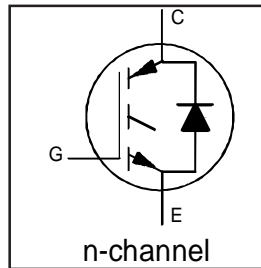


IRG4PH40UD2

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE UltraFast CoPack IGBT

Features

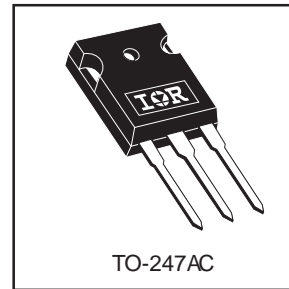
- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes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



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.72V$
@ $V_{GE} = 15V, I_C = 20A$

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	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	40	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	20	
I_{CM}	Pulse Collector Current ①	160	
I_{LM}	Clamped Inductive Load current ①	160	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	10	
I_{FM}	Diode Maximum Forward Current	40	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
T_J	Operating Junction and Storage Temperature Range	-55 to +150	°C
T_{STG}			
	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.)

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Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

Parameter		Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.63	—	V/°C	$V_{GE} = 0V, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.72	2.1	V	$I_C = 20A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.15	—		$I_C = 40A, V_{GE} = 15V, T_J = 125^\circ\text{C}$
		—	1.7	—		$I_C = 20A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance $\text{\textcircled{C}}$	11	18	—	S	$V_{CE} = 100V, I_C = 20A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	2500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	3.4	3.8	V	$I_F = 10A, V_{GE} = 0V$
		—	3.3	3.7		$I_F = 10A, V_{GE} = 0V, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (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	—		$V_{GE} = 15V, R_G = 10\Omega$
$t_{d(off)}$	Turn-Off delay time	—	100	110		$T_J = 25^\circ\text{C}$
t_f	Fall time	—	280	340		Energy losses included "tail"
E_{on}	Turn-On Switching Loss	—	1440	—		$I_C = 20A, V_{CC} = 600V$
E_{off}	Turn-Off Switching Loss	—	1410	—	μJ	$V_{GE} = 15V, R_G = 10\Omega$
E_{tot}	Total Switching Loss	—	2850	3740		$T_J = 25^\circ\text{C}$
$t_{d(on)}$	Turn-On delay time	—	22	—	ns	$I_C = 20A, V_{CC} = 600V$
t_r	Rise time	—	32	—		$V_{GE} = 15V, R_G = 10\Omega, L = 1.0mH$
$t_{d(off)}$	Turn-Off delay time	—	190	—		$T_J = 150^\circ\text{C}$
t_f	Fall time	—	630	—		Energy losses included "tail"
E_{TS}	Total Switching Loss	—	5360	—	μJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from 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	$T_J = 25^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
		—	72	110		$T_J = 125^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
I_{rr}	Diode Peak Reverse Recovery Current	—	4.4	7.0	A	$T_J = 25^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
		—	5.9	8.8		$T_J = 125^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
Q_{rr}	Diode Reverse Recovery Charge	—	130	200	nC	$T_J = 25^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
		—	250	380		$T_J = 125^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
$di_{(rec)}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	210	—	A/ μs	$T_J = 25^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$
		—	180	—		$T_J = 125^\circ\text{C}, V_{CC} = 200V, I_F = 10A, di/dt = 200A/\mu s$

