International
IOR Rectifier

PD - 95399

IRG4PH20KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

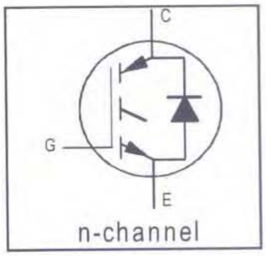
Short Circuit Rated
UltraFast IGBT

Features

- High short circuit rating optimized for motor control, t_{sc} =10µs, V_{CC} = 720V , T_J = 125°C, V_{GE} = 15V
- Combines low conduction losses with high switching speed
- Tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes

Benefits

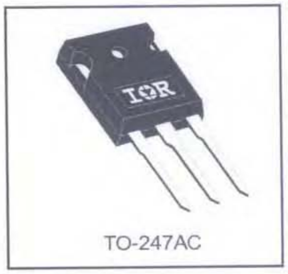
- Latest generation 4 IGBT's offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- Lead-Free



V_{CES} = 1200V

$V_{CE(on)\ typ.}$ = 3.17V

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



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	11	A
I_C @ T_C = 100°C	Continuous Collector Current	5.0	
I_{CM}	Pulsed Collector Current ①	22	
I_{LM}	Clamped Inductive Load Current ②	22	
I_F @ T_C = 100°C	Diode Continuous Forward Current	5.0	
I_{FM}	Diode Maximum Forward Current	22	
t_{sc}	Short Circuit Withstand Time	10	µs
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	——	——	3.5	
$R_{\theta CS}$	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)

6/16/04

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	—	1.13	—	V/°C	V_{GE} = 0V, I_C = 2.5mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	3.17	4.3	V	I_C = 5.0A	V_{GE} = 15V
		—	4.04	—		I_C = 11A	See Fig. 2, 5
		—	2.84	—		I_C = 5.0A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	—	6.5		V_{CE} = V_{GE}, I_C = 250μA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 1mA	
g_{fe}	Forward Transconductance ④	2.3	3.5	—	S	V_{CE} = 100V, I_C = 5.0A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	V_{GE} = 0V, V_{CE} = 1200V	
		—	—	1000		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.5	2.9	V	I_C = 5.0A	See Fig. 13
		—	2.2	2.6		I_C = 5.0A, 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)	—	28	43	nC	I_C = 5.0A V_{CC} = 400V See Fig.8 V_{GE} = 15V		
Q_{ge}	Gate - Emitter Charge (turn-on)	—	4.4	6.6				
Q_{gc}	Gate - Collector Charge (turn-on)	—	12	18				
$t_{d(on)}$	Turn-On Delay Time	—	50	—	ns	T_J = 25°C I_C = 5.0A, V_{CC} = 800V V_{GE} = 15V, R_G = 50Ω Energy losses include "tail" and diode reverse recovery See Fig. 9,10,18		
t_r	Rise Time	—	30	—				
$t_{d(off)}$	Turn-Off Delay Time	—	100	150				
t_f	Fall Time	—	250	380				
E_{on}	Turn-On Switching Loss	—	0.62	—	mJ			
E_{off}	Turn-Off Switching Loss	—	0.30	—				
E_{ts}	Total Switching Loss	—	0.92	1.2				
t_{sc}	Short Circuit Withstand Time	10	—	—	μs	V_{CC} = 720V, T_J = 125°C V_{GE} = 15V, R_G = 50Ω		
$t_{d(on)}$	Turn-On Delay Time	—	50	—	ns	T_J = 150°C, See Fig. 10,11,18 I_C = 5.0A, V_{CC} = 800V V_{GE} = 15V, R_G = 50Ω, Energy losses include "tail" and diode reverse recovery		
t_r	Rise Time	—	30	—				
$t_{d(off)}$	Turn-Off Delay Time	—	110	—				
t_f	Fall Time	—	620	—				
E_{ts}	Total Switching Loss	—	1.6	—	mJ			
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package		
C_{ies}	Input Capacitance	—	435	—	pF	V_{GE} = 0V V_{CC} = 30V See Fig. 7 f = 1.0MHz		
C_{oes}	Output Capacitance	—	44	—				
C_{res}	Reverse Transfer Capacitance	—	8.3	—				
t_{rr}	Diode Reverse Recovery Time	—	51	77	ns	T_J = 25°C	See Fig.	I_F = 5.0A V_R = 200V di/dt = 200A/μs
		—	68	102		T_J = 125°C	14	
I_{rr}	Diode Peak Reverse Recovery Current	—	6.0	9.0	A	T_J = 25°C	See Fig.	
		—	7.0	11		T_J = 125°C	15	
Q_{rr}	Diode Reverse Recovery Charge	—	183	274	nC	T_J = 25°C	See Fig.	
		—	285	427		T_J = 125°C	16	
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	380	—	A/μs	T_J = 25°C	See Fig.	
		—	307	—		T_J = 125°C	17	

