PD 9.1573

International
IOR Rectifier

PRELIMINARY

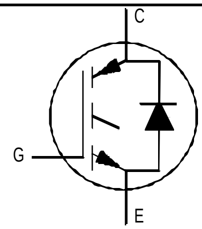
IRG4PH50UD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast CoPack IGBT

Features

- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED^{TM} ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package



n-channel

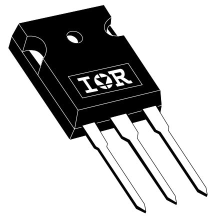
V_{CES} = 1200V

$V_{CE(on)\ typ.}$ = 2.78V

@V_{GE} = 15V, I_C = 24A

Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	45	A
I_C @ T_C = 100°C	Continuous Collector Current	24	
I_{CM}	Pulsed Collector Current ①	180	
I_{LM}	Clamped Inductive Load Current ②	180	
I_F @ T_C = 100°C	Diode Continuous Forward Current	7.0	
I_{FM}	Diode Maximum Forward Current	32	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	200	W
P_D @ T_C = 100°C	Maximum Power Dissipation	78	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	–––	–––	0.64	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	–––	–––	0.83	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	–––	0.24	–––	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	–––	–––	40	
Wt	Weight	–––	6 (0.21)	–––	g (oz)

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	1200	—	—	V	V_{GE} = 0V, I_C = 250µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.20	—	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.56	3.5	V	I_C = 20A	V_{GE} = 15V
		—	2.78	3.7		I_C = 24A	See Fig. 2, 5
		—	3.20	—		I_C = 45A	
		—	2.54	—		I_C = 24A, 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	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance ④	23	35	—	S	V_{CE} = 100V, I_C = 24A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V	
		—	—	6500		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.0	V	I_C = 16A	See Fig. 13
		—	2.1	2.5		I_C = 16A, 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)	—	160	250	nC	I_C = 24A	
Qge	Gate - Emitter Charge (turn-on)	—	27	40		V_{CC} = 400V See Fig. 8	
Q_{gc}	Gate - Collector Charge (turn-on)	—	53	80		V_{GE} = 15V	
$t_{d(on)}$	Turn-On Delay Time	—	47	—	ns	T_J = 25°C	
t_r	Rise Time	—	24	—		I_C = 24A, V_{CC} = 800V	
$t_{d(off)}$	Turn-Off Delay Time	—	110	170		V_{GE} = 15V, R_G = 5.0Ω	
t_f	Fall Time	—	180	260		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	—	2.10	—	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	—	1.50	—		See Fig. 9, 10, 18	
E_{ts}	Total Switching Loss	—	3.60	4.6			
$t_{d(on)}$	Turn-On Delay Time	—	46	—	ns	T_J = 150°C, See Fig. 11, 18	
t_r	Rise Time	—	27	—		I_C = 24A, V_{CC} = 800V	
$t_{d(off)}$	Turn-Off Delay Time	—	240	—		V_{GE} = 15V, R_G = 5.0Ω	
t_f	Fall Time	—	330	—		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	—	6.38	—	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	3600	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	160	—		V_{CC} = 30V See Fig. 7	
C_{res}	Reverse Transfer Capacitance	—	31	—		f = 1.0MHz	
t_{rr}	Diode Reverse Recovery Time	—	90	135	ns	T_J = 25°C See Fig.	
		—	164	245		T_J = 125°C 14	I_F = 16A
I_{rr}	Diode Peak Reverse Recovery Current	—	5.8	10	A	T_J = 25°C See Fig.	
		—	8.3	15		T_J = 125°C 15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	260	675	nC	T_J = 25°C See Fig.	
		—	680	1838		T_J = 125°C 16	di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	120	—	A/µs	T_J = 25°C See Fig.	
		—	76	—		T_J = 125°C 17	