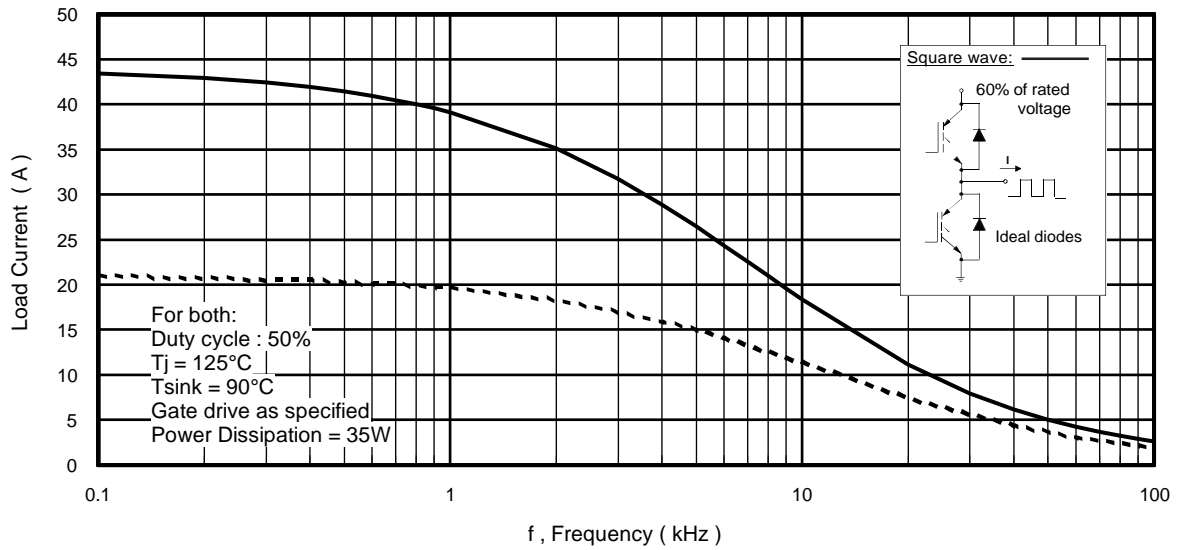


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

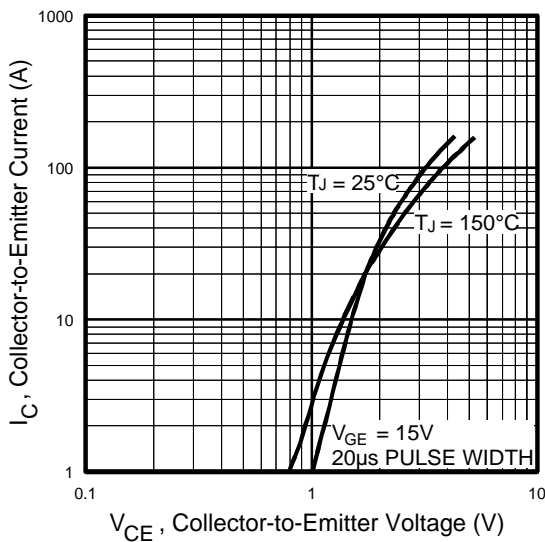


Fig. 2 - Typical Output Characteristics

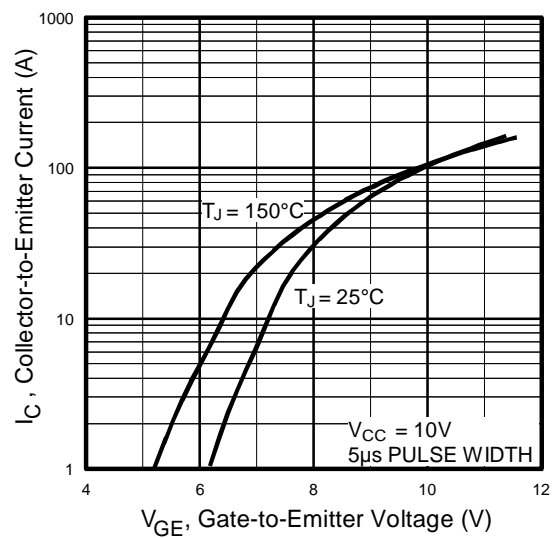


Fig. 3 - Typical Transfer Characteristics

IRG4PH40UD2

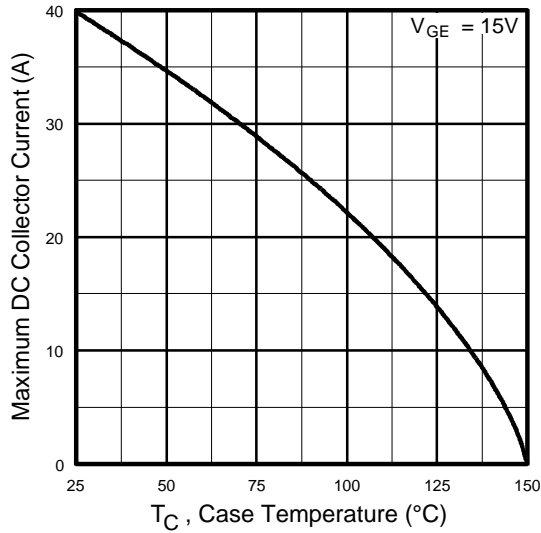


Fig. 4 - Maximum Collector Current vs. Case Temperature

