

IRG4PH40UD2-E

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

Features

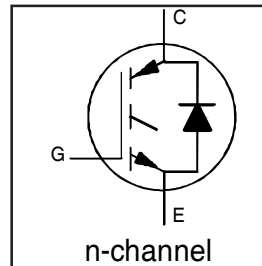
- UltraFast IGBT optimized for high operating frequencies up to 200kHz in resonant mode
- IGBT co-packaged with HEXFRED™ ultrafast ultra-soft-recovery anti-parallel diode for use in resonant circuits
- Industry standard TO-247AD package with extended leads

Benefits

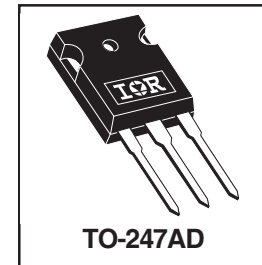
- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- HEXFRED diodes optimized for performance with IGBTs. Minimized recovery characteristics require less / no snubbing

Applications

- Induction cooking systems
- Microwave Ovens
- Resonant Circuits



$V_{CES} = 1200V$
$V_{CE(on) typ.} = 2.43V$
@ $V_{GE} = 15V, I_C = 21A$



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	41	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	21	A
I_{CM}	Pulse Collector Current ①	82	A
I_{LM}	Clamped Inductive Load current ②	82	A
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	10	A
I_{FM}	Diode Maximum Forward Current	40	A
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	W
T_J	Operating Junction and	-55 to +150	$^\circ C$
T_{STG}	Storage Temperature Range		
	Soldering Temperature, 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	$^\circ C/W$
$R_{\theta JC}$	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 ③	1200	—	—	V $V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage	18	—	—	V $V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.43	—	V/ $^\circ\text{C}$ $V_{GE} = 0V, I_C = 1mA$
$V_{CE(on)}$	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	—	$I_C = 21A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0	V $V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-11	—	mV/ $^\circ\text{C}$ $V_{CE} = V_{GE}, I_C = 250\mu A$
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	$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	3.4	3.8	V $I_F = 10A$ See Fig.13
		—	3.3	3.7	$I_F = 10A, T_J = 150^\circ\text{C}$
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)	—	100	150	$I_C = 21A$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	18	24	$V_{CC} = 400V$ See Fig.8
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	34	50	$V_{GE} = 15V$
$t_{d(on)}$	Turn-On delay time	—	22	—	ns $I_C = 21A, V_{CC} = 800V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
t_r	Rise time	—	26	—	
$t_{d(off)}$	Turn-Off delay time	—	100	140	
t_f	Fall time	—	200	300	
E_{on}	Turn-On Switching Loss	—	1950	—	μJ $T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18 $I_C = 21A, V_{CC} = 800V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery.
E_{off}	Turn-Off Switching Loss	—	1710	—	
E_{tot}	Total Switching Loss	—	3660	4490	
$t_{d(on)}$	Turn-On delay time	—	21	—	ns $T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18 $I_C = 21A, V_{CC} = 800V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" and diode reverse recovery.
t_r	Rise time	—	25	—	
$t_{d(off)}$	Turn-Off delay time	—	220	—	
t_f	Fall time	—	380	—	
E_{TS}	Total Switching Loss	—	6220	—	μJ
L_E	Internal Emitter Inductance	—	13	—	nH Measured 5mm from package
C_{ies}	Input Capacitance	—	2100	—	pF $V_{GE} = 0V$ $V_{CC} = 30V$, See Fig.7 $f = 1.0MHz$
C_{oes}	Output Capacitance	—	99	—	
C_{res}	Reverse Transfer Capacitance	—	12	—	
t_{rr}	Diode Reverse Recovery Time	—	50	76	ns $T_J = 25^\circ\text{C}$ See Fig 14
		—	72	110	$T_J = 125^\circ\text{C}$ 15
I_{rr}	Diode Peak Reverse Recovery Current	—	4.4	7.0	A $T_J = 25^\circ\text{C}$ See Fig 15
		—	5.9	8.8	$T_J = 125^\circ\text{C}$ 16
Q_{rr}	Diode Reverse Recovery Charge	—	130	200	nC $T_J = 25^\circ\text{C}$ See Fig 17
		—	250	380	$T_J = 125^\circ\text{C}$ 17
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	210	—	A/ μs $T_J = 25^\circ\text{C}$ See Fig
		—	180	—	$T_J = 125^\circ\text{C}$ 17

