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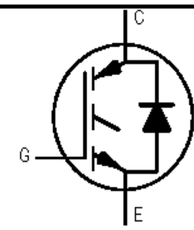
International
IOR Rectifier

PD- 95233

IRG4PF50WDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

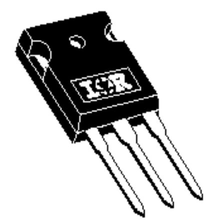
V_{CES} = 900V

$V_{CE(on)\ typ.}$ = 2.25V

@V_{GE} = 15V, I_C = 28A

Features

- Optimized for use in Welding and Switch-Mode Power Supply applications
- Industry benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest technology IGBT design offers tighter parameter distribution coupled with exceptional reliability
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package
- **Lead-Free**


TO-247AC

Benefits

- Lower switching losses allow more cost-effective operation and hence efficient replacement of larger-die MOSFETs up to 100kHz
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	900	V
I_C @ T_C = 25°C	Continuous Collector Current	51	A
I_C @ T_C = 100°C	Continuous Collector Current	28	
I_{CM}	Pulsed Collector Current ①	204	
I_{LM}	Clamped Inductive Load Current ②	204	
I_F @ T_C = 100°C	Diode Continuous Forward Current	16	
I_{FM}	Diode Maximum Forward Current	204	
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)

04/30/04

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	900	—	—	V	V_{GE} = 0V, I_C = 250μA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.295	—	V/°C	V_{GE} = 0V, I_C = 3.5mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.25	2.7	V	I_C = 28A	V_{GE} = 15V
		—	2.74	—		I_C = 60A	See Fig. 2, 5
		—	2.12	—		I_C = 28A, 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	26	39	—	S	V_{CE} = 50V, I_C = 28A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	500	μA	V_{GE} = 0V, V_{CE} = 900V	
		—	—	2.0		V_{GE} = 0V, V_{CE} = 10V, T_J = 25°C	
		—	—	6.5	mA	V_{GE} = 0V, V_{CE} = 900V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.5	V	I_C = 16A	See Fig. 13
		—	2.1	3.0		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	240	nC	I_C = 28A	
Qge	Gate - Emitter Charge (turn-on)	—	19	29		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	—	71	—	ns	T_J = 25°C	
t_r	Rise Time	—	50	—		I_C = 28A, V_{CC} = 720V	
$t_{d(off)}$	Turn-Off Delay Time	—	150	220		V_{GE} = 15V, R_G = 5.0Ω	
t_f	Fall Time	—	110	170		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	—	2.63	—	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	—	1.34	—		See Fig. 9, 10, 18	
E_{ts}	Total Switching Loss	—	3.97	5.3			
$t_{d(on)}$	Turn-On Delay Time	—	69	—	ns	T_J = 150°C, See Fig. 11, 18	
t_r	Rise Time	—	52	—		I_C = 28A, V_{CC} = 720V	
$t_{d(off)}$	Turn-Off Delay Time	—	270	—		V_{GE} = 15V, R_G = 5.0Ω	
t_f	Fall Time	—	190	—		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	—	6.0	—	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	3300	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	200	—		V_{CC} = 30V See Fig. 7	
C_{res}	Reverse Transfer Capacitance	—	45	—		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	

