PD- 91621C

International
IOR Rectifier

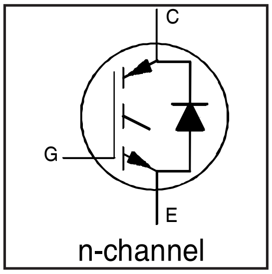
IRG4PH40UD

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

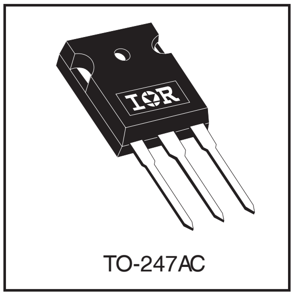
V_{CES} = 1200V

$V_{CE(on)\ typ.}$ = 2.43V

@V_{GE} = 15V, I_C = 21A

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	41	A
I_C @ T_C = 100°C	Continuous Collector Current	21	
I_{CM}	Pulsed Collector Current ①	82	
I_{LM}	Clamped Inductive Load Current ②	82	
I_F @ T_C = 100°C	Diode Continuous Forward Current	8.0	
I_{FM}	Diode Maximum Forward Current	130	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	160	W
P_D @ T_C = 100°C	Maximum Power Dissipation	65	
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	–––	–––	0.77	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	–––	–––	1.7	
$R_{\theta CS}$	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	—	0.43	—	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.43	3.1	V	I_C = 21A	V_{GE} = 15V
		—	2.97	—		I_C = 41A	See Fig. 2, 5
		—	2.47	—		I_C = 21A, 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	—	-11	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance ④	16	24	—	S	V_{CE} = 100V, I_C = 21A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V	
		—	—	5000		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.6	3.3	V	I_C = 8.0A	See Fig. 13
		—	2.4	3.1		I_C = 8.0A, 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)	—	86	130	nC	I_C = 21A		
Qge	Gate - Emitter Charge (turn-on)	—	13	20		V_{CC} = 400V	See Fig. 8	
Q_{gc}	Gate - Collector Charge (turn-on)	—	29	44		V_{GE} = 15V		
$t_{d(on)}$	Turn-On Delay Time	—	46	—	ns	T_J = 25°C		
t_r	Rise Time	—	35	—		I_C = 21A, V_{CC} = 800V		
$t_{d(off)}$	Turn-Off Delay Time	—	97	150		V_{GE} = 15V, R_G = 10Ω		
t_f	Fall Time	—	240	360		Energy losses include "tail" and		
E_{on}	Turn-On Switching Loss	—	1.80	—	mJ	diode reverse recovery.		
E_{off}	Turn-Off Switching Loss	—	1.93	—		See Fig. 9, 10, 18		
E_{ts}	Total Switching Loss	—	3.73	4.6				
$t_{d(on)}$	Turn-On Delay Time	—	42	—	ns	T_J = 150°C,	See Fig. 11, 18	
t_r	Rise Time	—	32	—		I_C = 21A, V_{CC} = 800V		
$t_{d(off)}$	Turn-Off Delay Time	—	240	—		V_{GE} = 15V, R_G = 10Ω		
t_f	Fall Time	—	510	—		Energy losses include "tail" and		
E_{ts}	Total Switching Loss	—	7.04	—	mJ	diode reverse recovery.		
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package		
C_{ies}	Input Capacitance	—	1800	—	pF	V_{GE} = 0V		
C_{oes}	Output Capacitance	—	120	—		V_{CC} = 30V	See Fig. 7	
C_{res}	Reverse Transfer Capacitance	—	18	—		f = 1.0MHz		
t_{rr}	Diode Reverse Recovery Time	—	63	95	ns	T_J = 25°C	See Fig.	
		—	106	160		T_J = 125°C	14	I_F = 8.0A
I_{rr}	Diode Peak Reverse Recovery Current	—	4.5	8.0	A	T_J = 25°C	See Fig.	
		—	6.2	11		T_J = 125°C	15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	140	380	nC	T_J = 25°C	See Fig.	
		—	335	880		T_J = 125°C	16	di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	—	133	—	A/µs	T_J = 25°C	See Fig.	
	During t_b	—	85	—		T_J = 125°C	17	