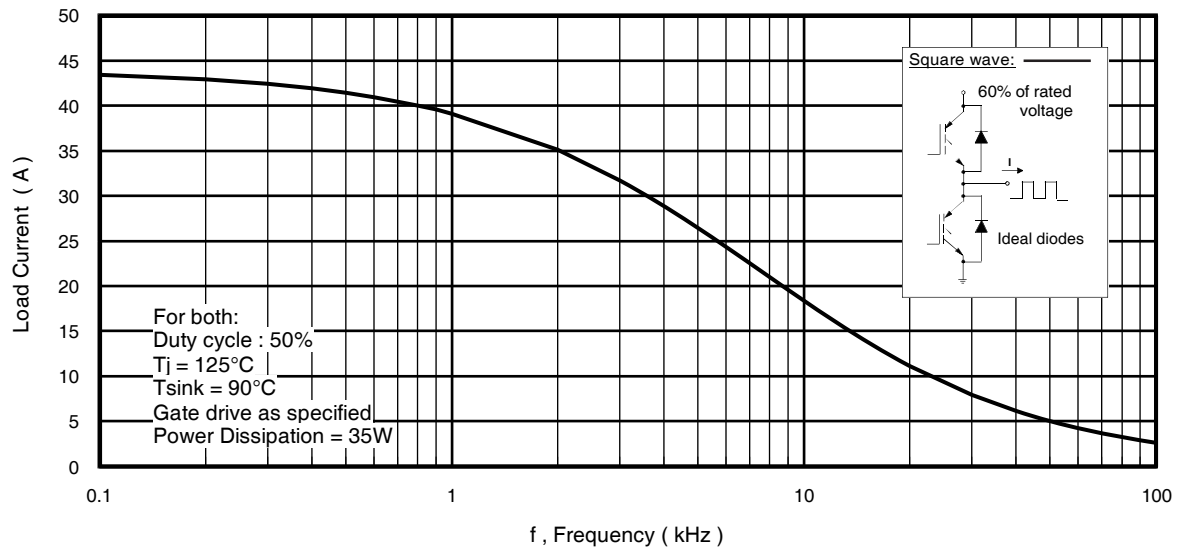


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

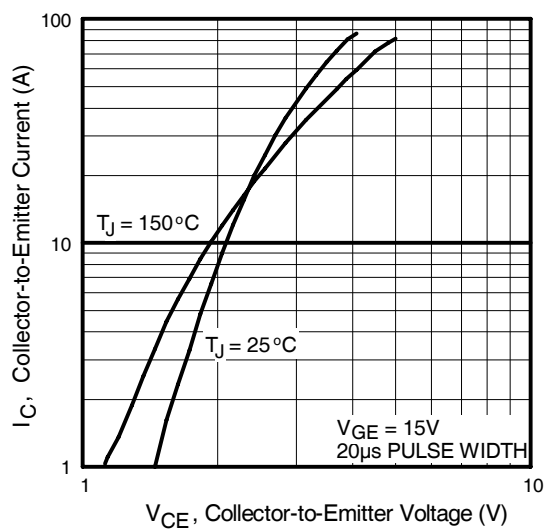


Fig. 2 - Typical Output Characteristics
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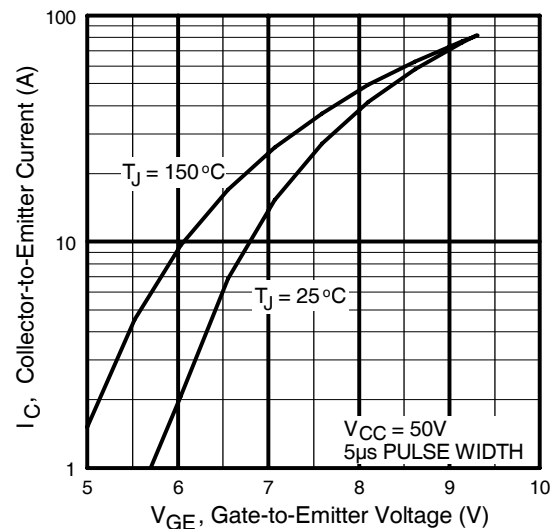