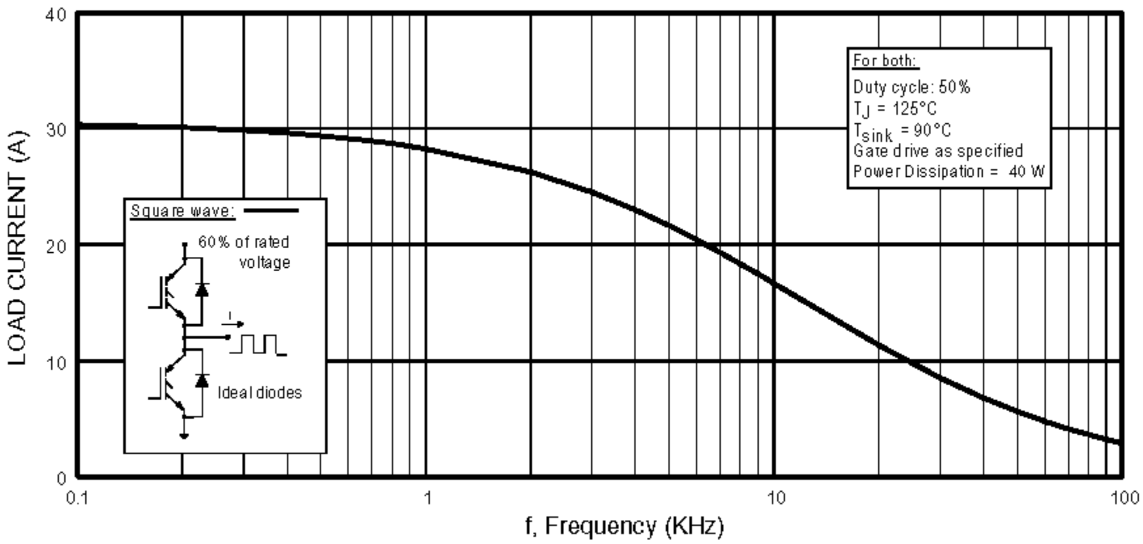


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

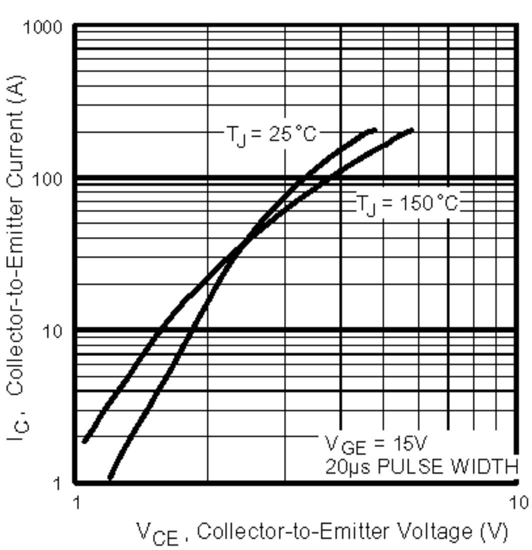


Fig. 2 - Typical Output Characteristics

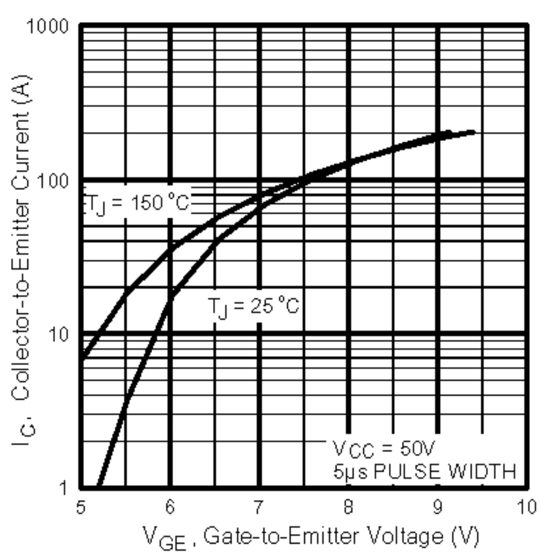


Fig. 3 - Typical Transfer Characteristics

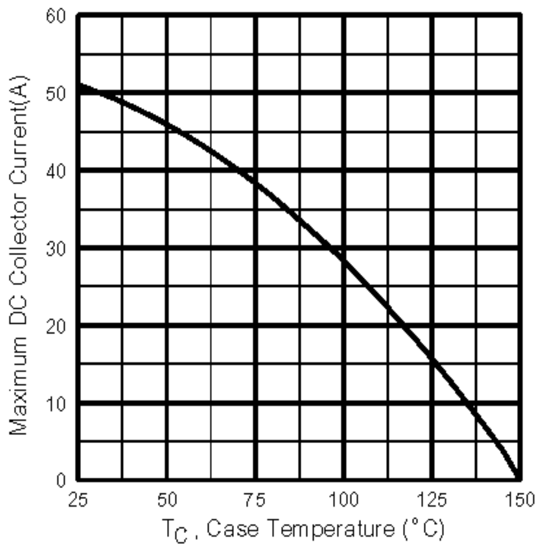


Fig. 4 - Maximum Collector Current vs. Case Temperature