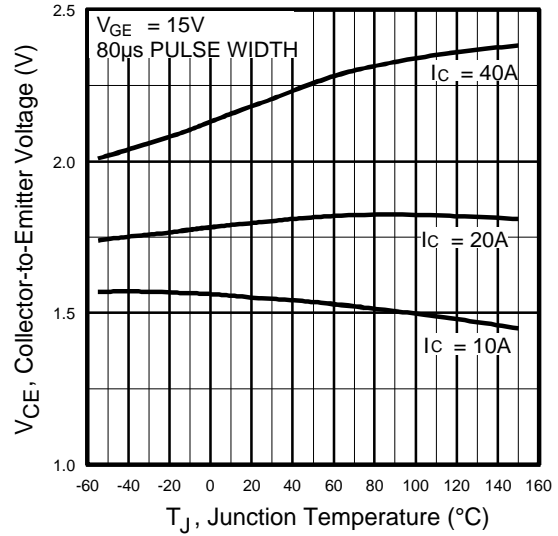


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

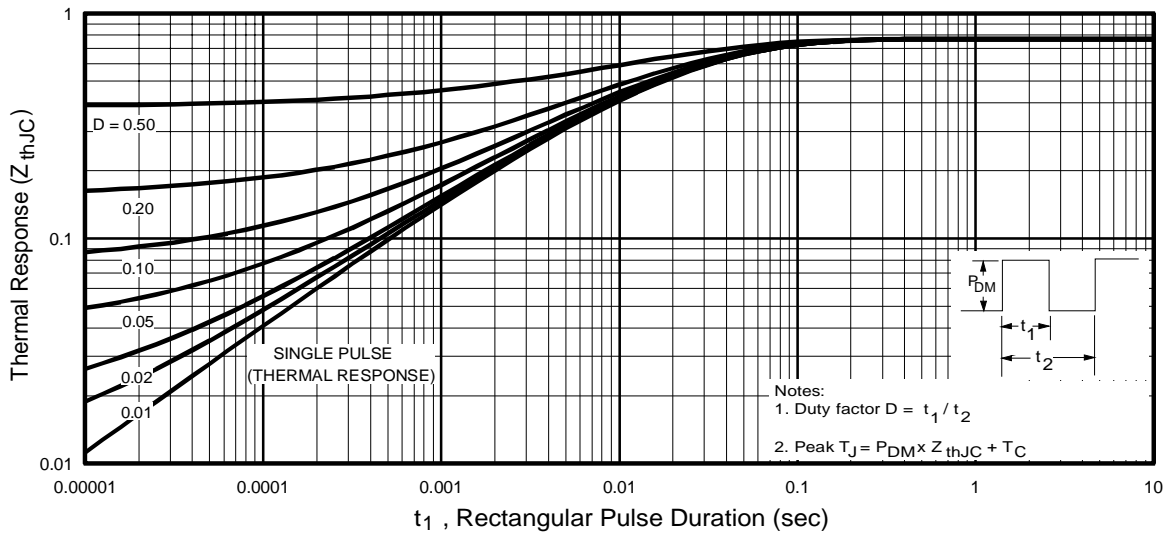


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

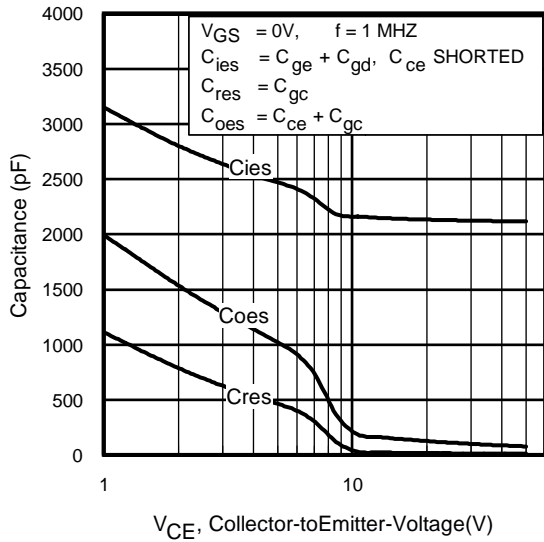


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

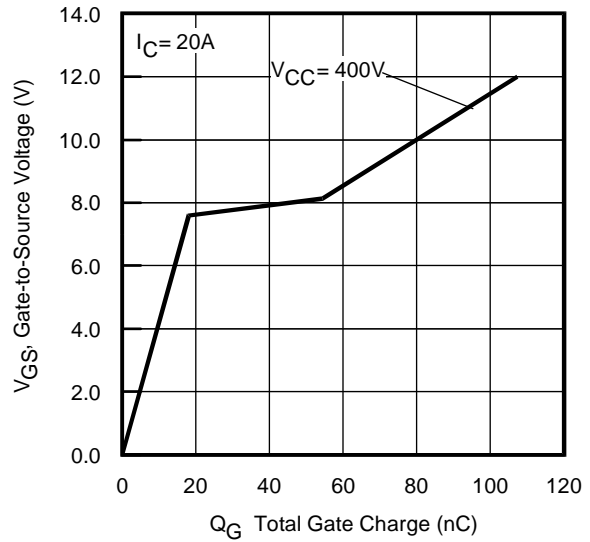