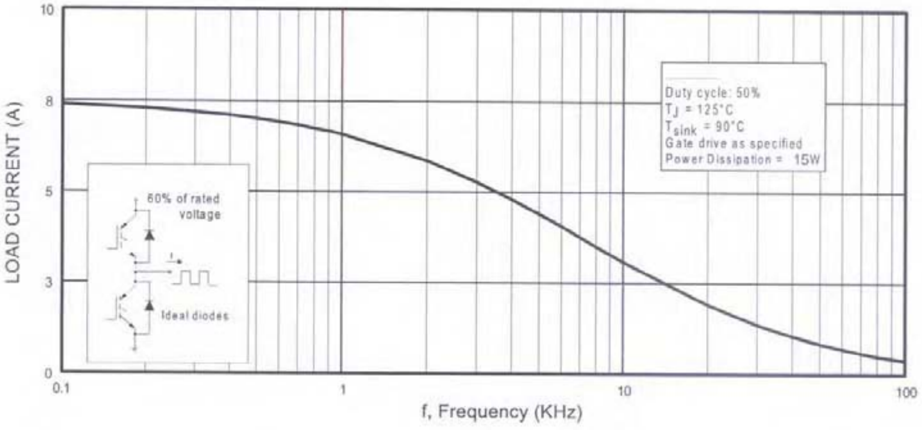


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

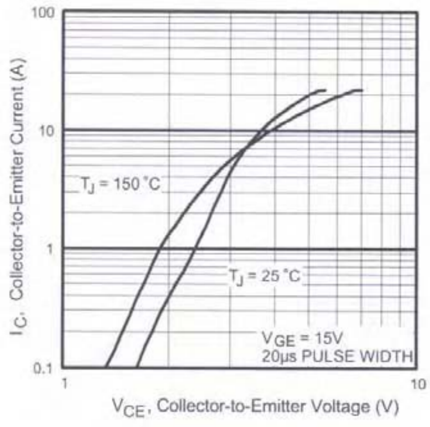


Fig. 2 - Typical Output Characteristics

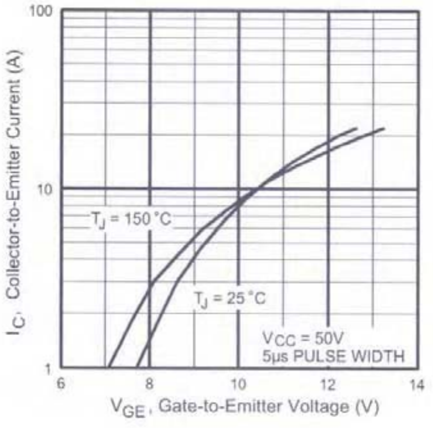


Fig. 3 - Typical Transfer Characteristics

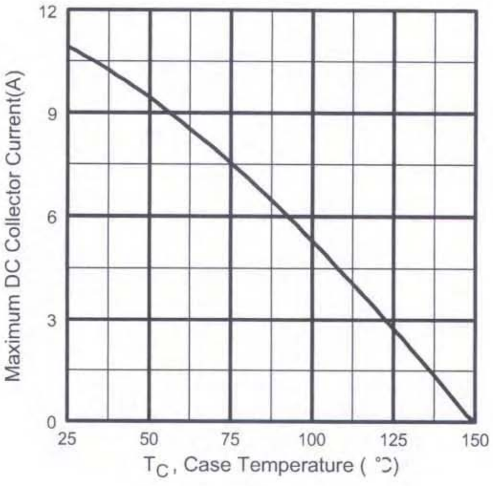


Fig. 4 - Maximum Collector Current vs. Case Temperature

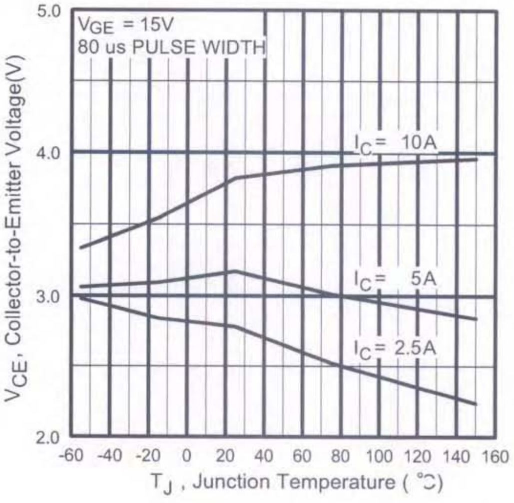


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

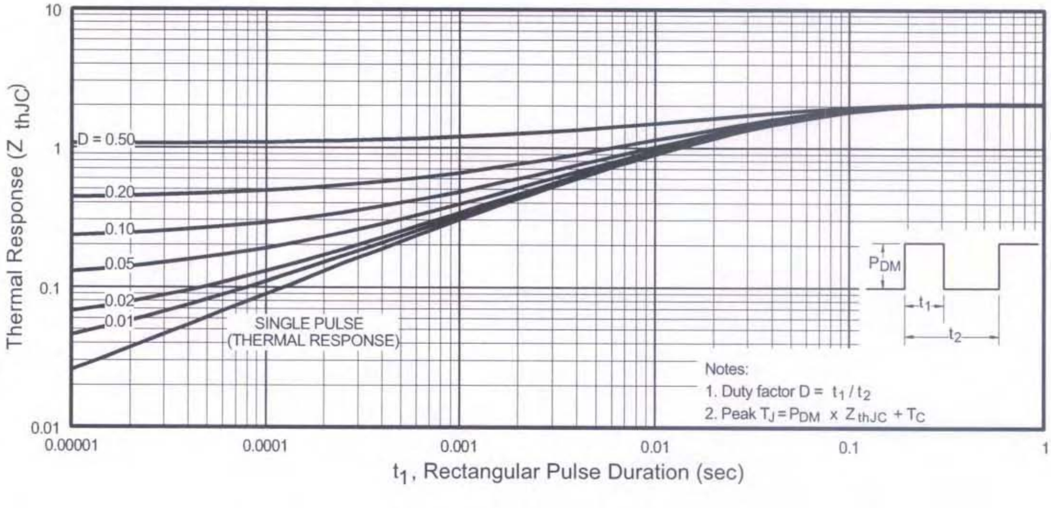


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