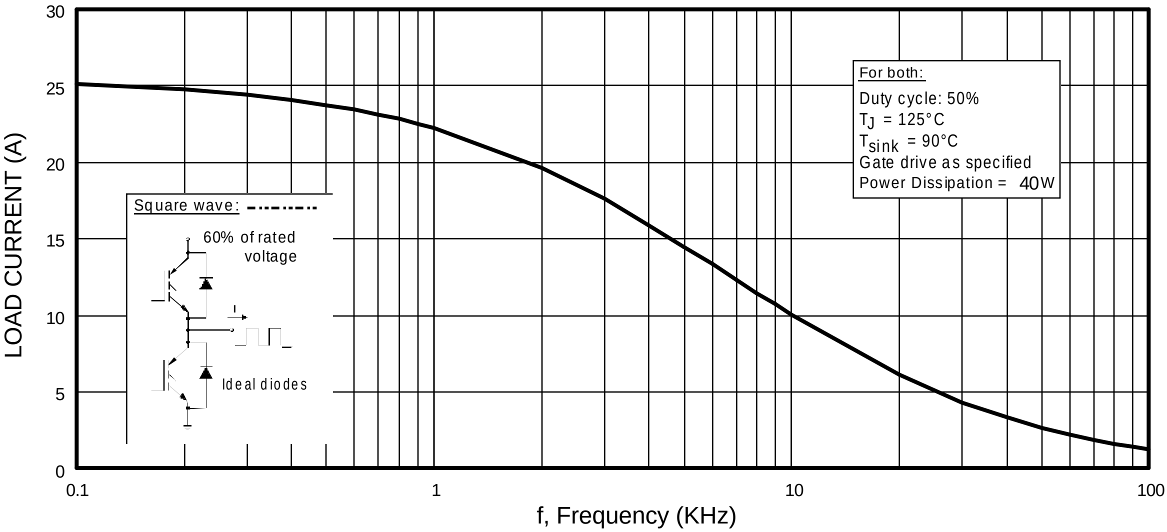


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

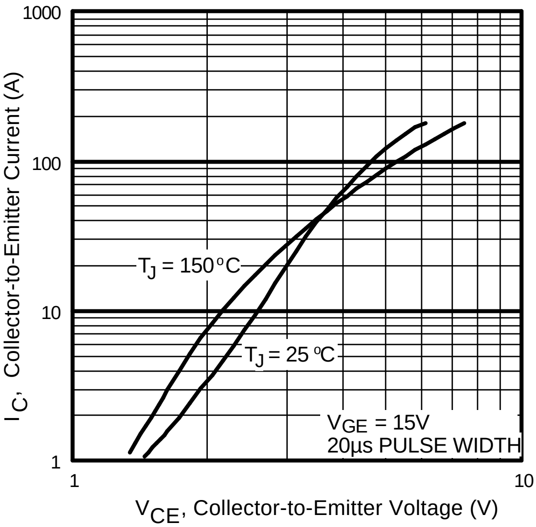


Fig. 2 - Typical Output Characteristics

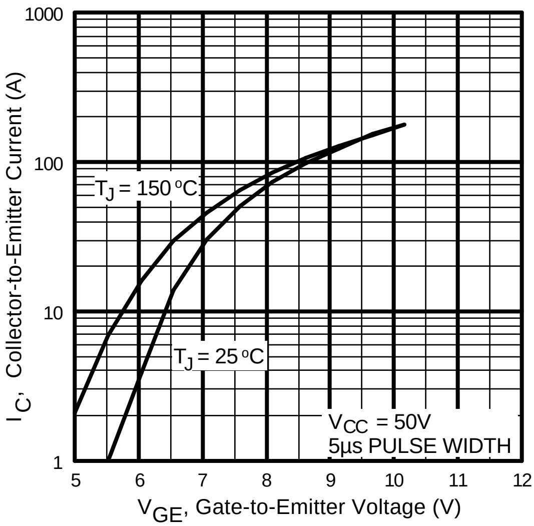


Fig. 3 - Typical Transfer Characteristics

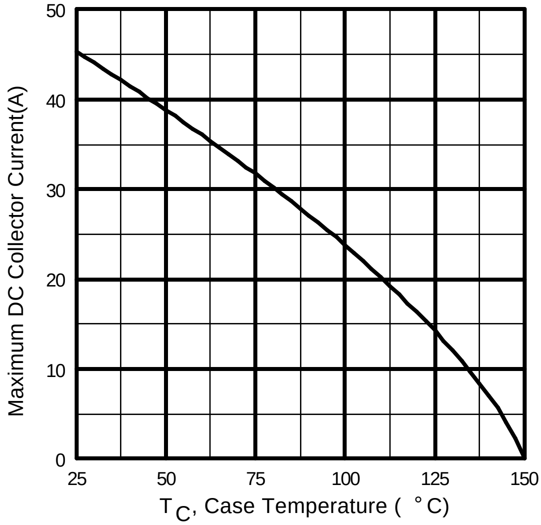


