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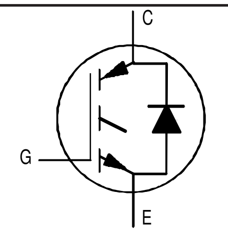
International
IOR Rectifier

PD - 93765

IRG4IBC10UD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast Co-Pack IGBT



N-channel

V_{CES} = 600V

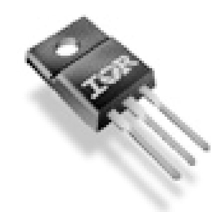
$V_{CE(on)\ typ.}$ = 2.15V

@V_{GE} = 15V, I_C = 5.0A

$t_{f(typ.)}$ = 140ns

Features

- UltraFast: Optimized for high operating up to 80 kHz in hard switching, > 200 kHz in resonant mode
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED® ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220 Full-Pak


TO-220 Full-Pak

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

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	6.8	A
I_C @ T_C = 100°C	Continuous Collector Current	3.9	
I_{CM}	Pulsed Collector Current ①	27	
I_{LM}	Clamped Inductive Load Current ②	27	
I_F @ T_C = 100°C	Diode Continuous Forward Current	3.9	
I_{FM}	Diode Maximum Forward Current	27	
V_{ISOL}	RMS Isolated Voltage, Terminal to case, t=1min	2500	V
V_{GE}	Gate-to-Emitter Voltage	± 20	
P_D @ T_C = 25°C	Maximum Power Dissipation	25	W
P_D @ T_C = 100°C	Maximum Power Dissipation	10	
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	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	–––	5.0	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	–––	9.0	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	–––	65	
Wt	Weight	2.1 (0.075)	–––	g (oz)

10/27/99

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	—	0.54	—	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.15	2.6	V	I_C = 5.0A	V_{GE} = 15V
		—	2.61	—		I_C = 8.5A	See Fig. 2, 5
		—	2.30	—		I_C = 5.0A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage ④	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-8.7	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance	2.8	4.2	—	S	V_{CE} = 100V, I_C = 5.0A	
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 = 125°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 = 5.0A	
Qge	Gate - Emitter Charge (turn-on)	—	2.6	4.0		V_{CC} = 400V See Fig. 8	
Q_{gc}	Gate - Collector Charge (turn-on)	—	5.8	8.7		V_{GE} = 15V	
$t_{d(on)}$	Turn-On Delay Time	—	40	—	ns	T_J = 25°C	
t_r	Rise Time	—	16	—		I_C = 5.0A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	—	87	130		V_{GE} = 15V, R_G = 100W	
t_f	Fall Time	—	140	210		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	—	0.14	—	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	—	0.12	—		See Fig. 9, 10, 18	
E_{ts}	Total Switching Loss	—	0.26	0.33			
$t_{d(on)}$	Turn-On Delay Time	—	38	—	ns	T_J = 150°C, See Fig. 11, 18	
t_r	Rise Time	—	18	—		I_C = 5.0A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	—	95	—		V_{GE} = 15V, R_G = 100W	
t_f	Fall Time	—	250	—		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	—	0.45	—	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	270	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	21	—		V_{CC} = 30V See Fig. 7	
C_{res}	Reverse Transfer Capacitance	—	3.5	—		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