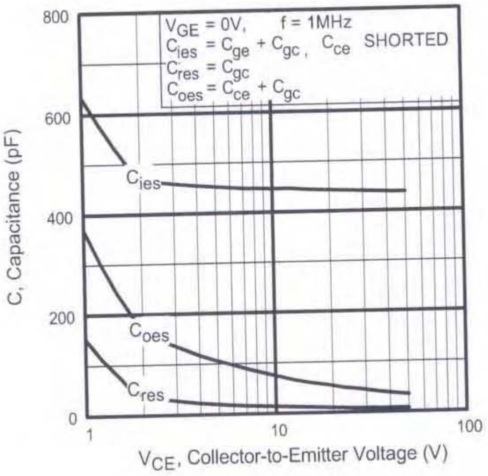


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

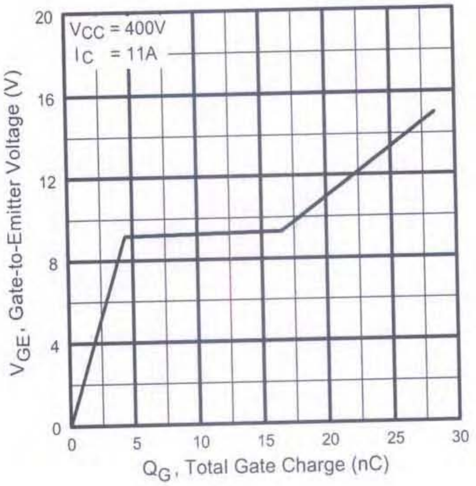


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

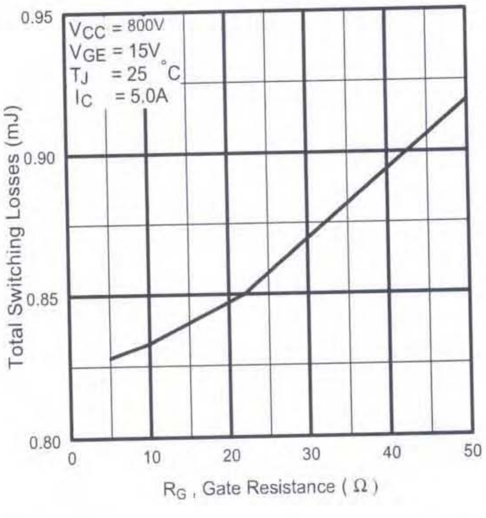


Fig. 9 - Typical Switching Losses vs. Gate Resistance

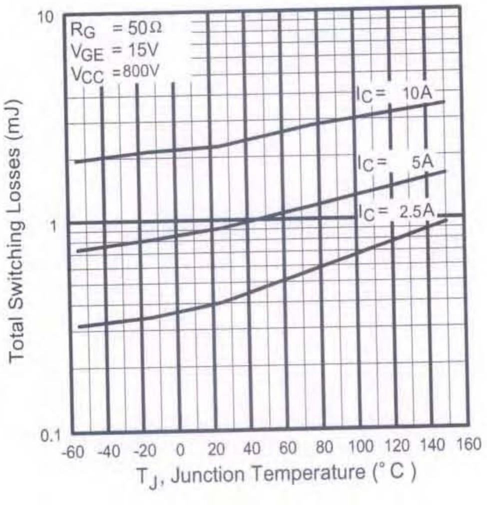


Fig. 10 - Typical Switching Losses vs. Junction Temperature

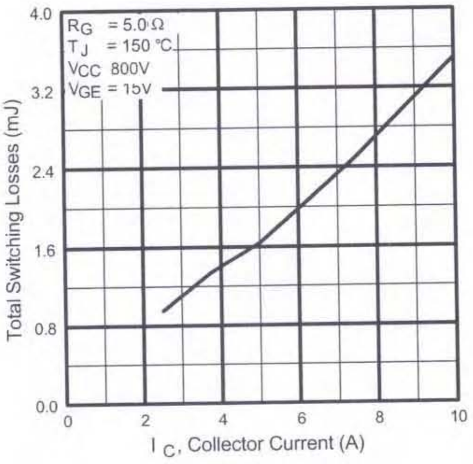


Fig. 11 - Typical Switching Losses vs. Collector Current

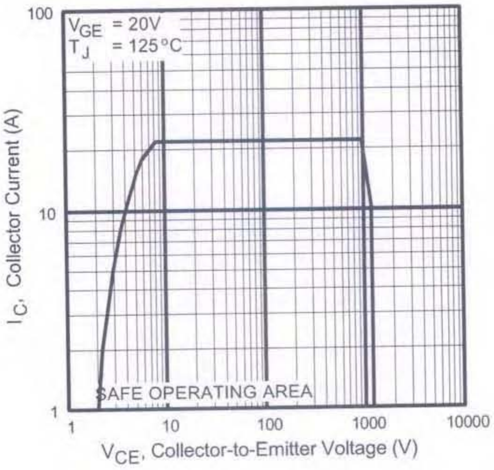


Fig. 12 - Turn-Off SOA

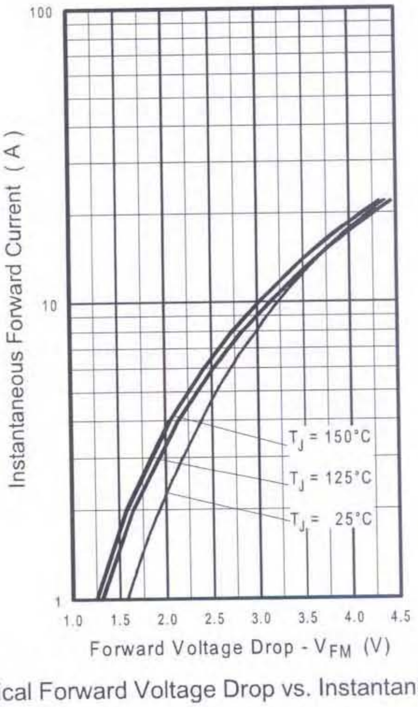