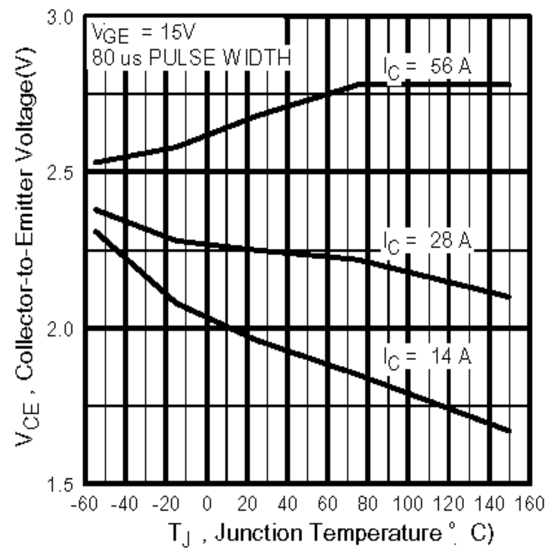


Fig. 5 - Collector-to-Emitter Voltage vs. Junction Temperature

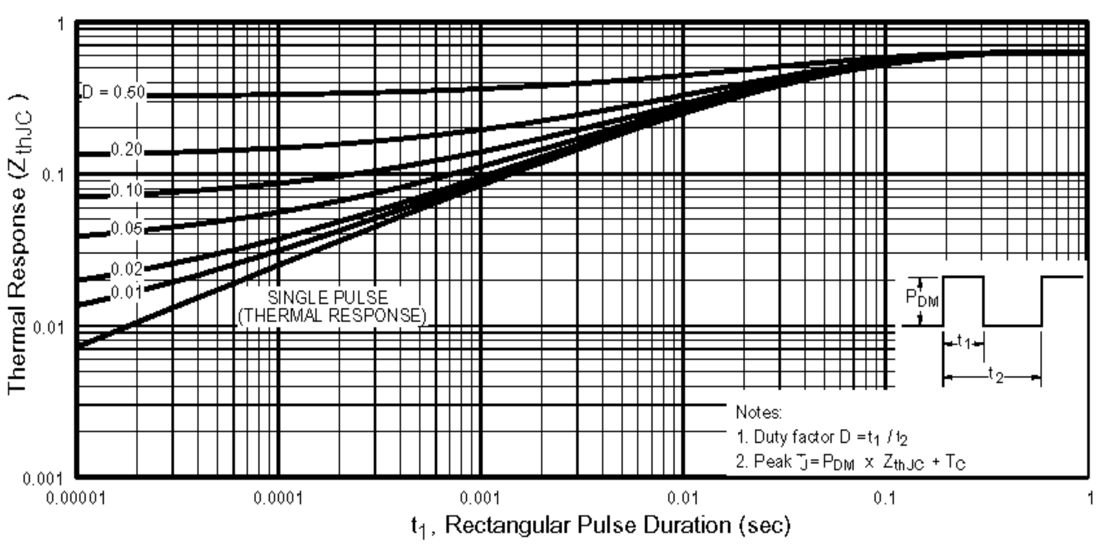


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

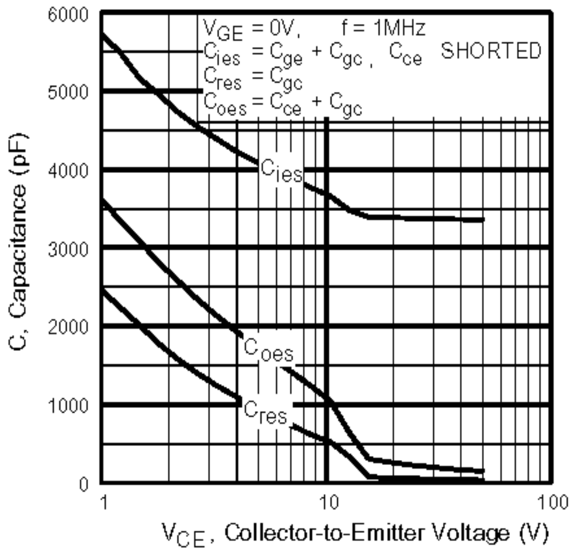


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

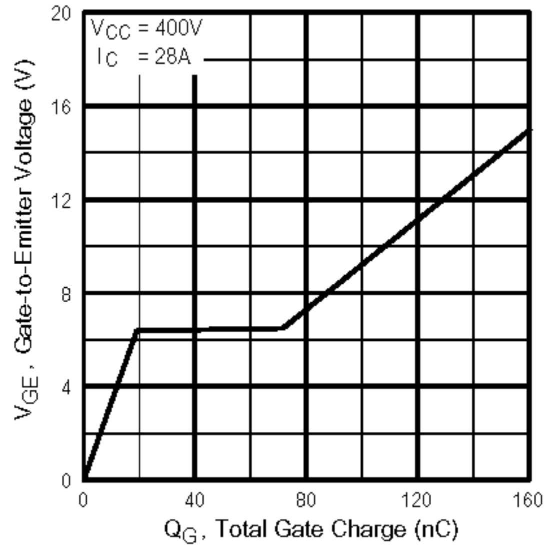


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