Fig. 4 - Maximum Collector Current vs. Case Temperature

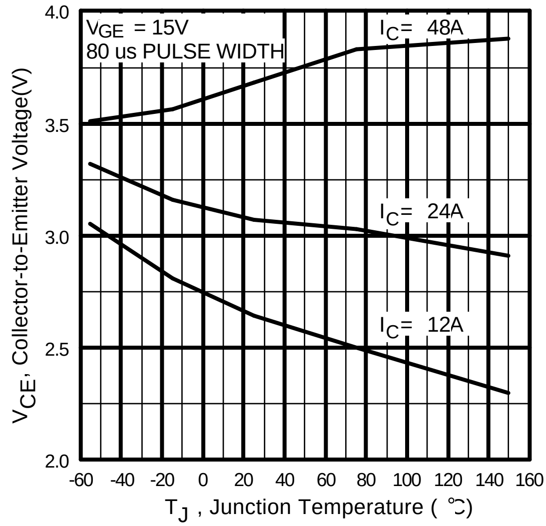


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

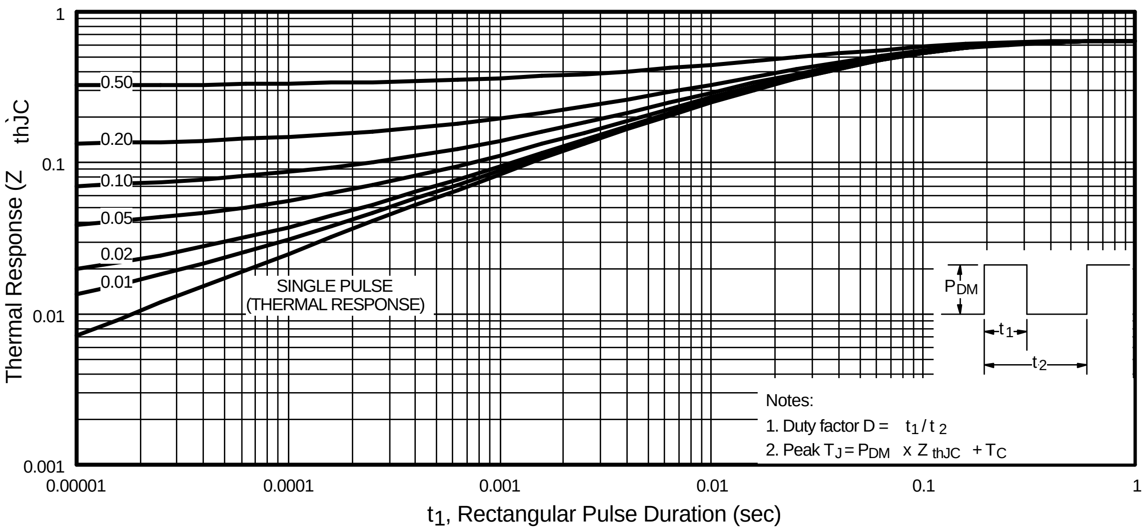


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

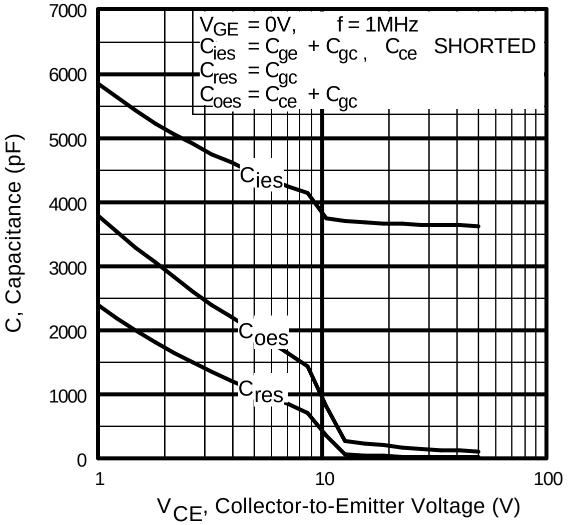