Fig. 8 - Typical Gate Charge vs. Gate-to-Source Voltage

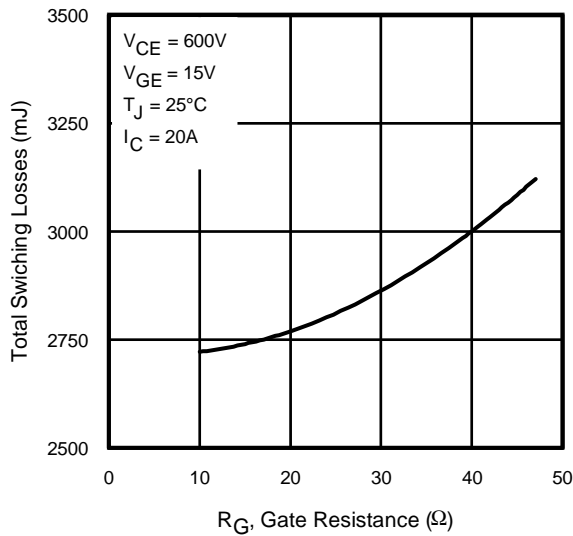


Fig. 9 - Typical Switching Losses vs. Gate Resistance

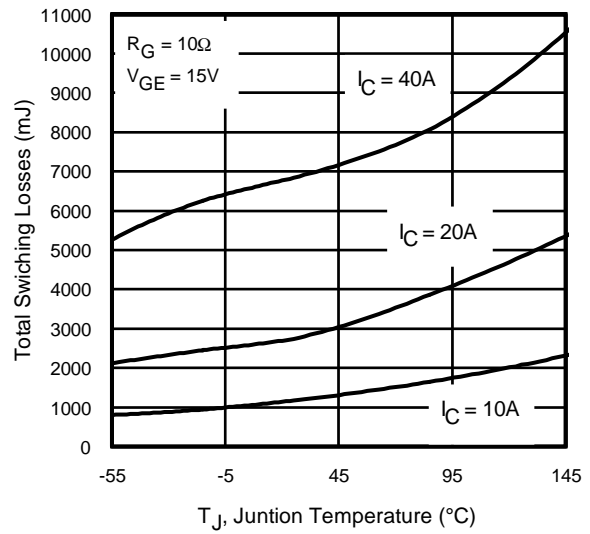


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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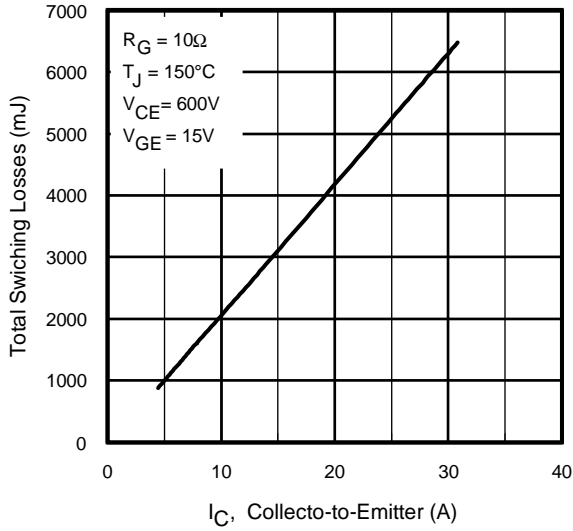