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

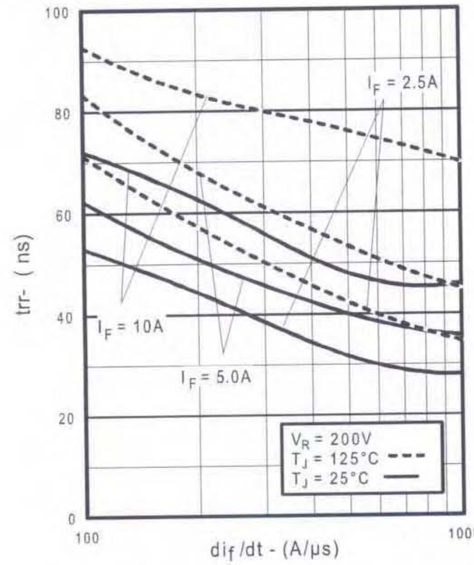


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

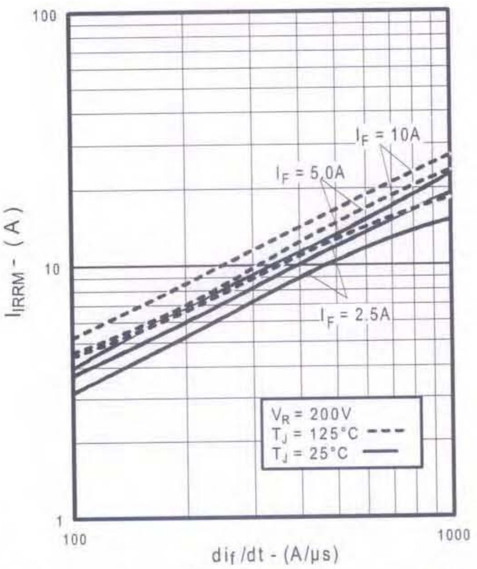


Fig. 15 - Typical Recovery Current vs. di_f/dt

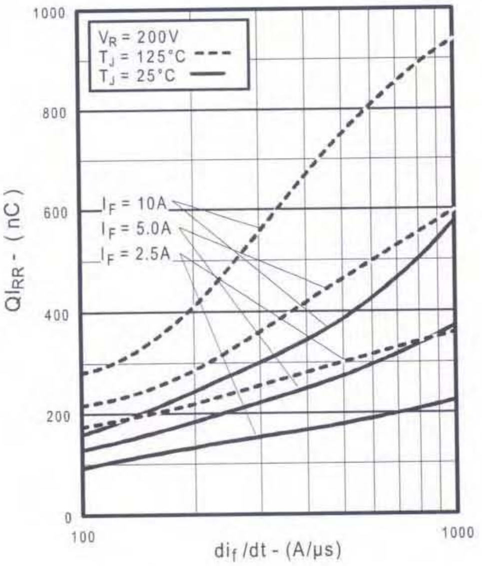


Fig. 16 - Typical Stored Charge vs. di_f/dt

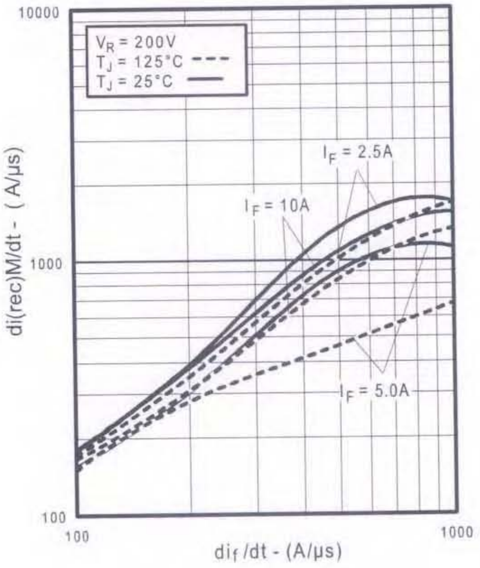


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

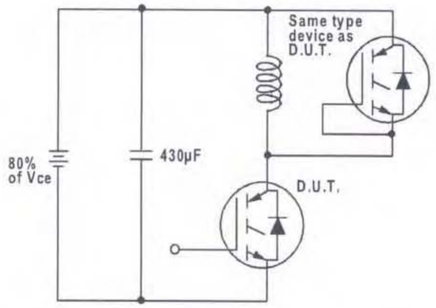


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

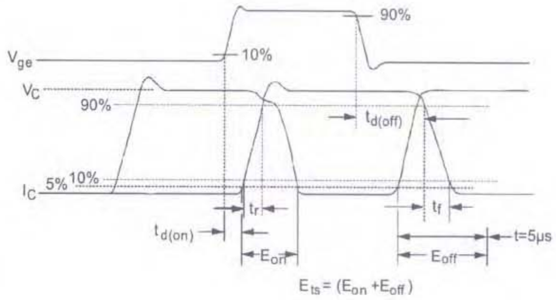


