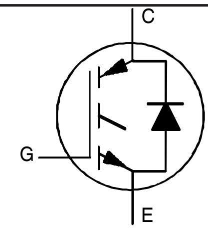
International
IOR Rectifier

IRG4PH40UD2

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast CoPack IGBT



n-channel

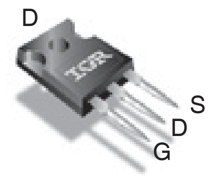
$V_{CES} = 1200V$

$V_{CE(on)\ typ.} = 1.72V$

$@V_{GE} = 15V, I_C = 20A$

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



TO-247AC

G	D	S
Gate	Drain	Source

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.

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	40	A
I_C @ T_C = 100°C	Continuous Collector Current	20	
I_{CM}	Pulse Collector Current ①	160	
I_{LM}	Clamped Inductive Load current ①	160	
I_F @ Tc = 100°C	Diode Continuous Forward Current	10	
I_{FM}	Diode Maximum Forward Current	40	
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
	Storage Temperature Range, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	——	——	0.77	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	——	——	2.5	
$R_{\theta CS}$	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.)

01/26/06

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	V_{GE} = 0V, I_C = 250µA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.63	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.72	2.1	V	I_C = 20A, V_{GE} = 15V, T_J = 25°C
		—	2.15	—		I_C = 40A, V_{GE} = 15V, T_J = 125°C
		—	1.7	—		I_C = 20A, V_{GE} = 15V, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
gfe	Forward Transconductance ⑤	11	18	—	S	V_{CE} = 100V, I_C = 20A
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V
		—	—	2.0		V_{GE} = 0V, V_{CE} = 10V, T_J = 25°C
		—	—	2500		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	3.4	3.8	V	I_F = 10A, V_{GE} = 0V
		—	3.3	3.7		I_F = 10A, V_{GE} = 0V, 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)	—	110	130	nC	I_C = 20A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	18	24		V_{CC} = 400V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	36	53		V_{GE} = 15V
$t_{d(on)}$	Turn-On delay time	—	23	—	ns	I_C = 20A, V_{CC} = 600V
t_r	Rise time	—	27	—		V_{GE} = 15V, R_G = 10Ω
$t_{d(off)}$	Turn-Off delay time	—	100	110		T_J = 25°C
t_f	Fall time	—	280	340		Energy losses inclued "tail"
E_{on}	Turn-On Switching Loss	—	1440	—	µJ	I_C = 20A, V_{CC} = 600V
E_{off}	Turn-Off Switching Loss	—	1410	—		V_{GE} = 15V, R_G = 10Ω
E_{tot}	Total Switching Loss	—	2850	3740		T_J = 25°C
$t_{d(on)}$	Turn-On delay time	—	22	—	ns	I_C = 20A, V_{CC} = 600V
t_r	Rise time	—	32	—		V_{GE} = 15V, R_G = 10Ω, L = 1.0mH
$t_{d(off)}$	Turn-Off delay time	—	190	—		T_J = 150°C
t_f	Fall time	—	630	—		Energy losses inclued "tail"
E_{TS}	Total Switching Loss	—	5360	—	µJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm froom package
C_{ies}	Input Capacitance	—	2100	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	99	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	12	—		f = 1.0MHz
t_{rr}	Diode Reverse Recovery Time	—	50	76	ns	T_J=25°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
		—	72	110		T_J=125°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
I_{rr}	Diode Peak Reverse Recovery Current	—	4.4	7.0	A	T_J=25°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
		—	5.9	8.8		T_J=125°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
Q_{rr}	Diode Reverse Recovery Charge	—	130	200	nC	T_J=25°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
		—	250	380		T_J=125°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	—	210	—	A/µs	T_J=25°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs
	During t_b	—	180	—		T_J=125°C, V_{CC} = 200V, I_F = 10A, di/dt = 200A/µs