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

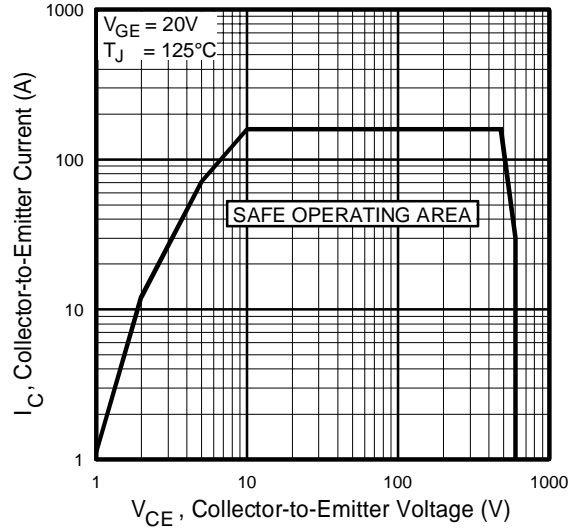


Fig. 12 - Turn-Off SOA

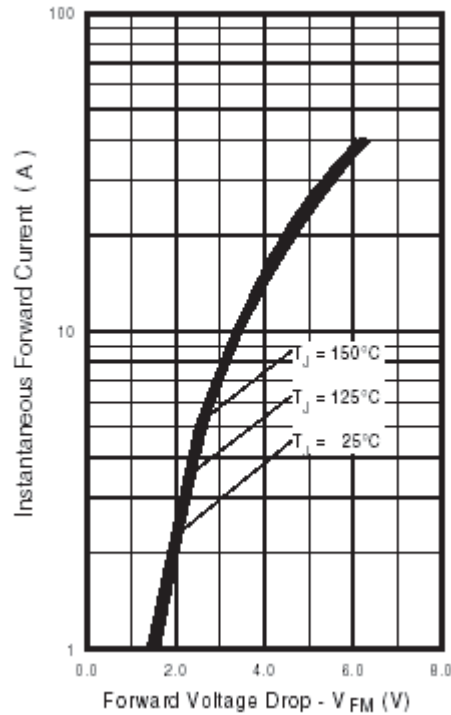


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

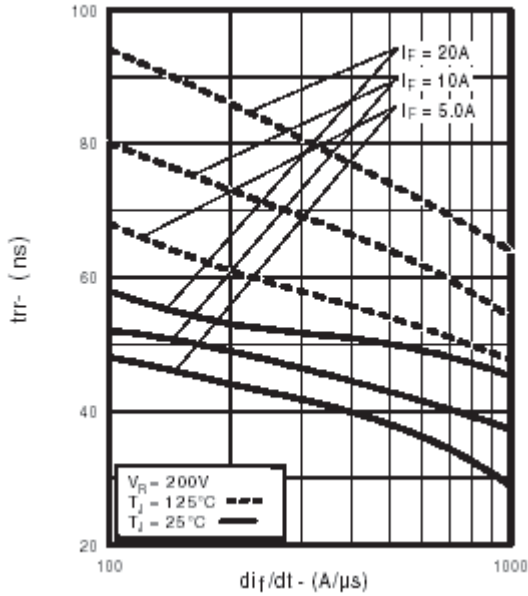


Fig. 14 - Typical Reverse Recovery vs. di_T/dt

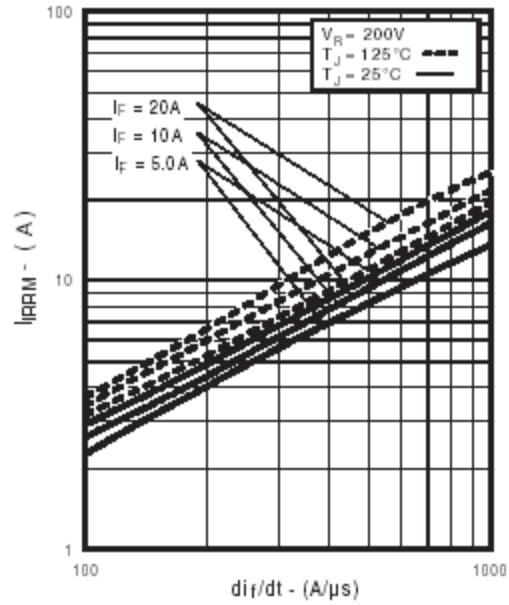