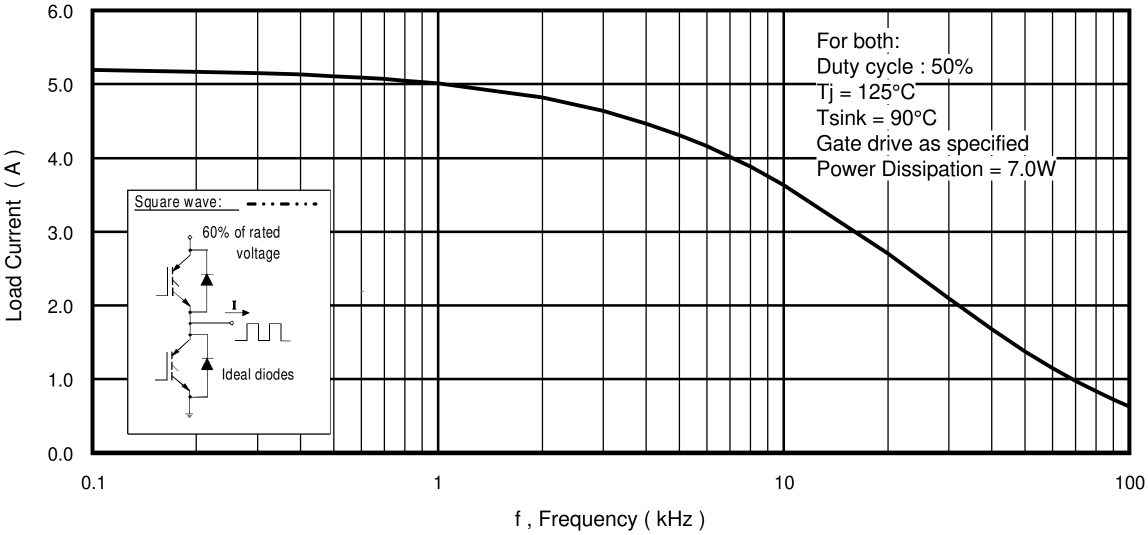


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

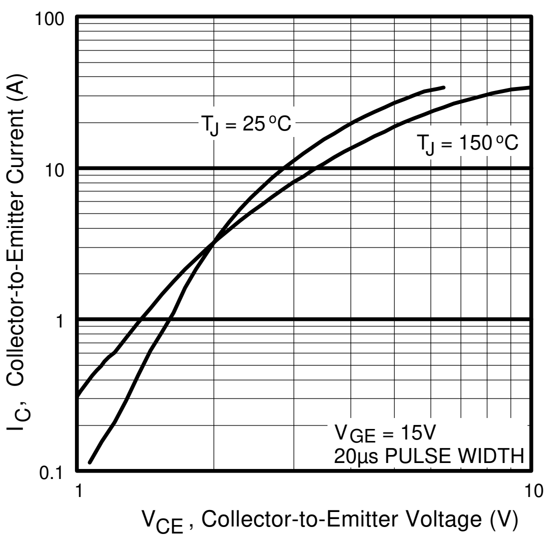


Fig. 2 - Typical Output Characteristics

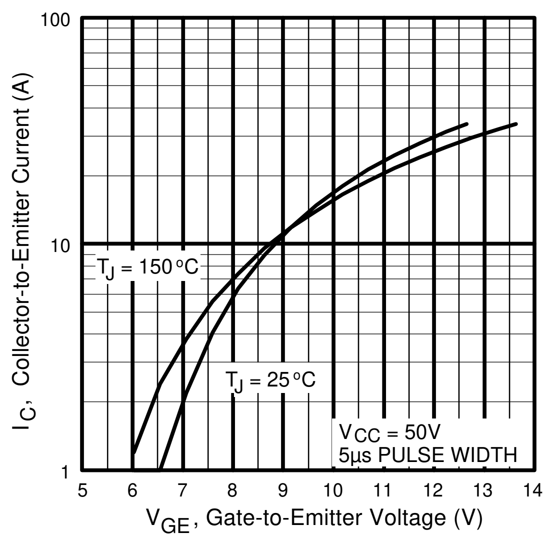


Fig. 3 - Typical Transfer Characteristics

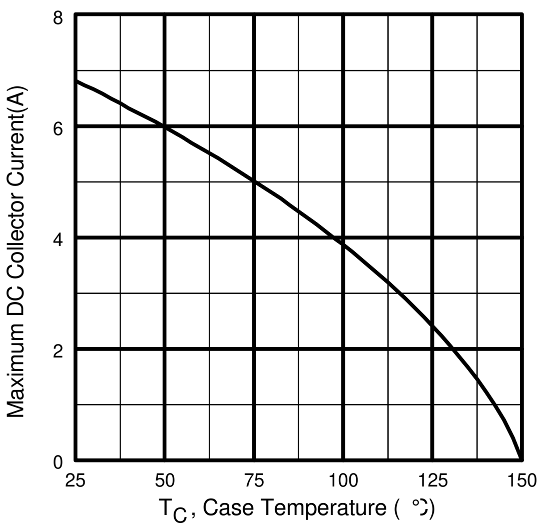


Fig. 4 - Maximum Collector Current vs. Case Temperature