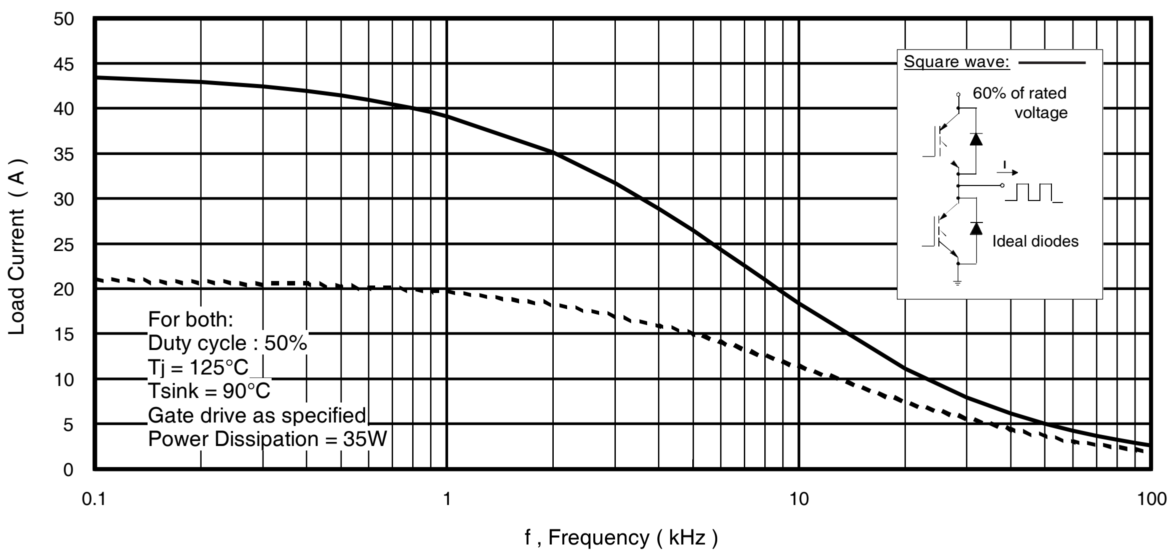


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

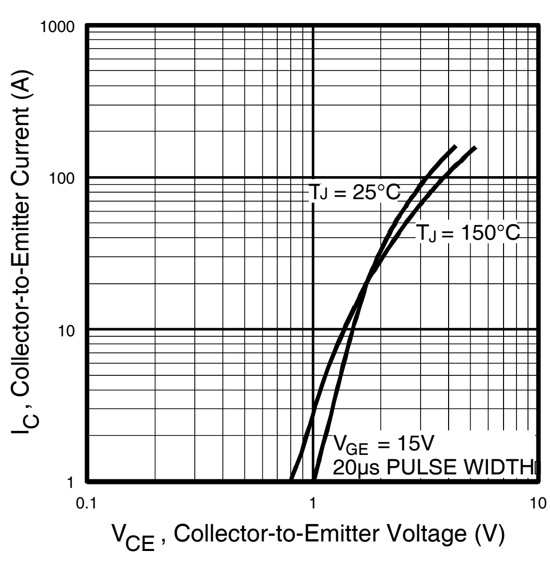


Fig. 2 - Typical Output Characteristics

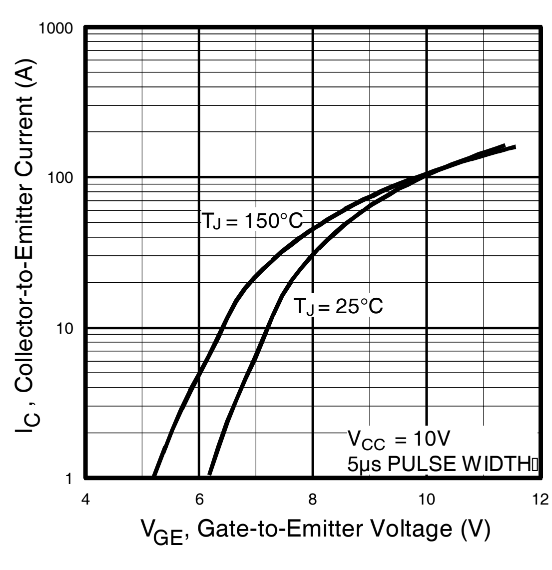


Fig. 3 - Typical Transfer Characteristics

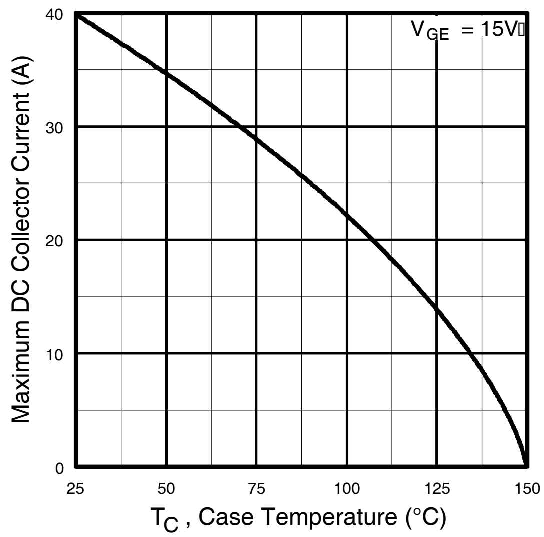


Fig. 4 - Maximum Collector Current vs. Case Temperature

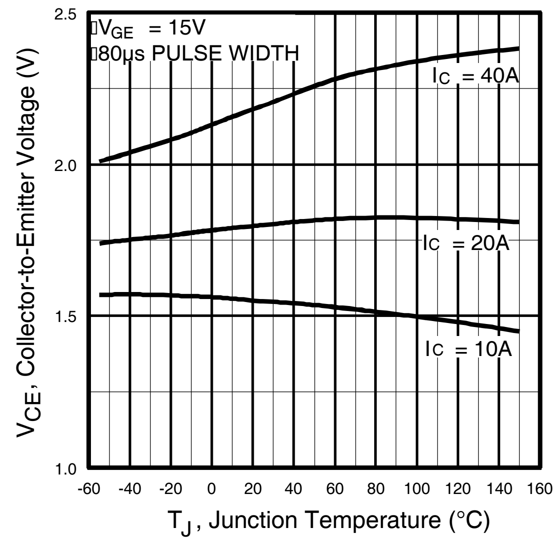


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

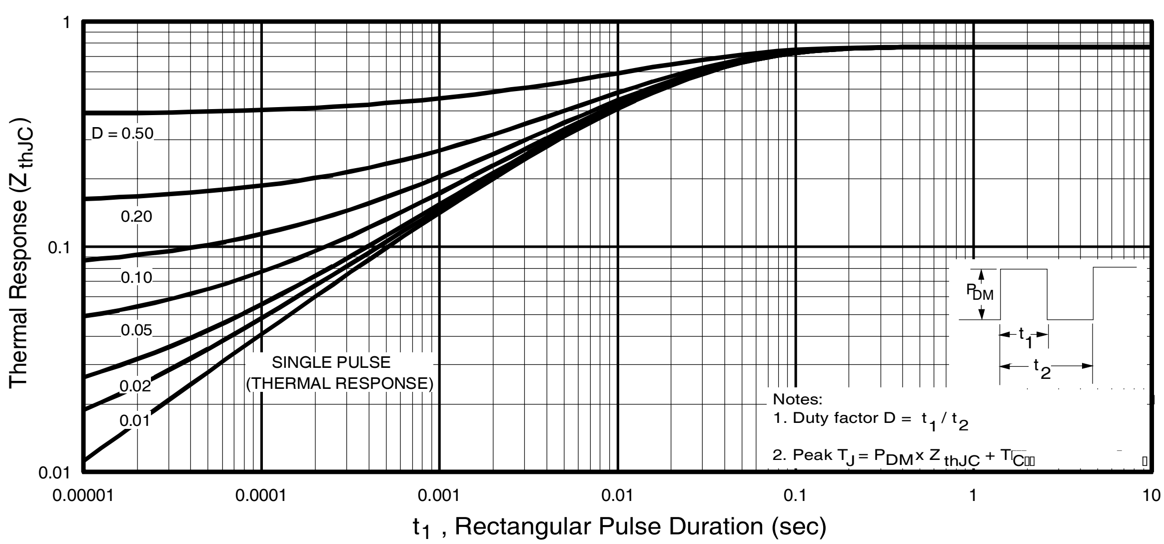