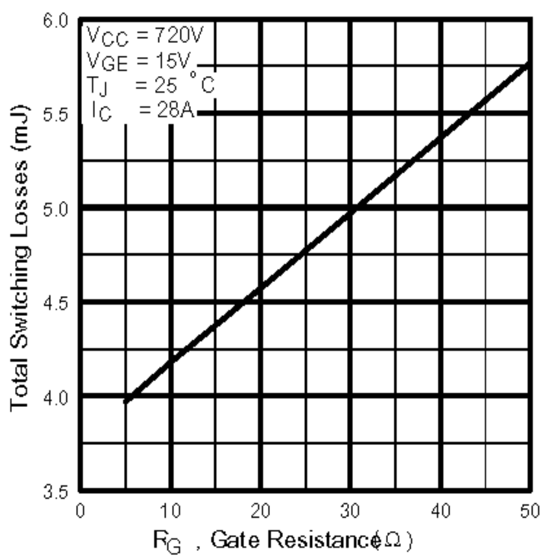


Fig. 9 - Typical Switching Losses vs. Gate Resistance

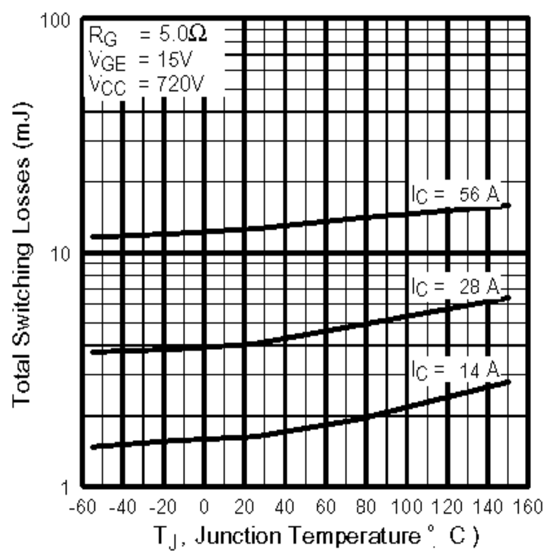


Fig. 10 - Typical Switching Losses vs. Junction Temperature

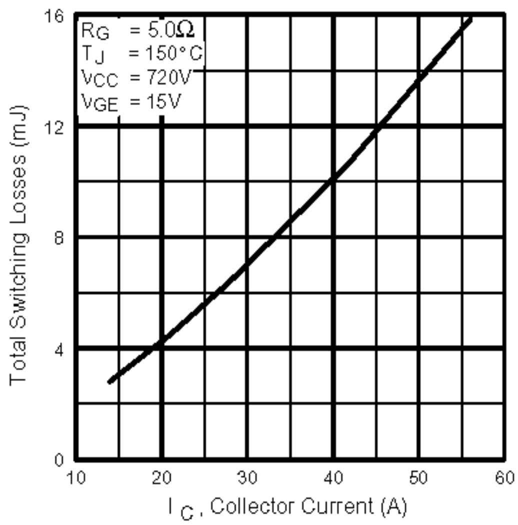


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

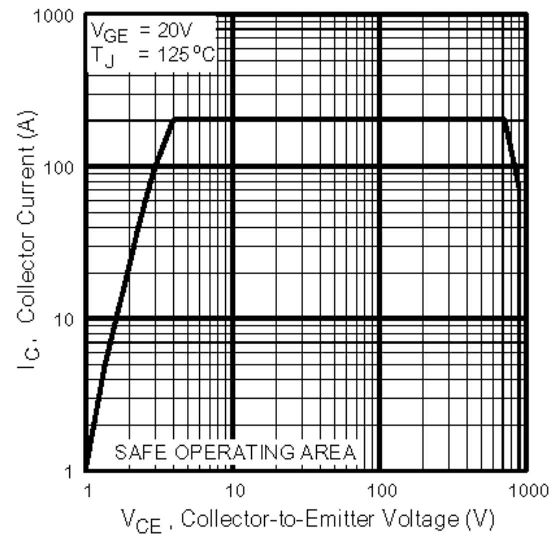