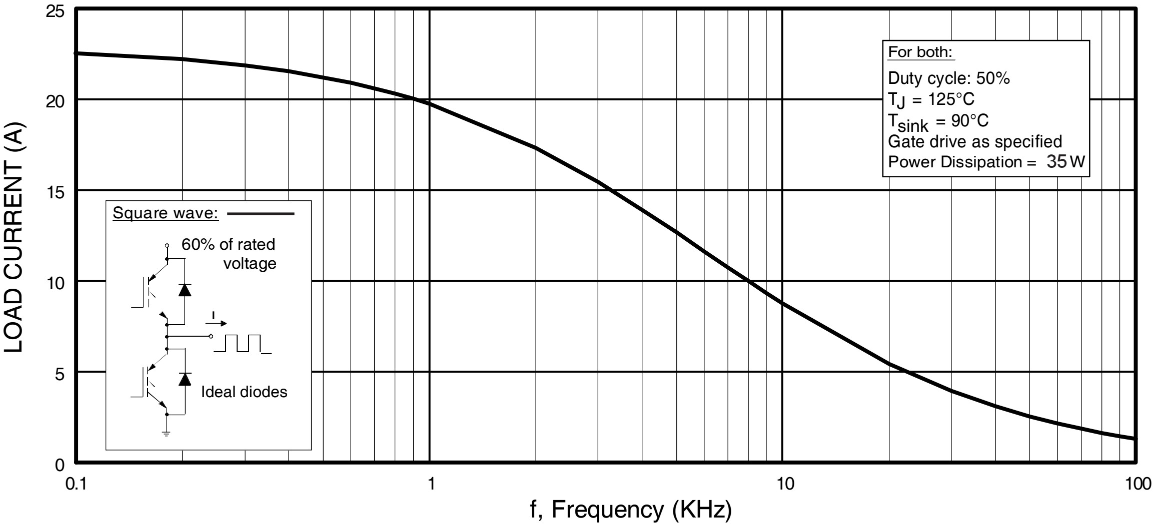


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

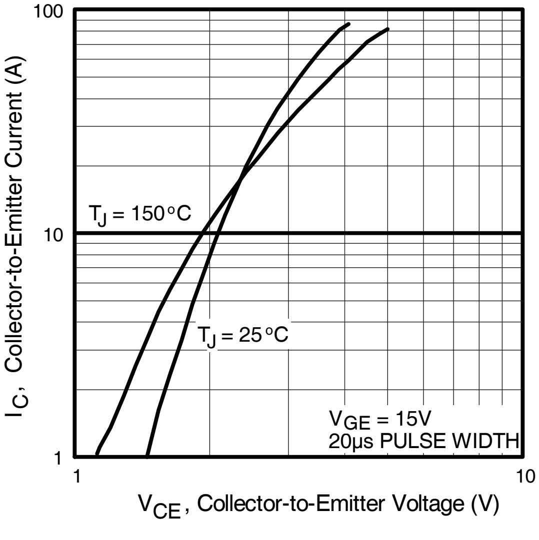


Fig. 2 - Typical Output Characteristics

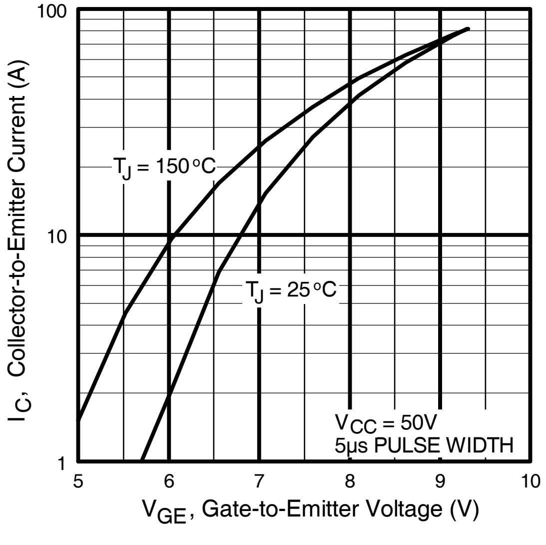


Fig. 3 - Typical Transfer Characteristics

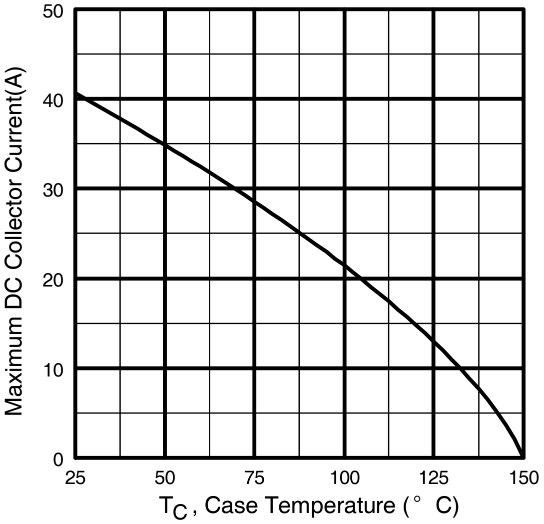


Fig. 4 - Maximum Collector Current vs. Case Temperature

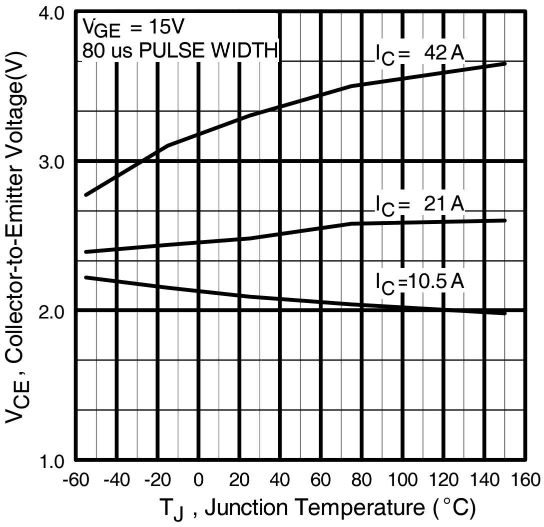


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

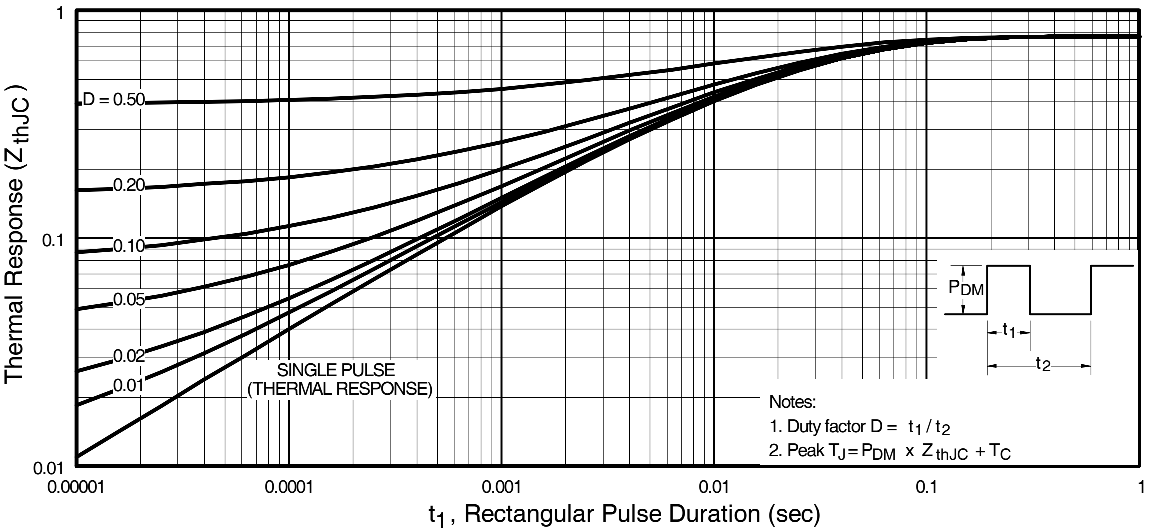