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

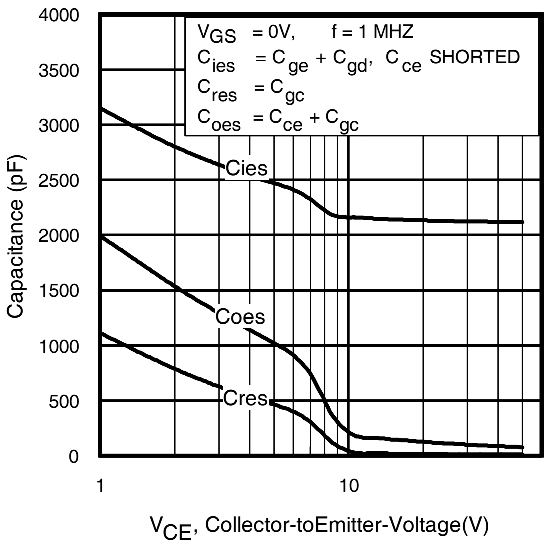


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

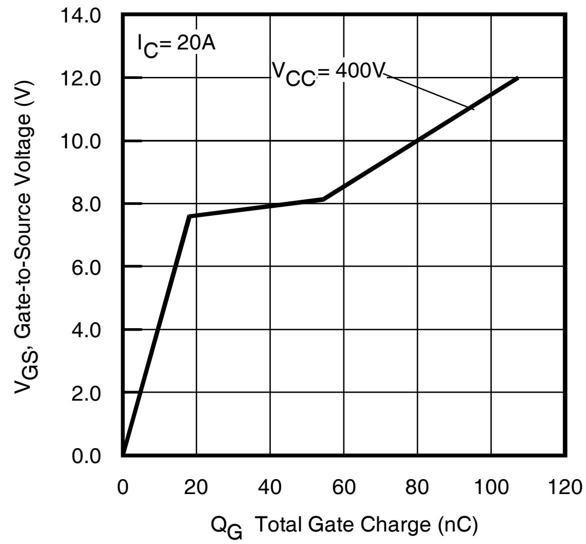


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

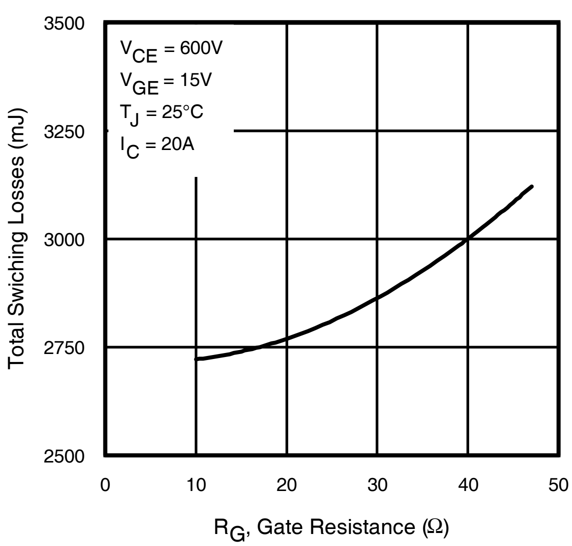


Fig. 9 - Typical Switching Losses vs. Gate Resistance

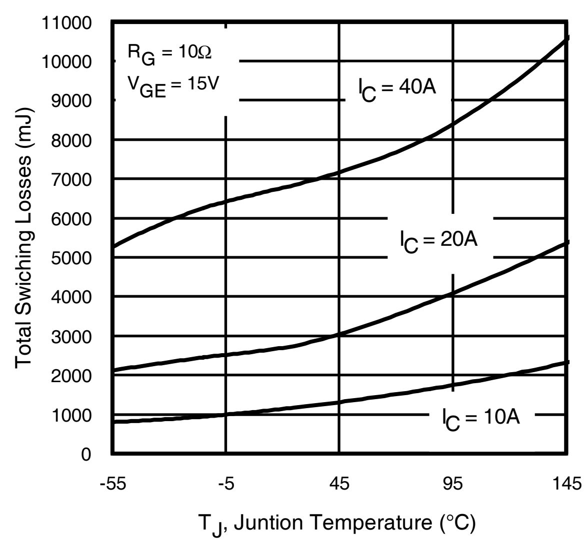


Fig. 10 - Typical Switching Losses vs. Junction Temperature

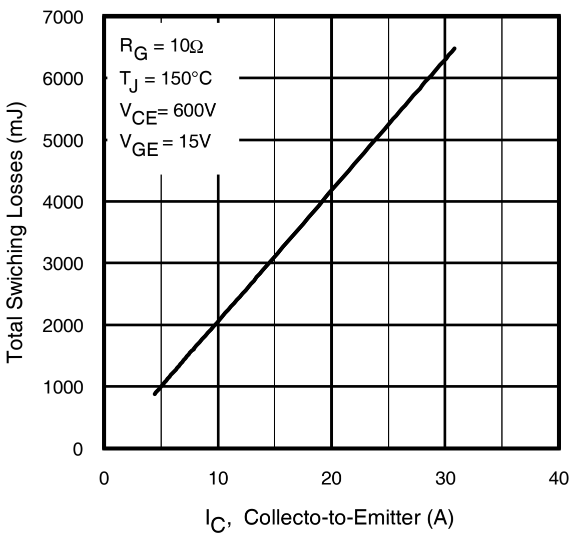