Fig. 12 - Turn-Off SOA

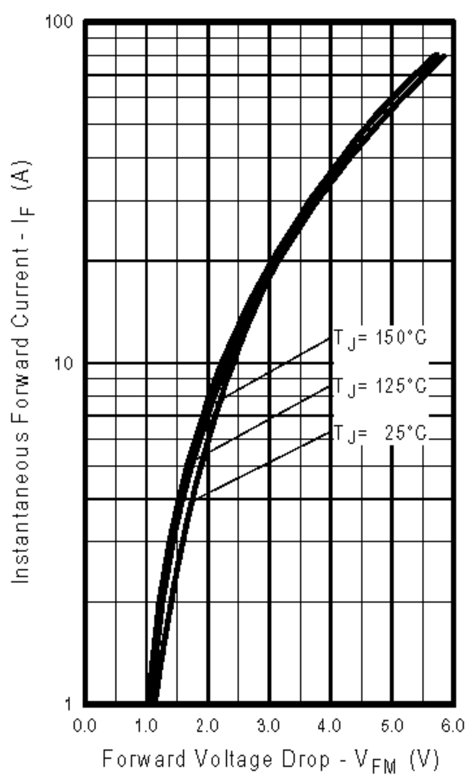


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

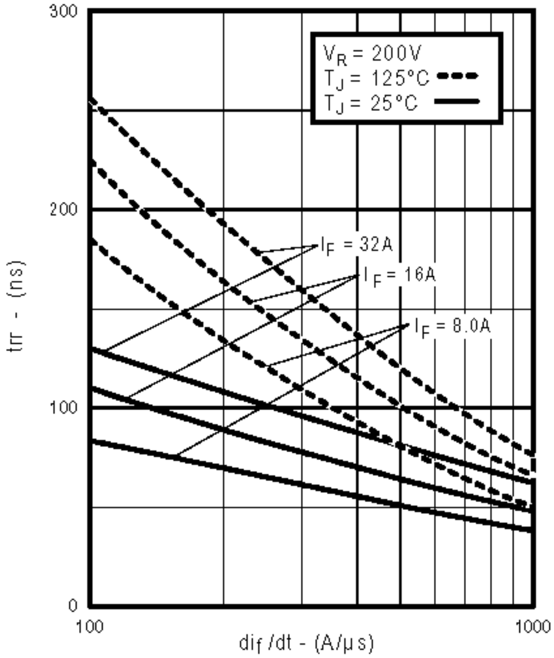


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

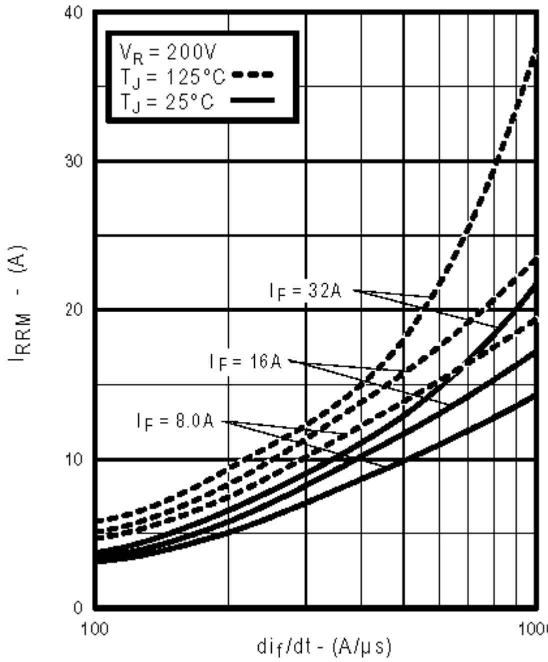


Fig. 15 - Typical Recovery Current vs. di_f/dt

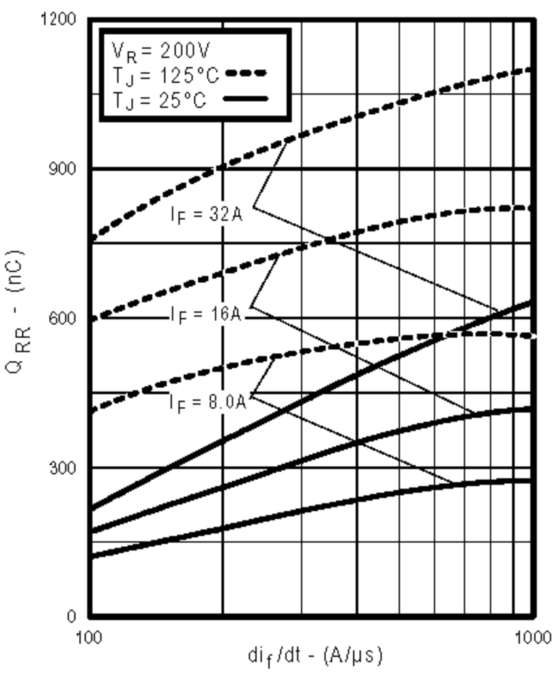