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

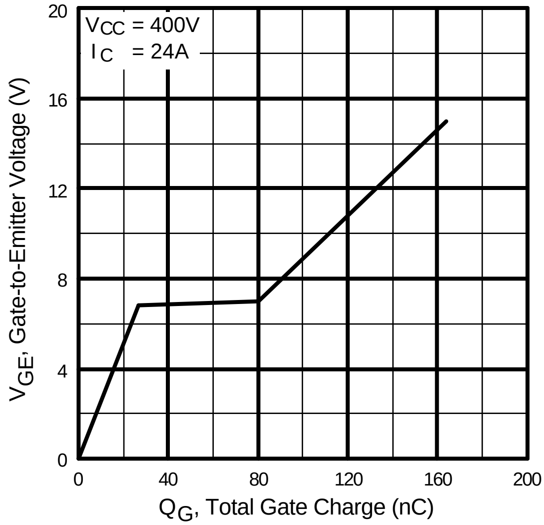


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

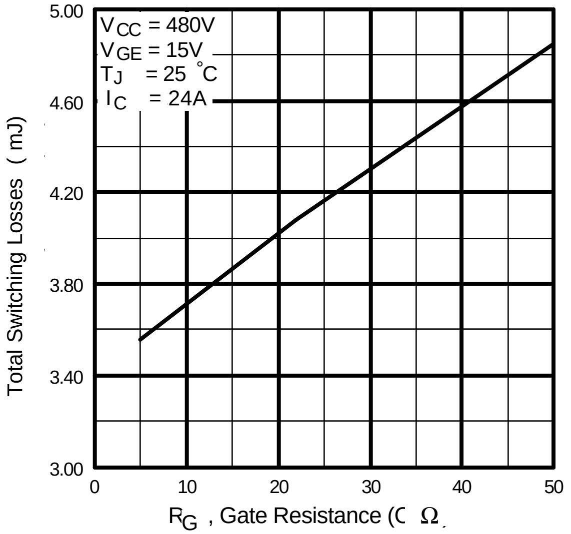


Fig. 9 - Typical Switching Losses vs. Gate Resistance

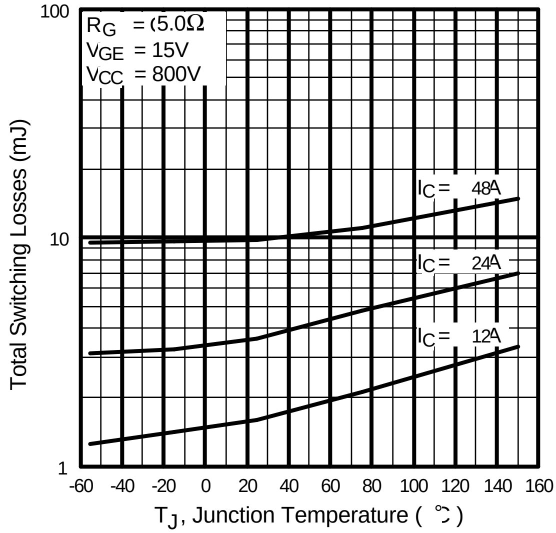
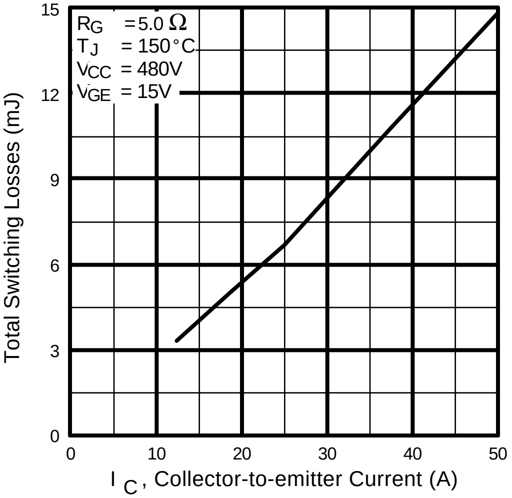