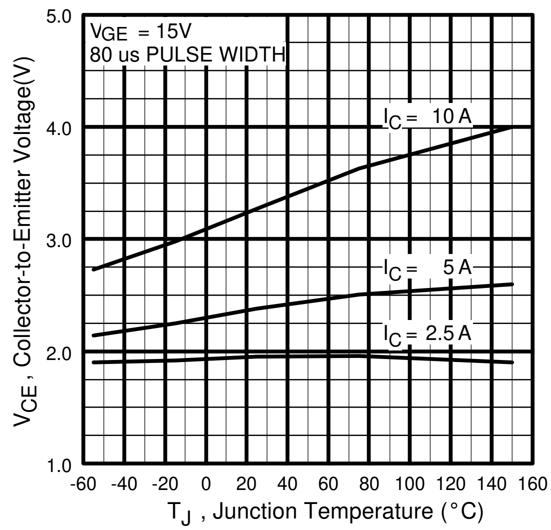


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

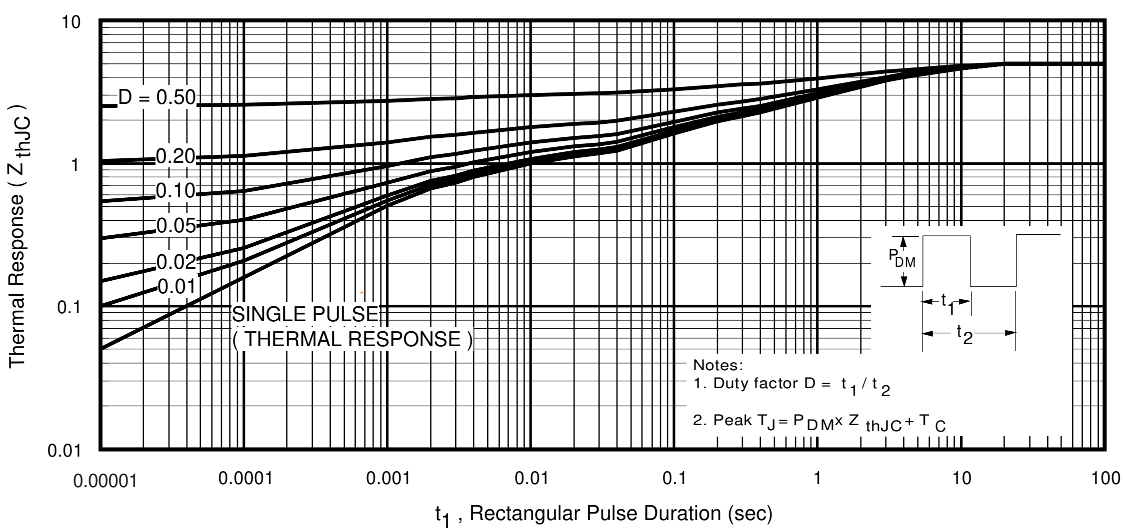


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

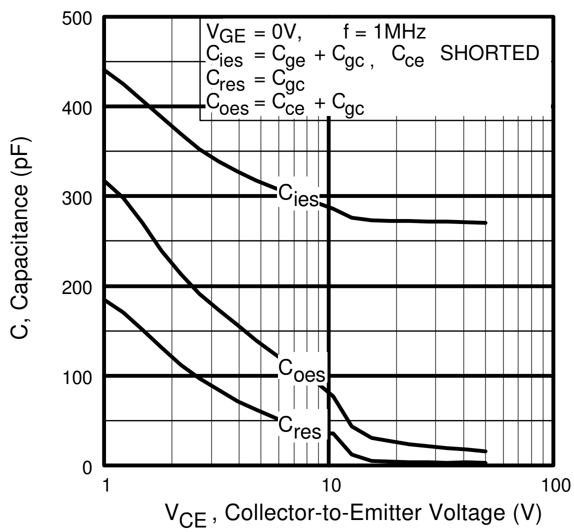


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

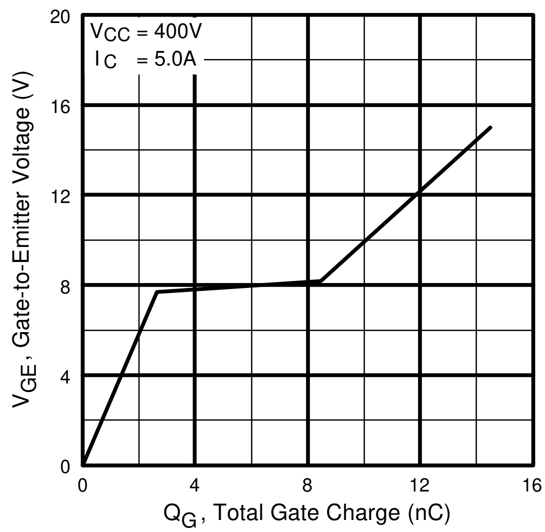