Fig. 16 - Typical Stored Charge vs. di_f/dt

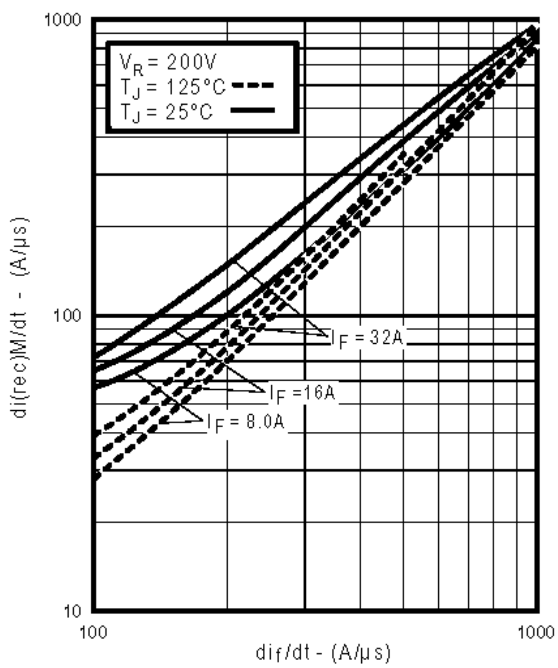


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

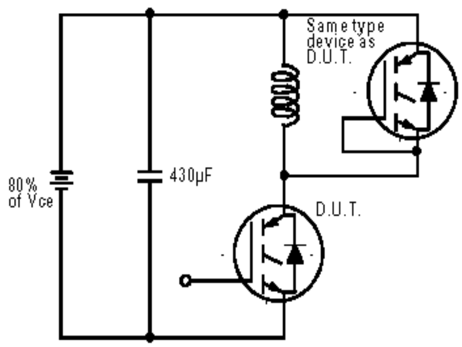


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

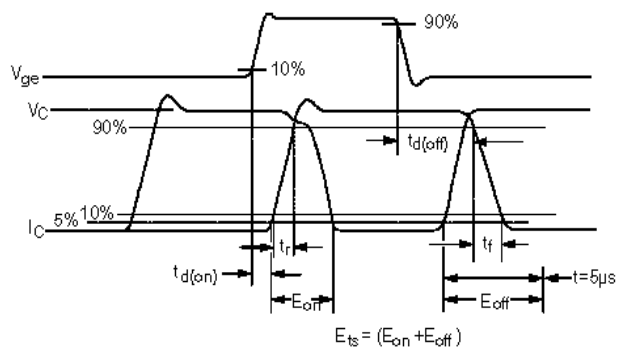


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

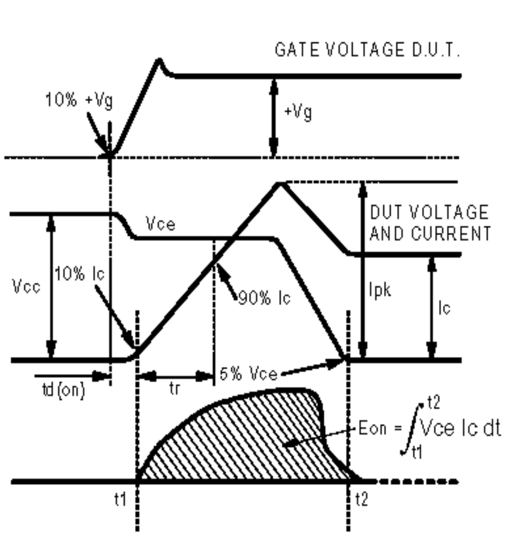


