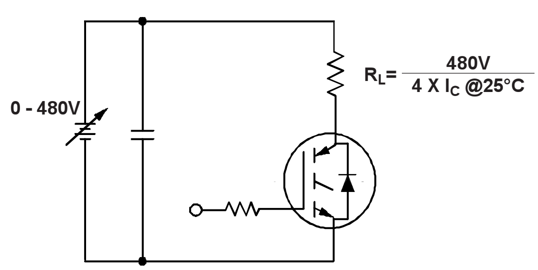


Figure 20. Pulsed Collector Current Test Circuit

Notes:

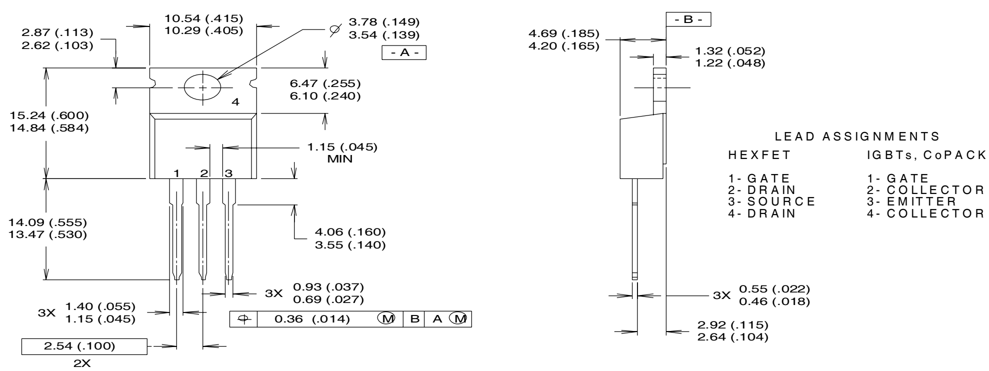
① Repetitive rating: V_{GE}=20V; pulse width limited by maximum junction temperature (figure 20)

② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G = 50Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

TO-220AB Package Outline

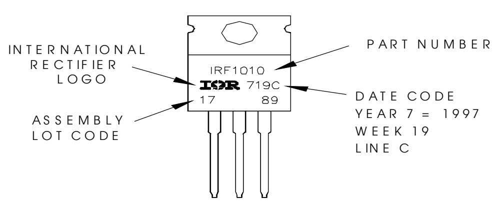


NOTES:
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

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



Data and specifications subject to change without notice.
This product has been designed and qualified for the Industrial market.
Qualification Standards can be found on IR's Web site.

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