Fig. 10 - Typical Switching Losses vs. Junction Temperature



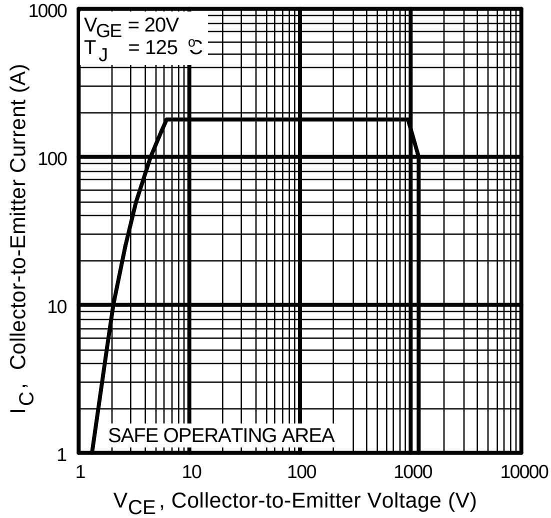


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

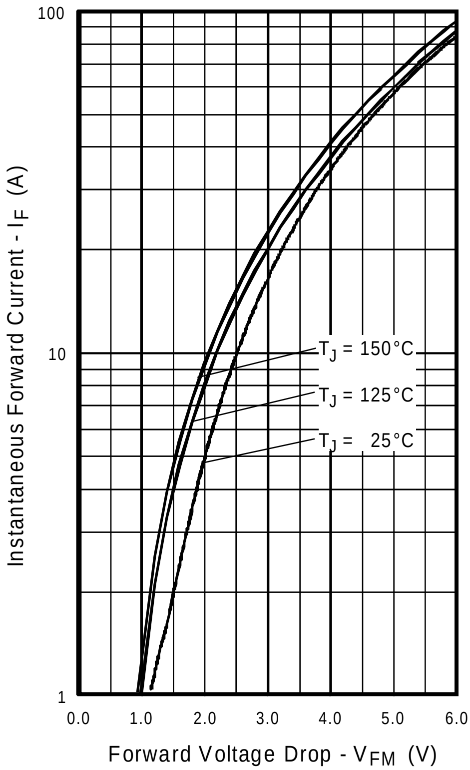


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