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

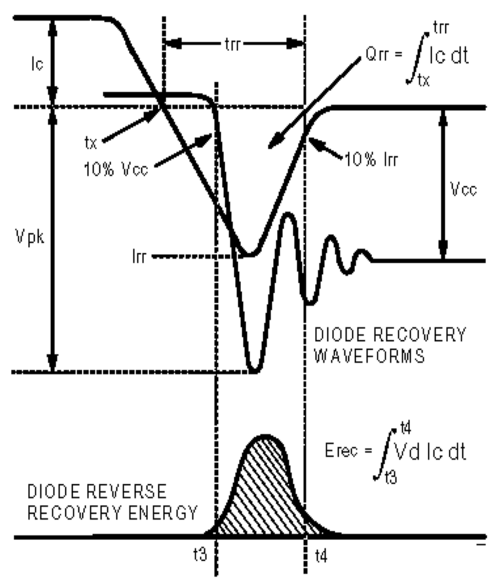


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

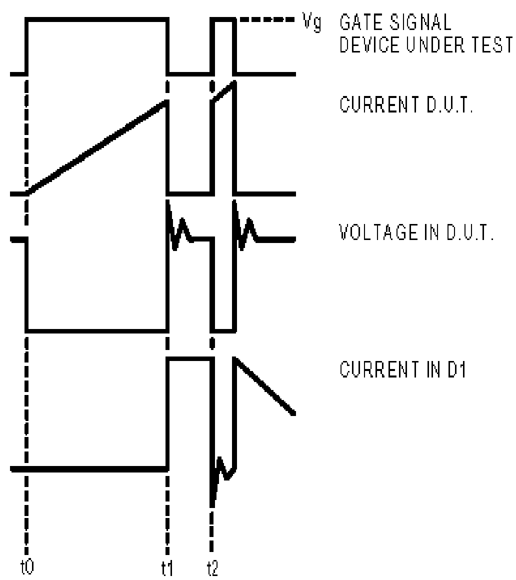


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

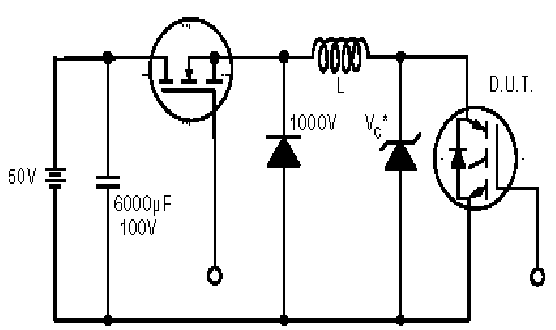


Figure 19. Clamped Inductive Load Test Circuit

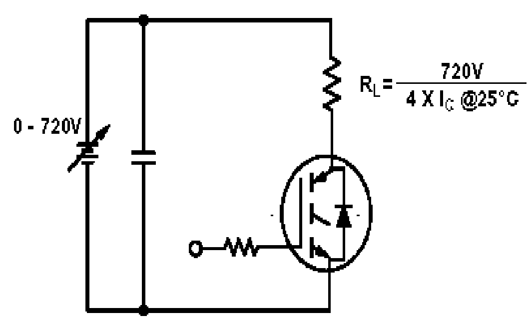