Fig. 15 - Typical Recovery Current vs. di_T/dt

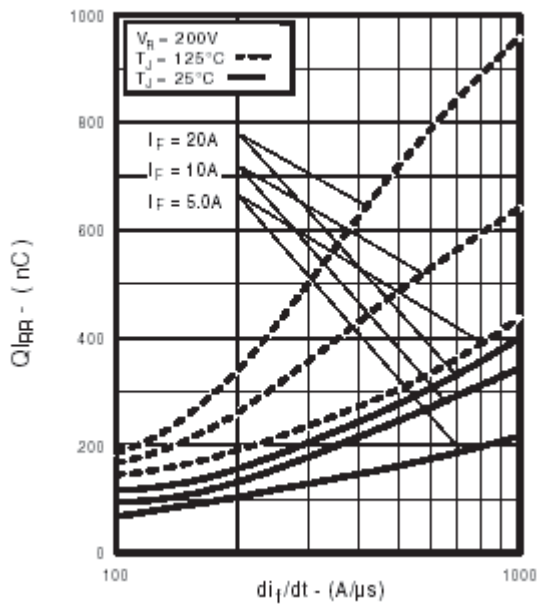


Fig. 16 - Typical Stored Charge vs. di_T/dt

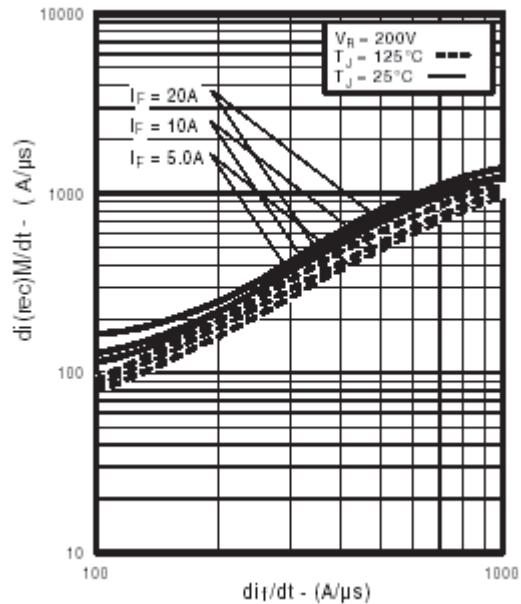


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_T/dt

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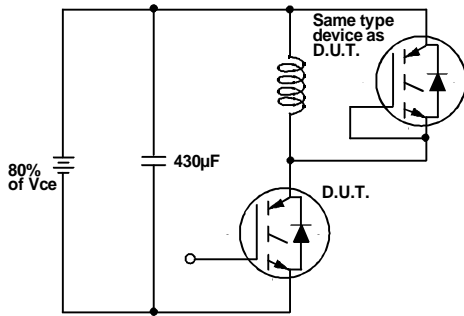