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

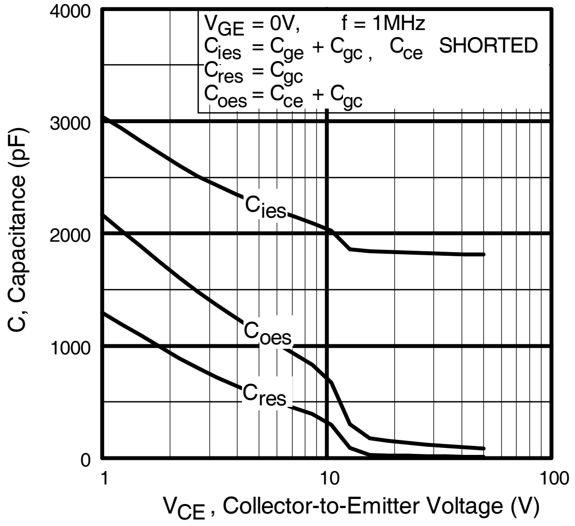


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

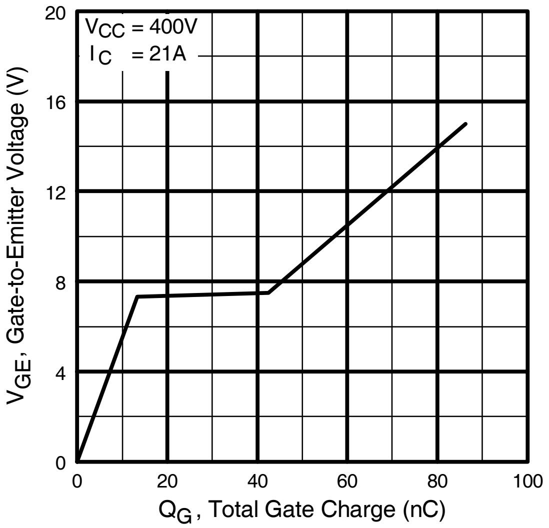


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

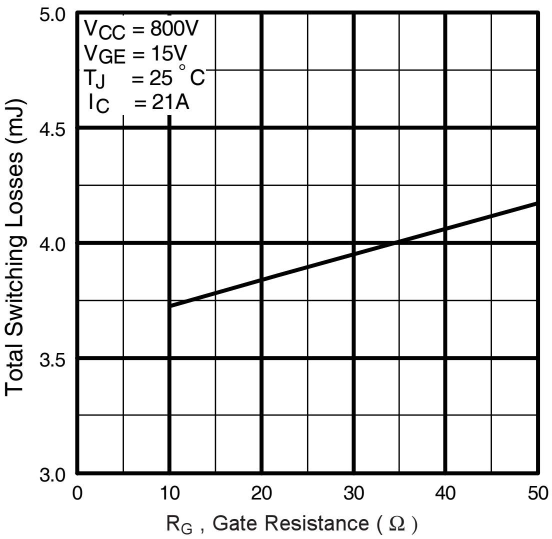


Fig. 9 - Typical Switching Losses vs. Gate Resistance

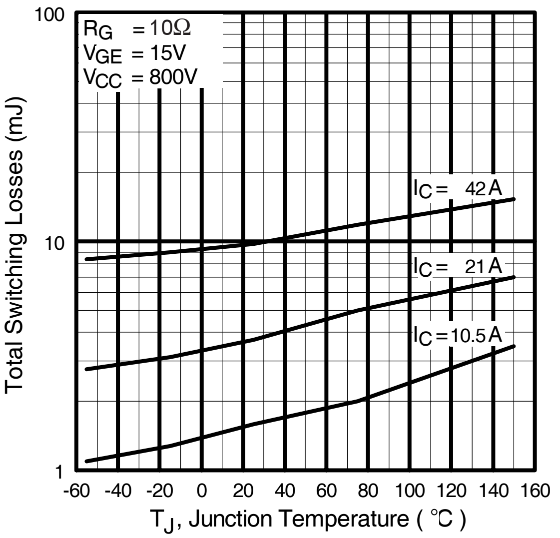


Fig. 10 - Typical Switching Losses vs. Junction Temperature

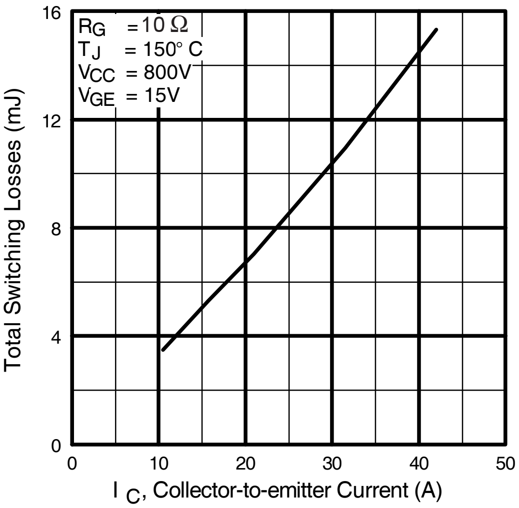


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