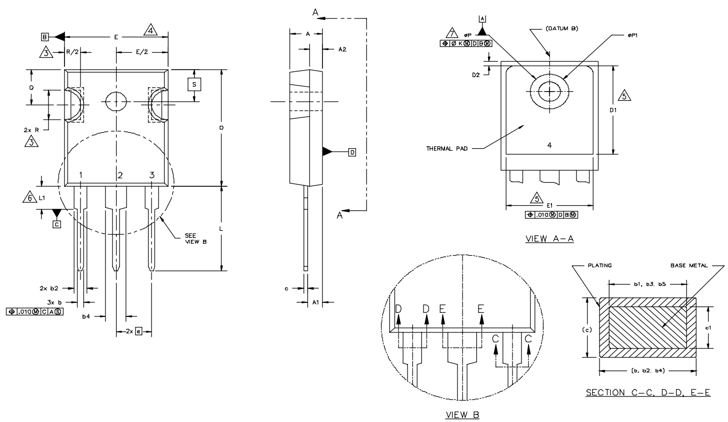


Figure 20. Pulsed Collector Current Test Circuit

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 INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.	NOTES
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

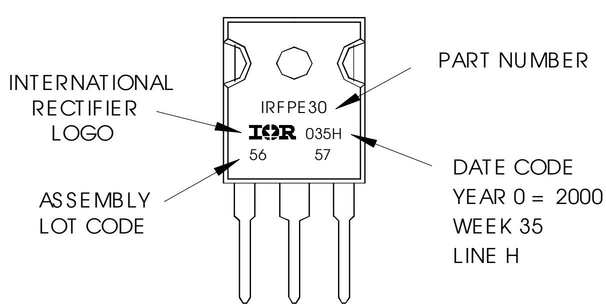
DIODES

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