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

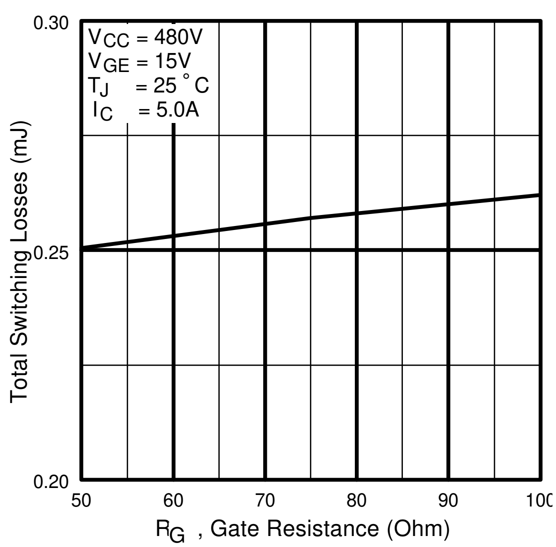


Fig. 9 - Typical Switching Losses vs. Gate Resistance

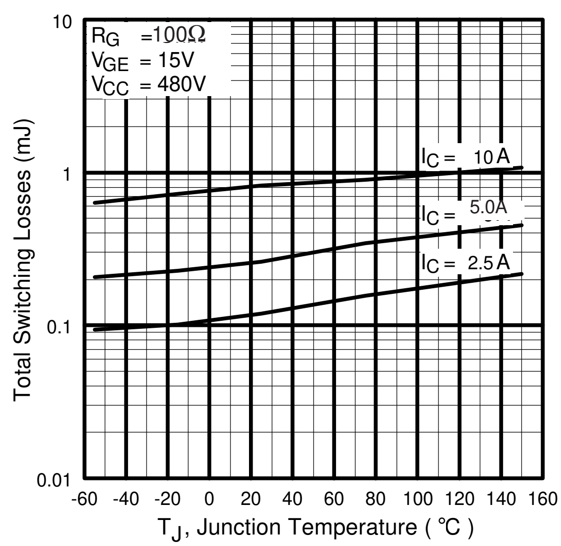


Fig. 10 - Typical Switching Losses vs. Junction Temperature

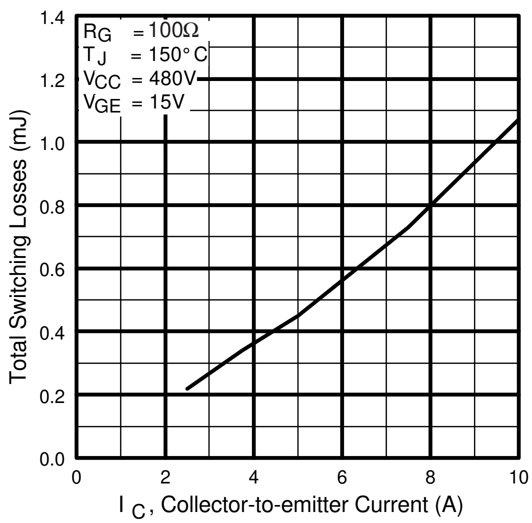


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