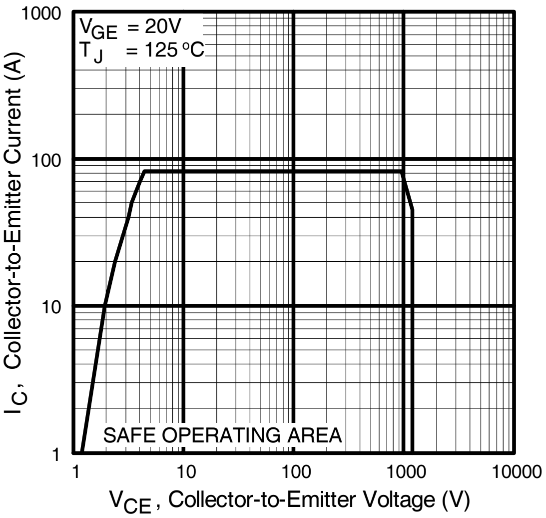


Fig. 12 - Turn-Off SOA

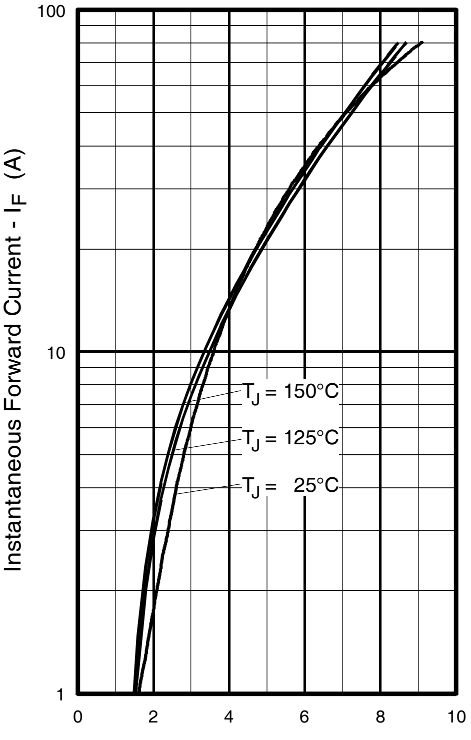


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

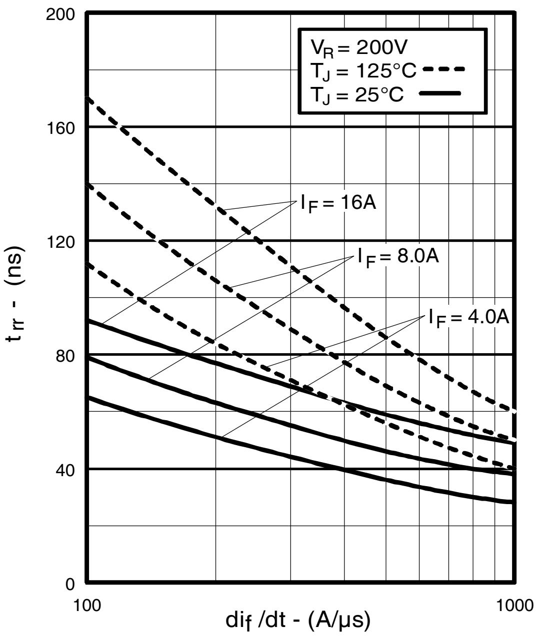


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

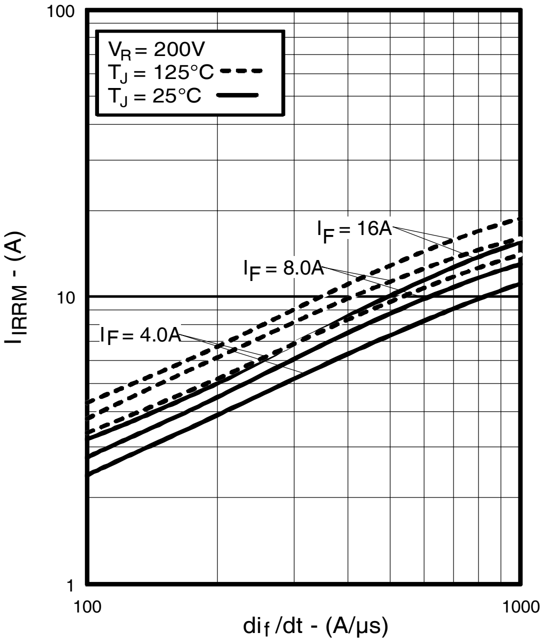


Fig. 15 - Typical Recovery Current vs. di_f/dt

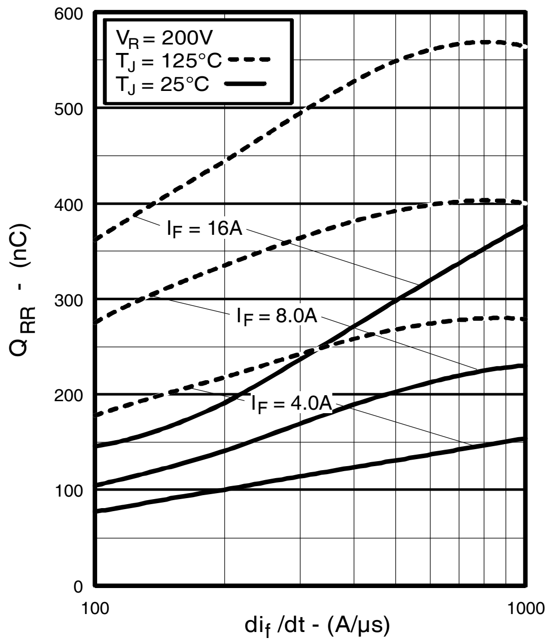


Fig. 16 - Typical Stored Charge vs. di_f/dt

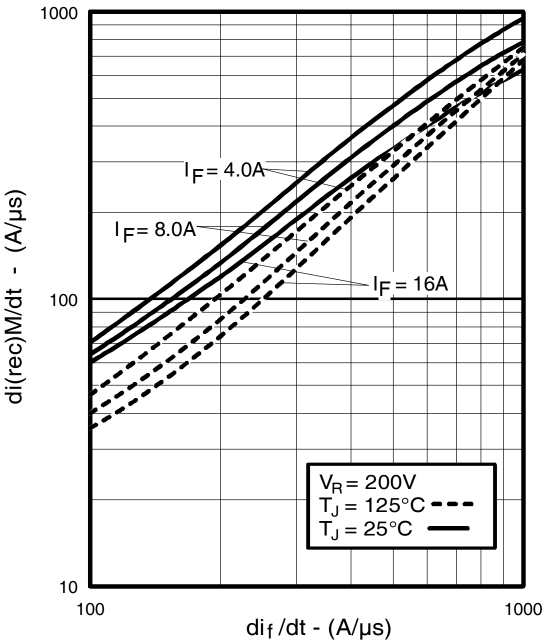


Fig. 17 - Typical $di_{(rec)M}$/dt vs. di_f/dt