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

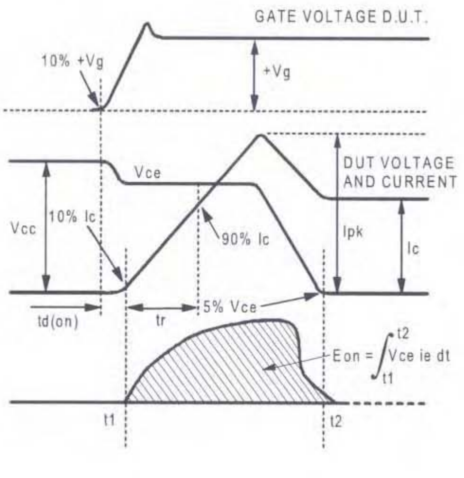


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

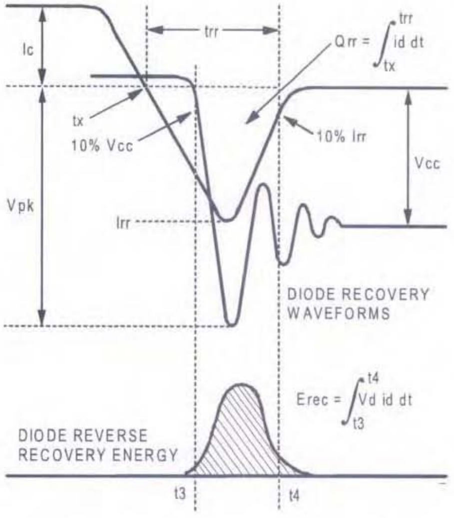


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

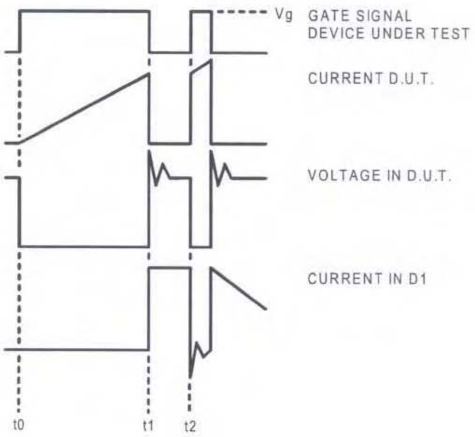


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

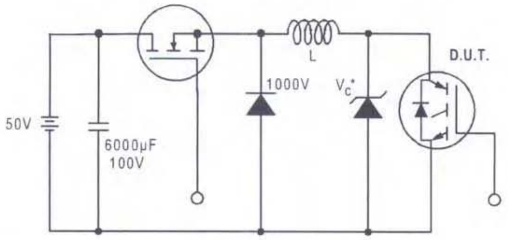


Figure 19. Clamped Inductive Load Test Circuit

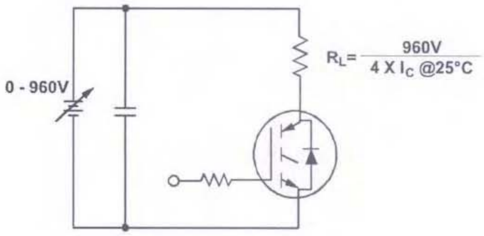


Figure 20. Pulsed Collector Current
Test Circuit

Notes:

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