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

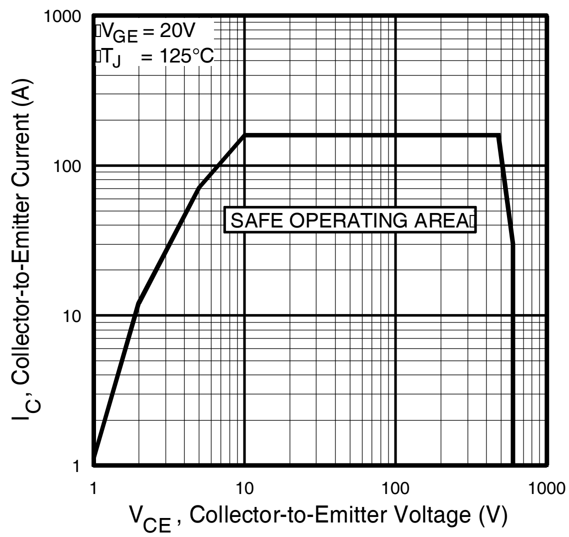


Fig. 12 - Turn-Off SOA

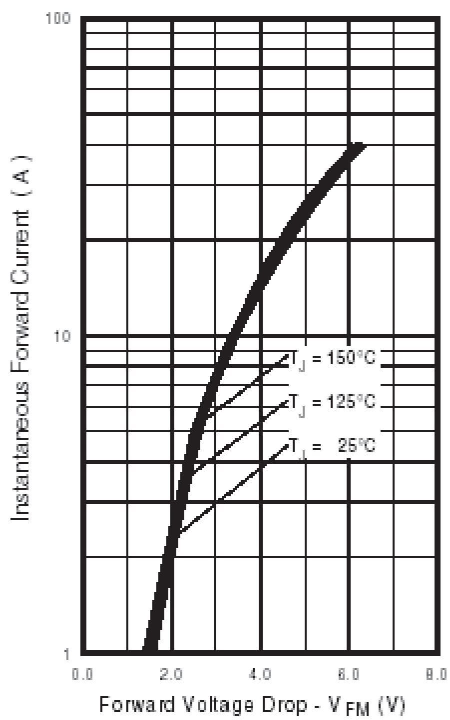


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

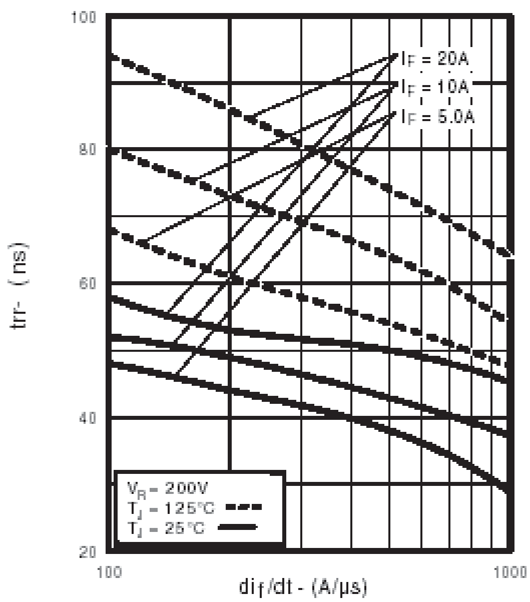


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

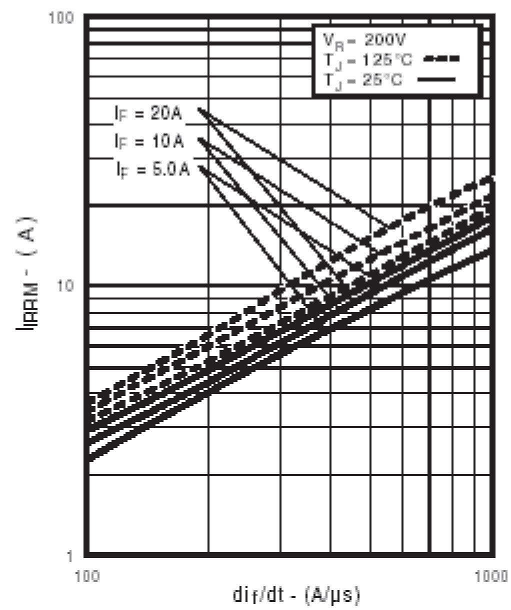


Fig. 15 - Typical Recovery Current vs. di_f/dt

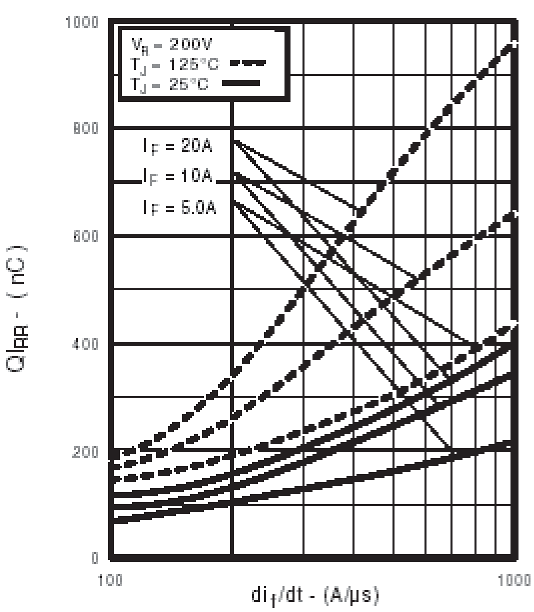


Fig. 16 - Typical Stored Charge vs. di_f/dt