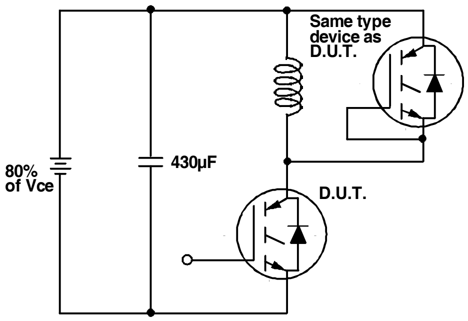


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

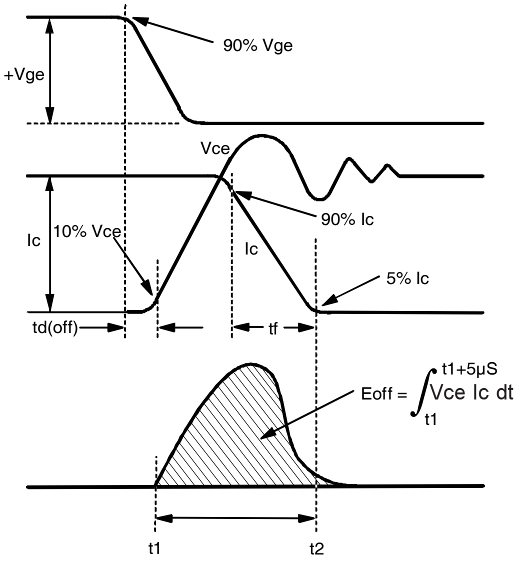


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

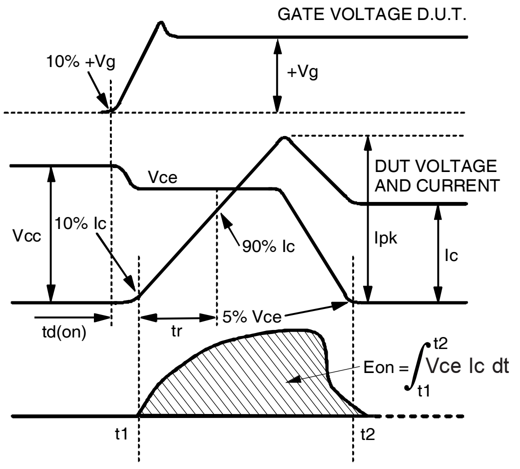


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

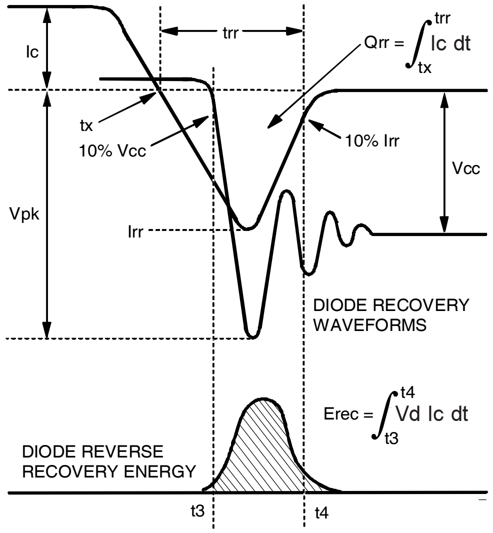


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

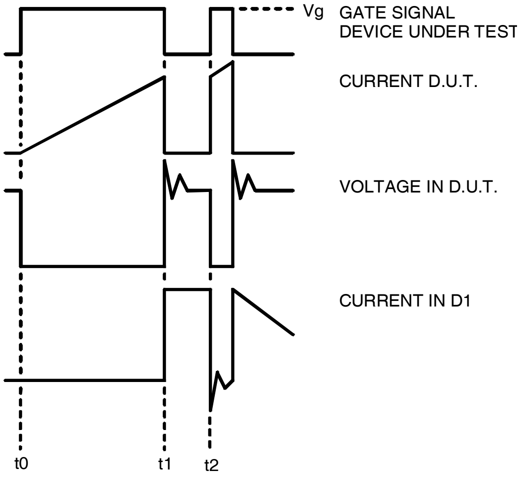


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

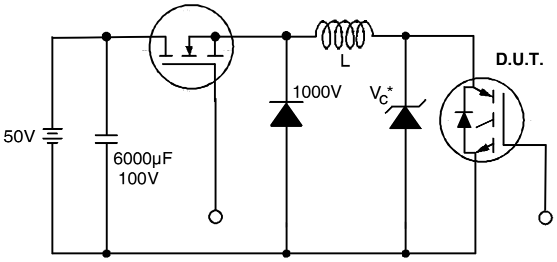