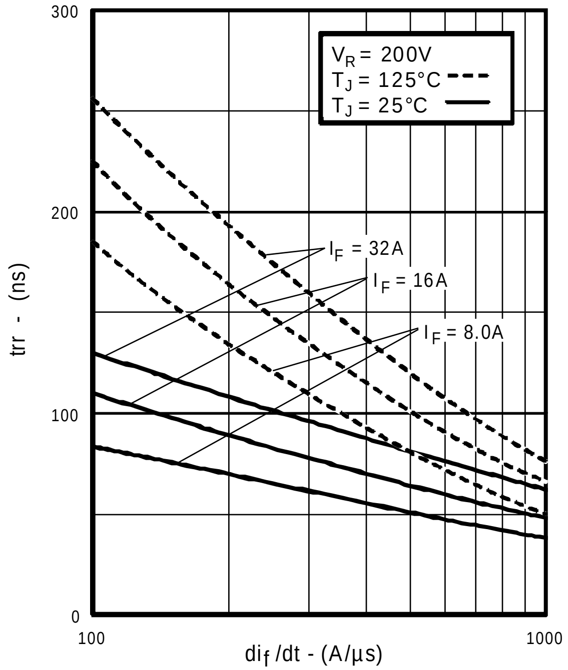


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

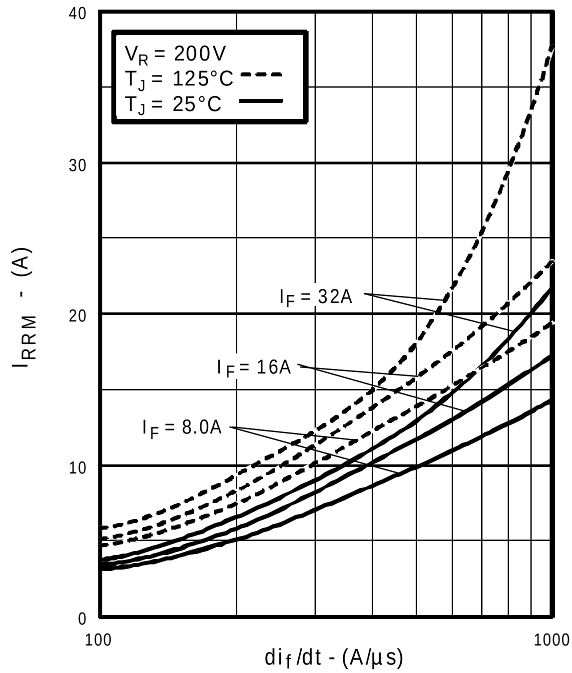


Fig. 15 - Typical Recovery Current vs. di_f/dt

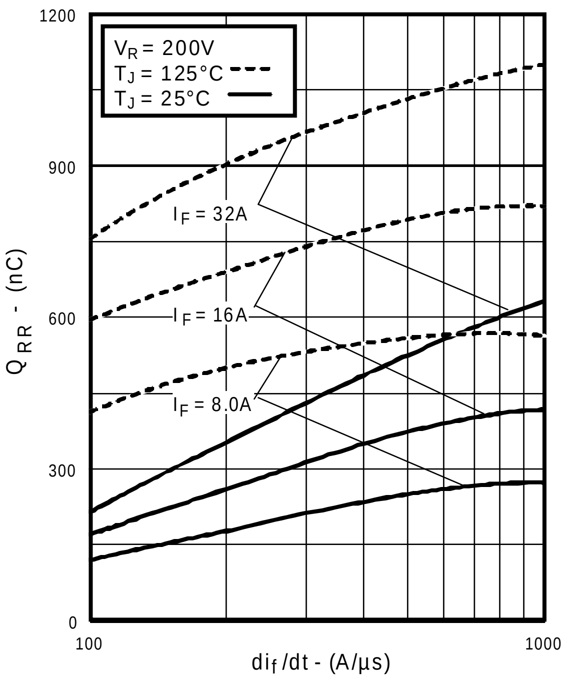


Fig. 16 - Typical Stored Charge vs. di_f/dt