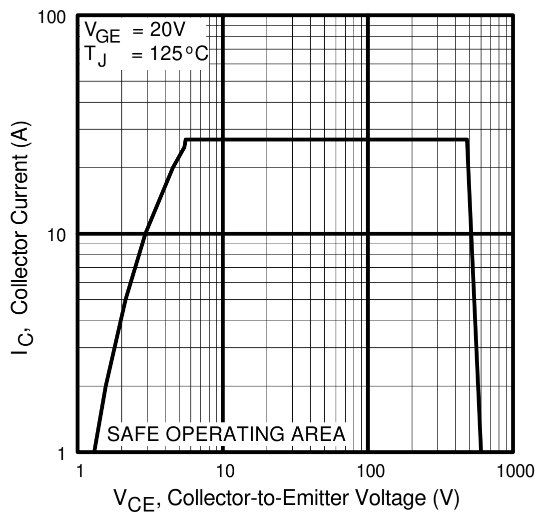


Fig. 12 - Turn-Off SOA

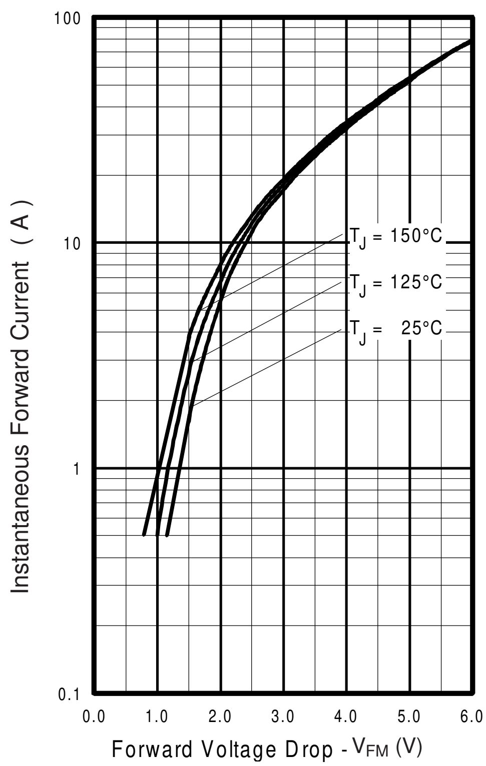


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

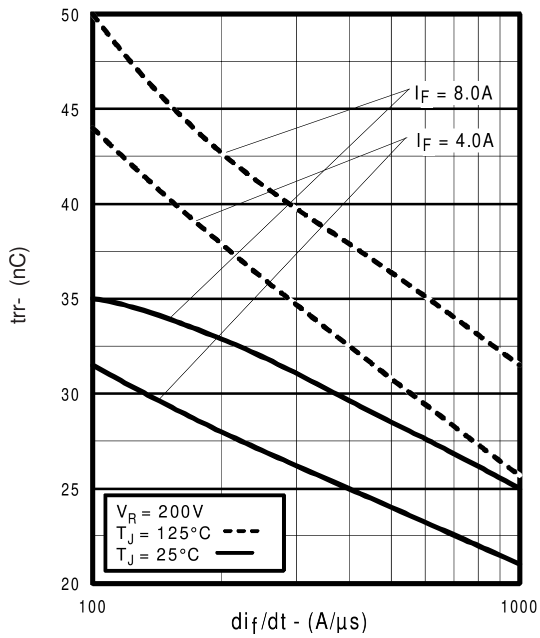


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

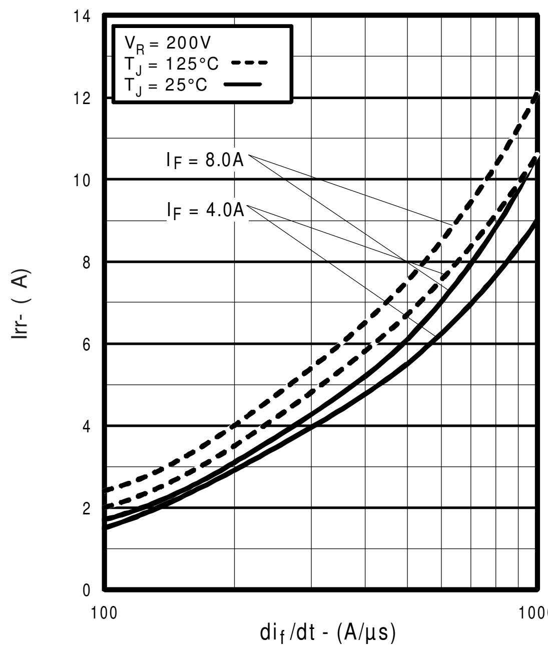


Fig. 15 - Typical Recovery Current vs. di_f/dt

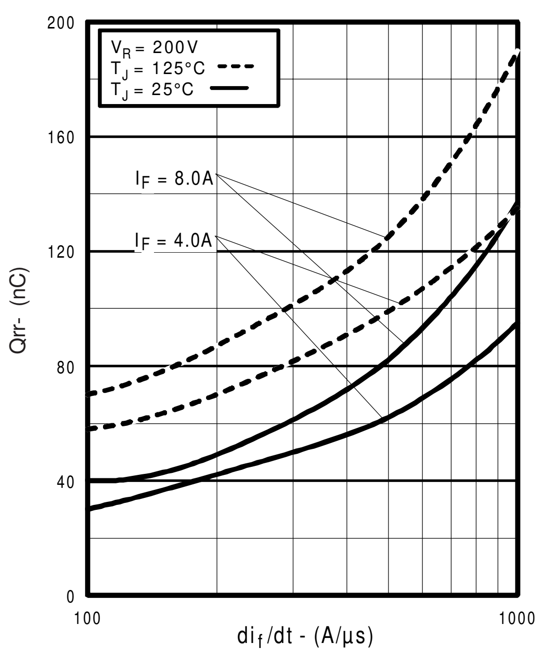