Figure 19. Clamped Inductive Load Test Circuit

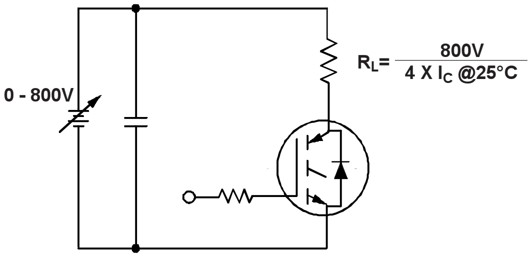


Figure 20. Pulsed Collector Current Test Circuit

Notes:

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

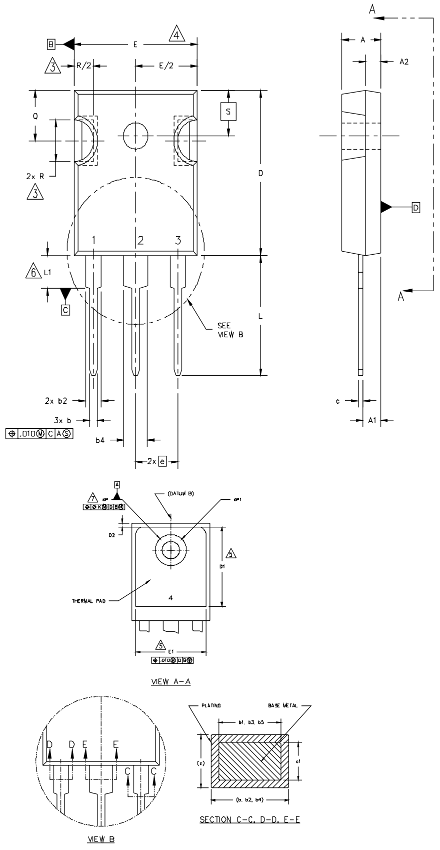
② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G= 10Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS]
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & 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. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENISONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. øP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154" [3.91].
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247 WITH THE EXCEPTION OF DIMENSION c.

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.37	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.034	0.38	0.86	
c1	.015	.030	0.38	0.76	
D	.776	.815	19.71	20.70	4
D1	.515	–	13.08	–	5
D2	.020	.030	0.51	0.76	
E	.602	.625	15.29	15.87	4
E1	.540	–	15.72	–	
e	.215 BSC		5.46 BSC		
øk	.010		2.54		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
N	3		7.62 BSC		
øP	.140	.144	3.56	3.66	
øP1	–	.275	–	6.98	
Q	.209	.224	5.31	5.69	
R	.178	.216	4.52	5.49	
S	.217 BSC		5.51 BSC		

LEAD ASSIGNMENTS

HEXFET

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

IGBTs, CoPACK

1.- GATE
2.- COLLECTOR
3.- EMITTER
4.- COLLECTOR

DIODES

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

TO-247AC package is not recommended for Surface Mount Application.

International
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