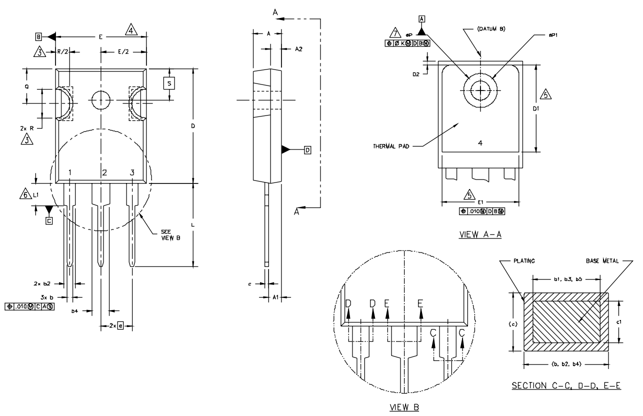
② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G= 5.0Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

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

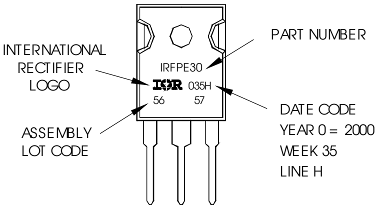
DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30
WITH ASSEMBLY
LOT CODE 5657
ASSEMBLED ON WW 35, 2000
IN THE ASSEMBLY LINE "H"

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



Data and specifications subject to change without notice.

International
IOR Rectifier

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