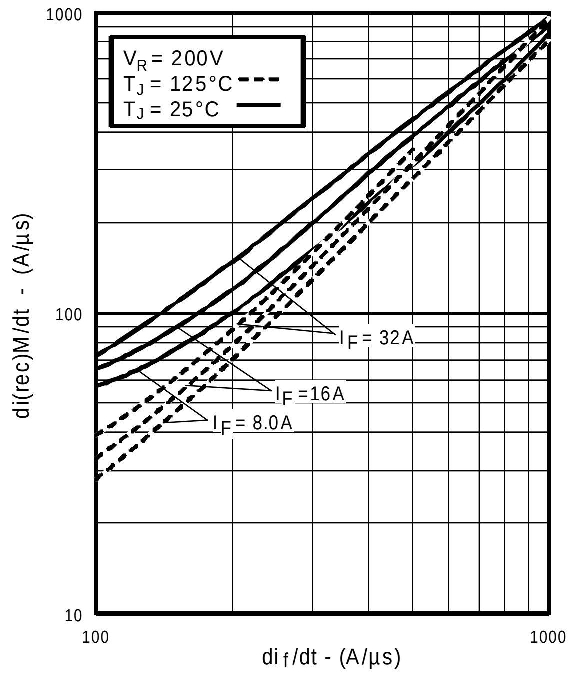


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

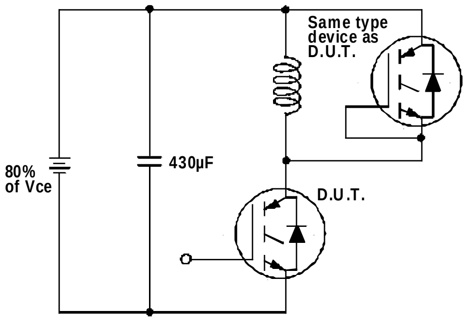


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

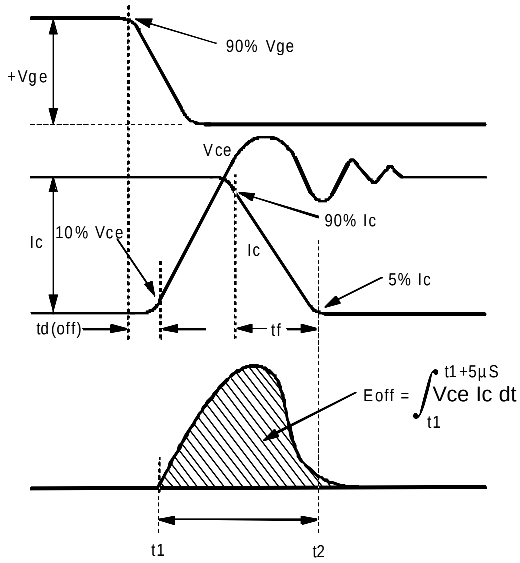
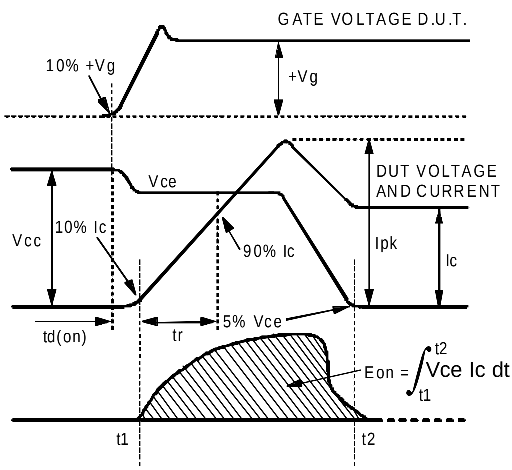