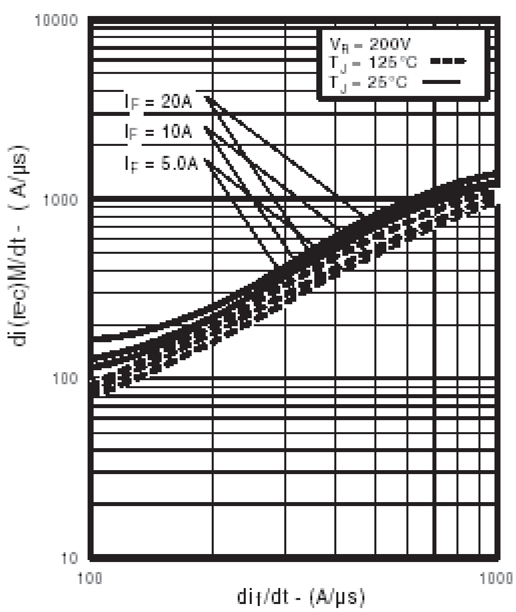


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

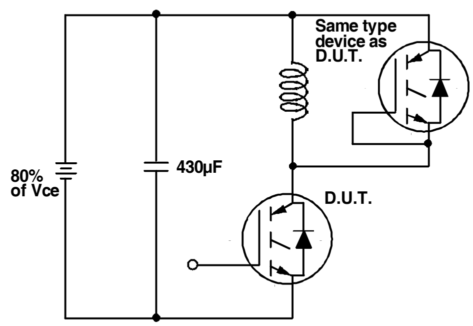


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

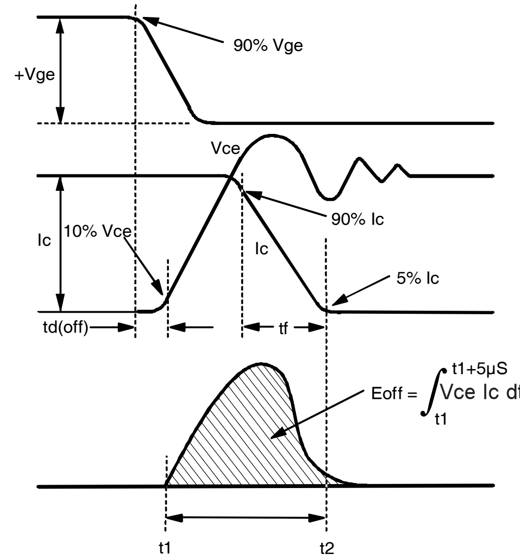


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

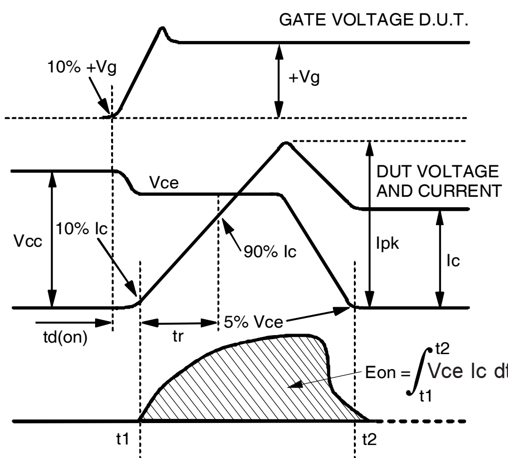


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

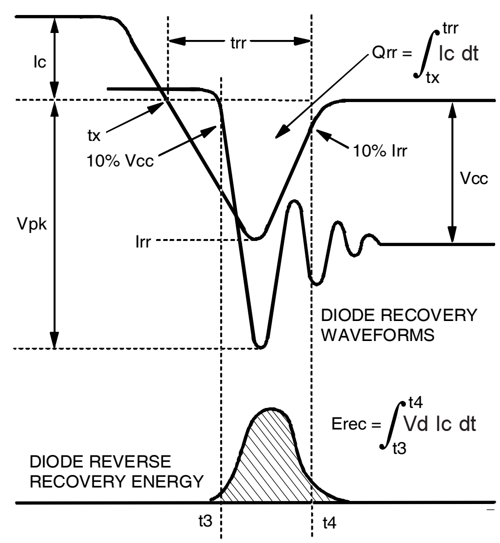


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

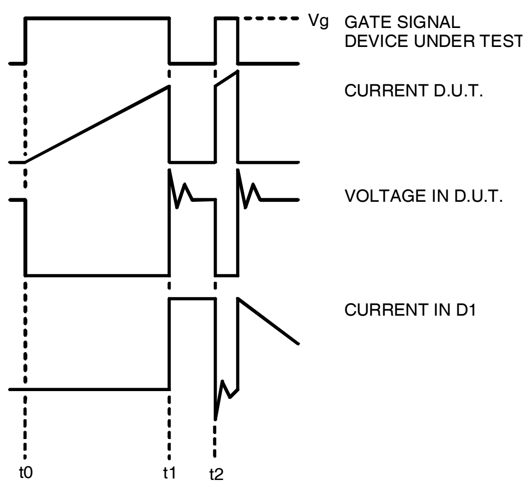