Fig. 16 - Typical Stored Charge vs. di_f/dt

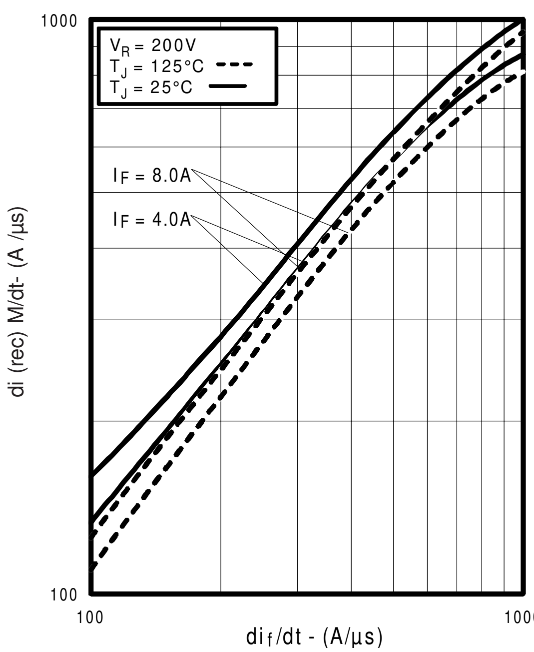


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

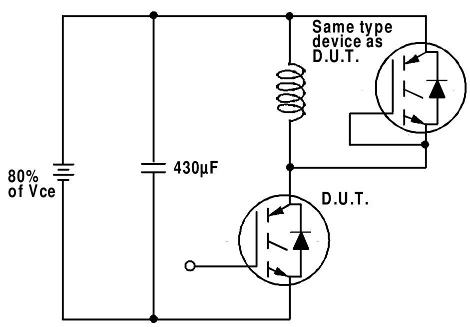


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

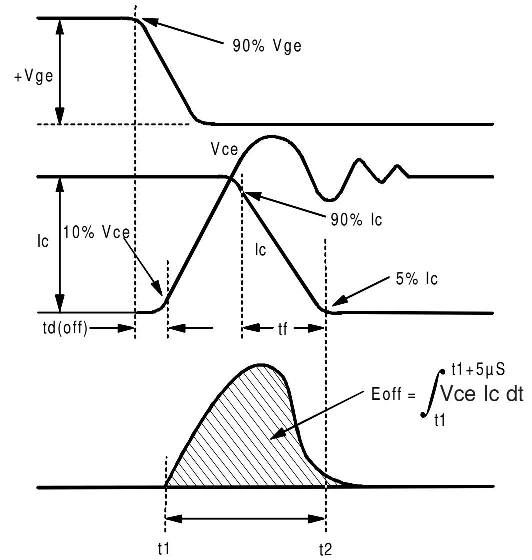


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