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

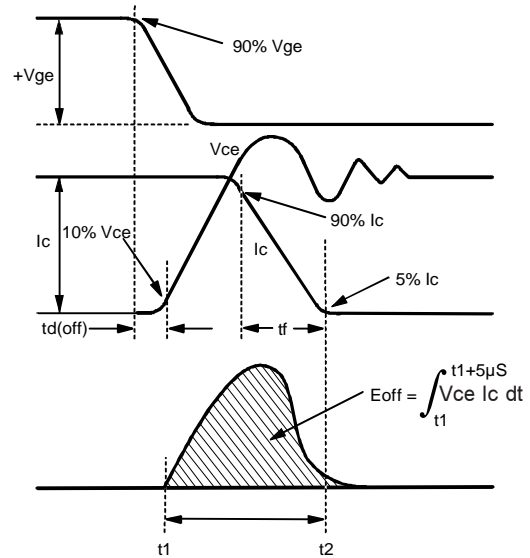


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

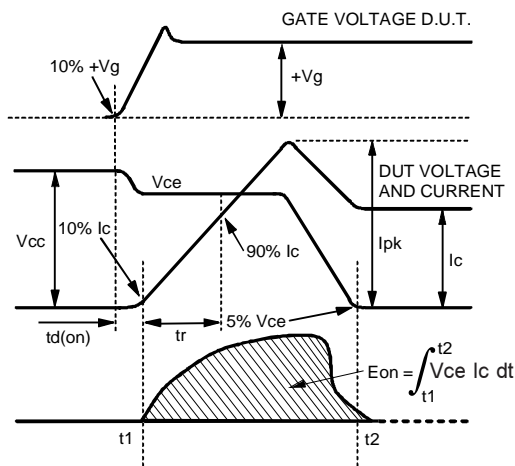


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

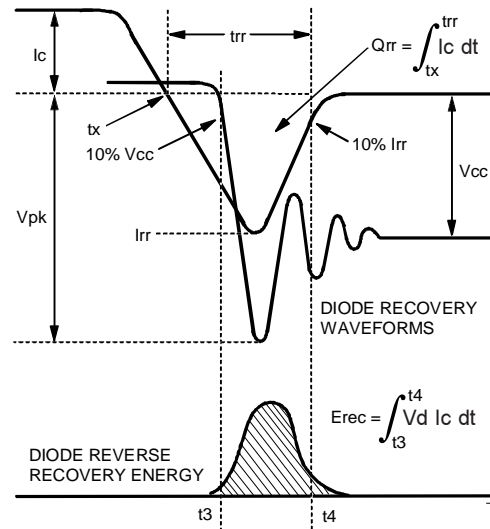
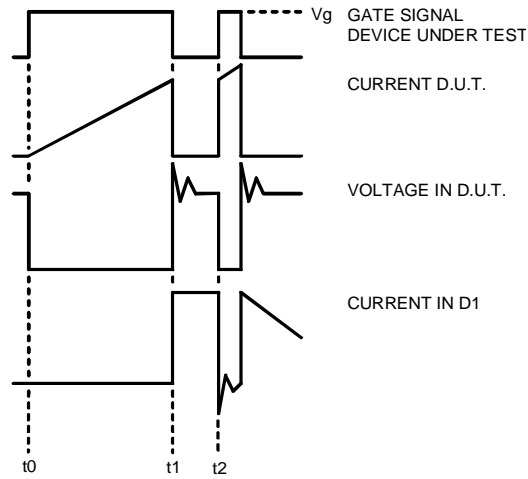
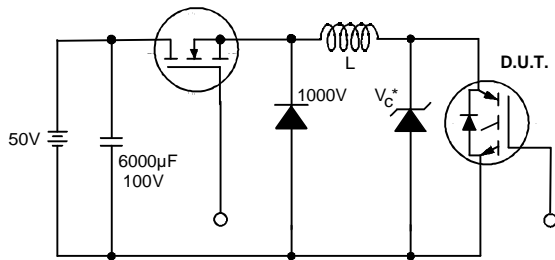