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

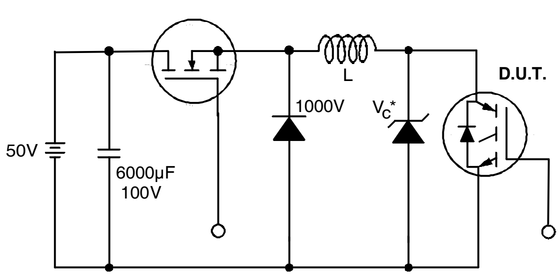


Figure 19. Clamped Inductive Load Test Circuit

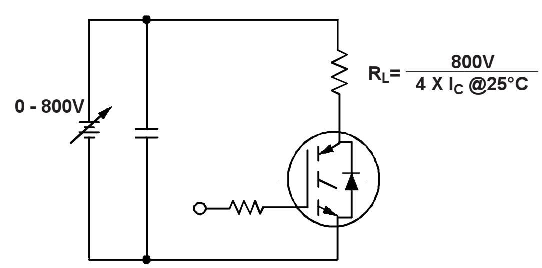
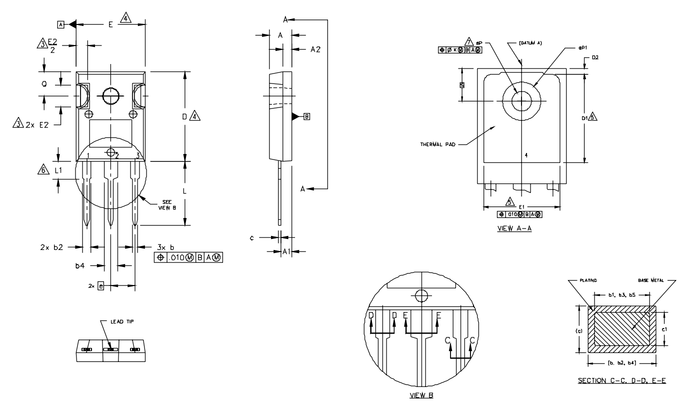


Figure 20. Pulsed Collector Current Test Circuit

TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
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 DIMENSIONS 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 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

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	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.71	20.70	4
D1	.515	–	13.08	–	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	–	13.46	–	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
øk	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
øP	.140	.144	3.56	3.66	
øP1	–	.291	–	7.39	
Q	.209	.224	5.31	5.69	
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

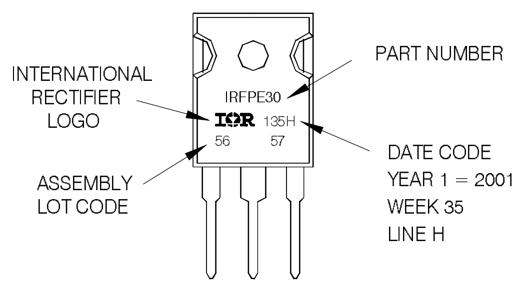
DIODES

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, 2001
IN THE ASSEMBLY LINE "H"

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



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

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.

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

International
IOR Rectifier

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Visit us at www.irf.com for sales contact information. 01/06

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