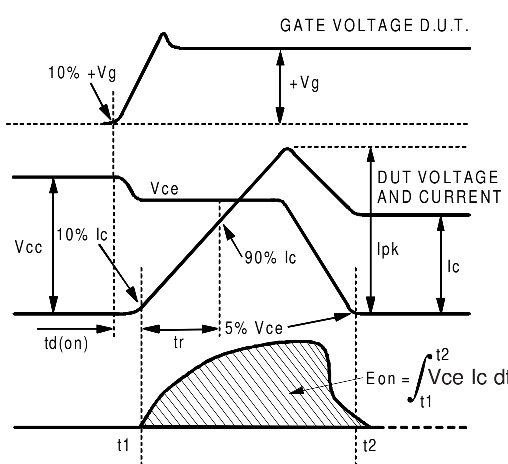


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

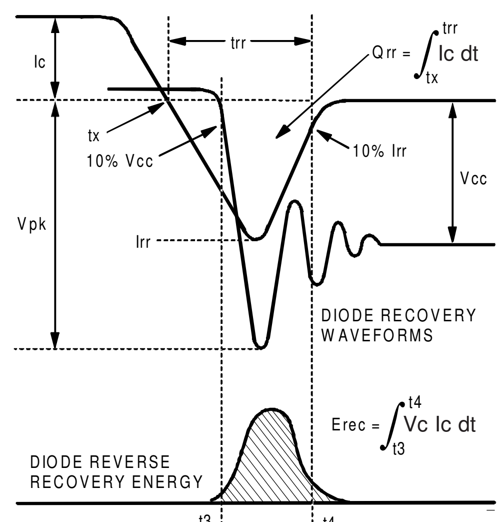


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

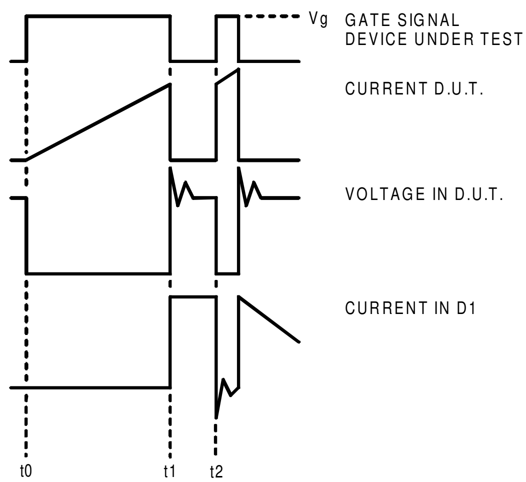


Fig. 18e - Macro Waveforms for Figure 18a's Test Circuit

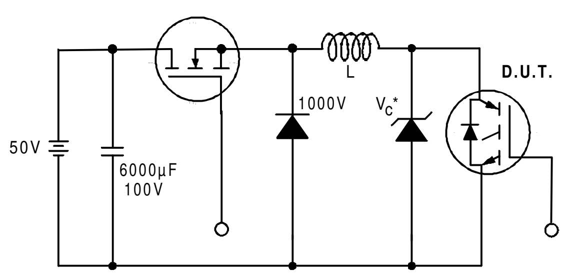