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f



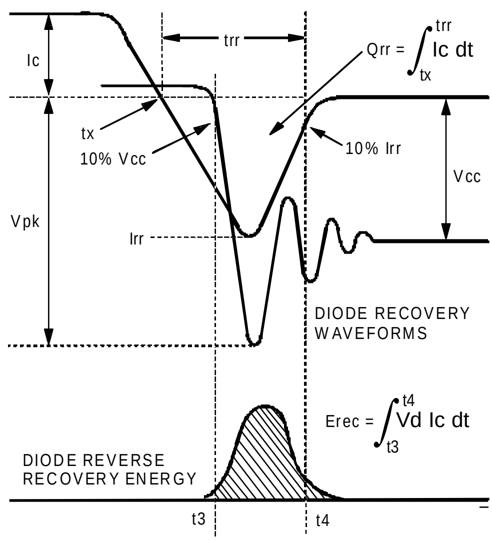


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

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

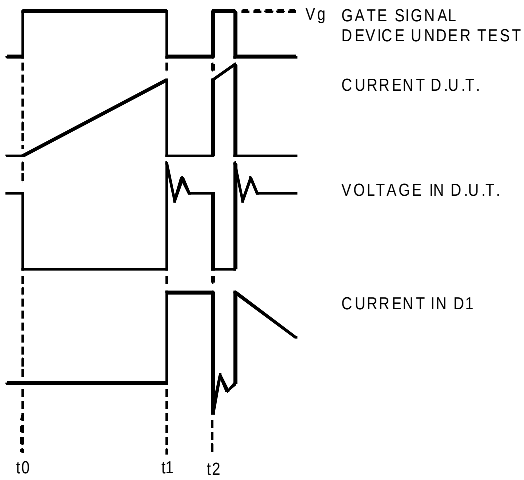


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

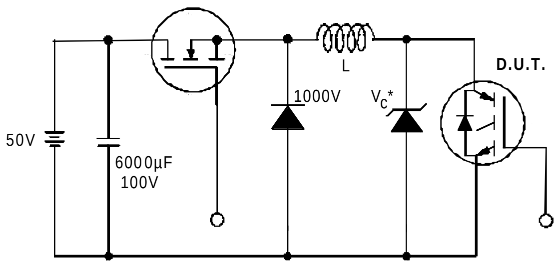


Figure 19. Clamped Inductive Load Test Circuit

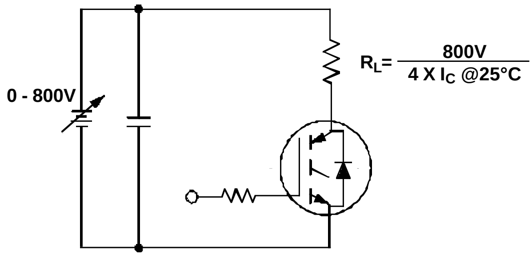


Figure 20. Pulsed Collector Current Test Circuit

Notes:

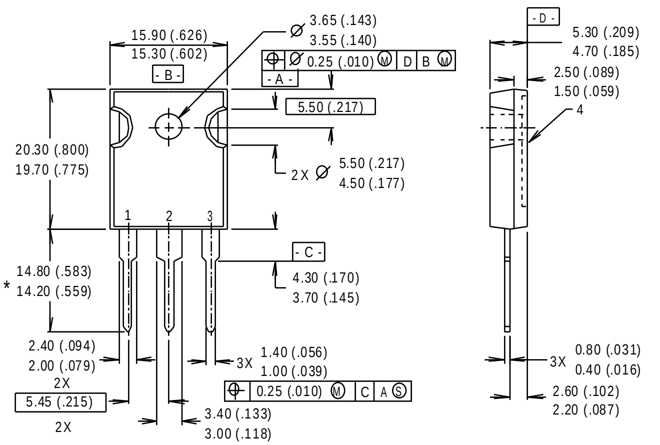
① Repetitive rating: V_{GE}=20V; pulse width limited by maximum junction temperature (figure 20)

② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G= 5.0Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

Case Outline — TO-247AC



NOTES:
1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
4 CONFORMS TO JEDEC OUTLINE TO-247AC.

LEAD ASSIGNMENTS
1 - GATE
2 - COLLECTOR
3 - EMITTER
4 - COLLECTOR

* LONGER LEADED (20mm) VERSION AVAILABLE (TO-247AD) TO ORDER ADD "-E" SUFFIX TO PART NUMBER

CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)
Dimensions in Millimeters and (Inches)

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IR CANADA: 7321 Victoria Park Ave., Suite 201, Markham, Ontario L3R 2Z8, Tel: (905) 475 1897
IR GERMANY: Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 6172 96590
IR ITALY: Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111
IR FAR EAST: K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo Japan 171 Tel: 81 3 3983 0086
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