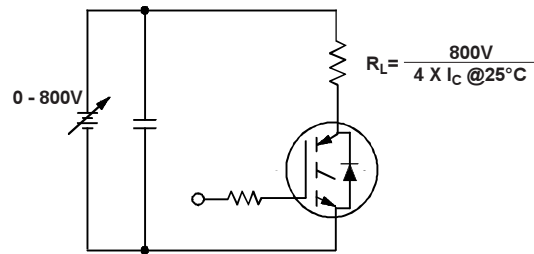
Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}



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



19. Clamped Inductive Load Test Circuit



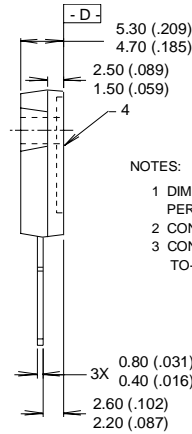
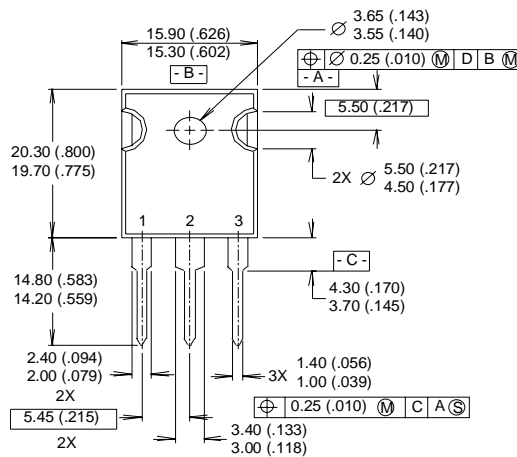
20. Pulsed Collector Current Test Circuit

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TO-247AC Package Outline

Dimensions are shown in millimeters (inches)

International
IR Rectifier



NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 2 CONTROLLING DIMENSION: INCH.
- 3 CONFORMS TO JEDEC OUTLINE TO-247-AC.

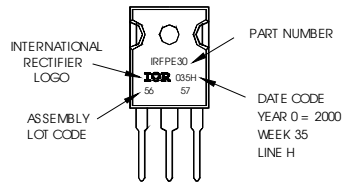
LEAD ASSIGNMENTS

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

TO-247AC Part Marking Information

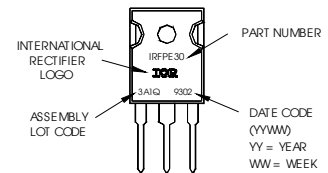
Notes: This part marking information applies to devices produced after 02/26/2001

EXAMPLE: THIS IS AN IRFP30 WITH ASSEMBLY LOT CODE 5667 ASSEMBLED ON WW 35, 2000 IN THE ASSEMBLY LINE "H"



Notes: This part marking information applies to devices produced before 02/26/2001 or for parts manufactured in GB.

EXAMPLE: THIS IS AN IRFP30 WITH ASSEMBLY LOT CODE 3A1Q



Notes:

- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=10\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

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

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
IR Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information. 07/03