Fig. 19 - Clamped Inductive Load Test Circuit

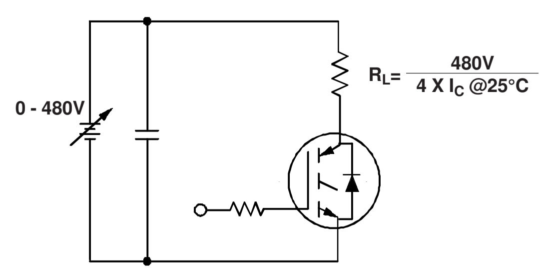
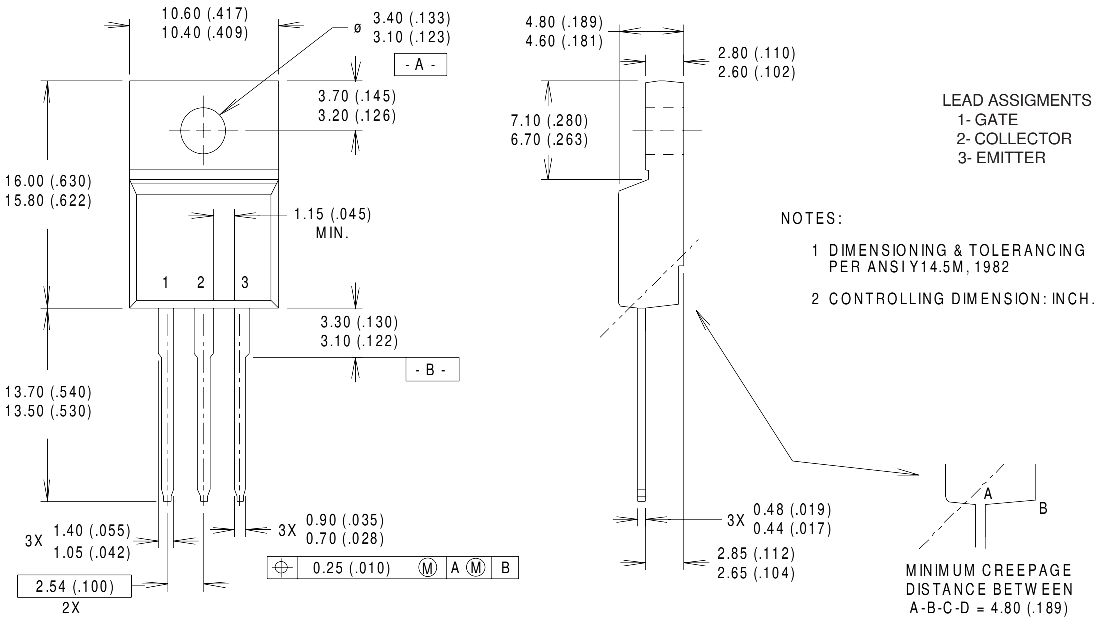


Fig. 20 - Pulsed Collector Current Test Circuit

TO-220 Full-Pak Package Outline



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= 100Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

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