Fig. 3 - Typical Transfer Characteristics

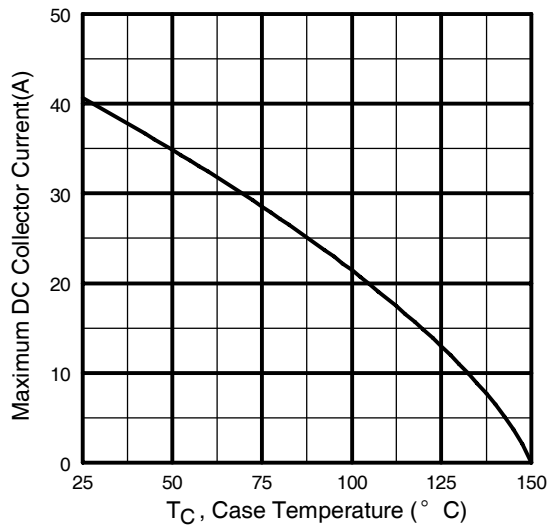


Fig. 4 - Maximum Collector Current vs. Case Temperature

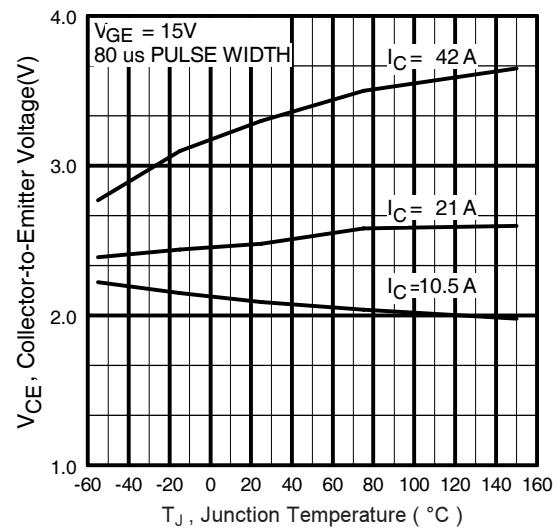


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

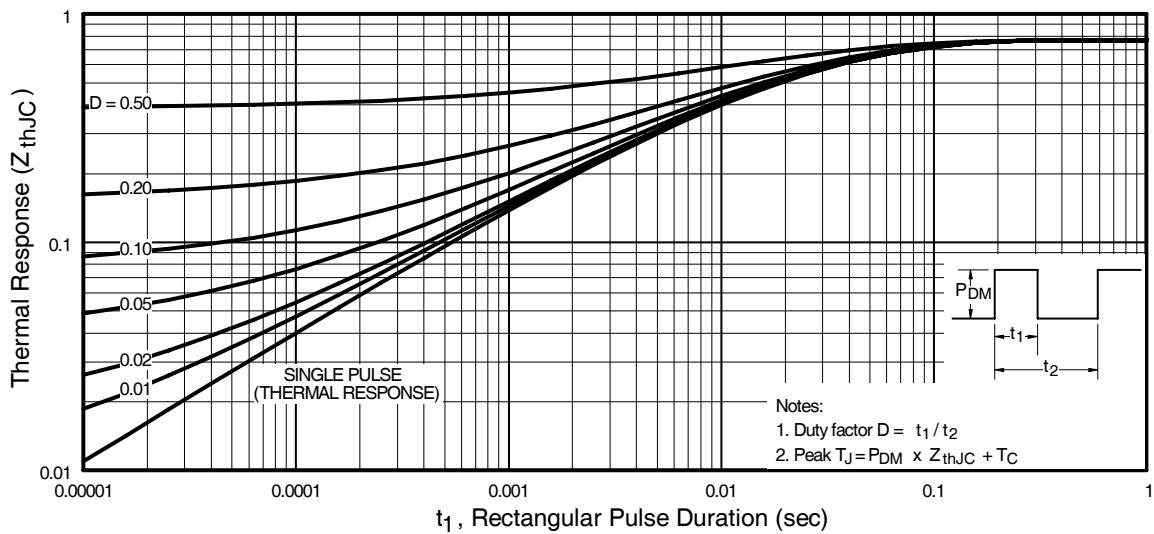


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

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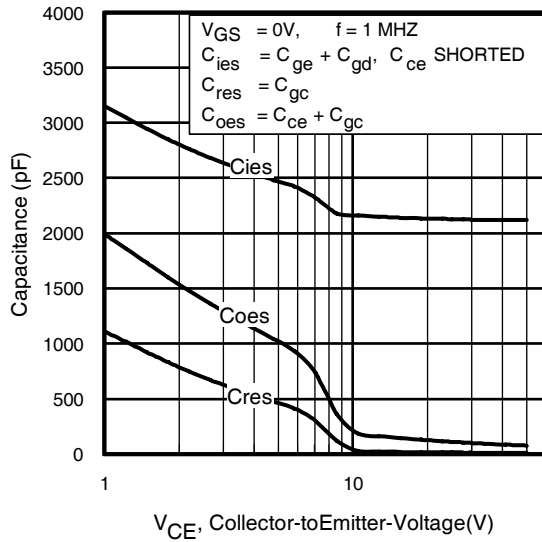


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

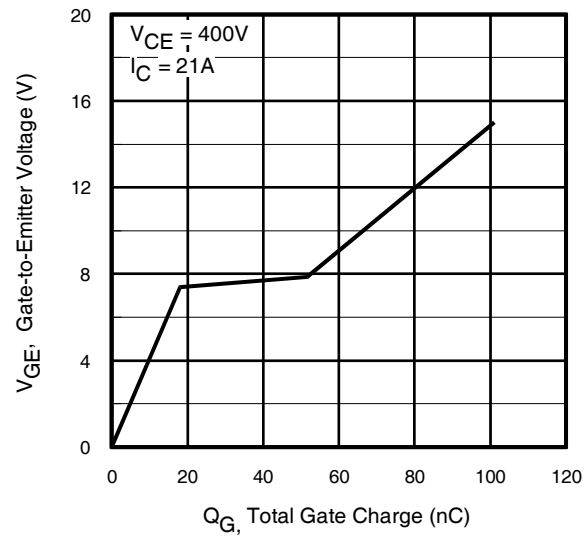


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

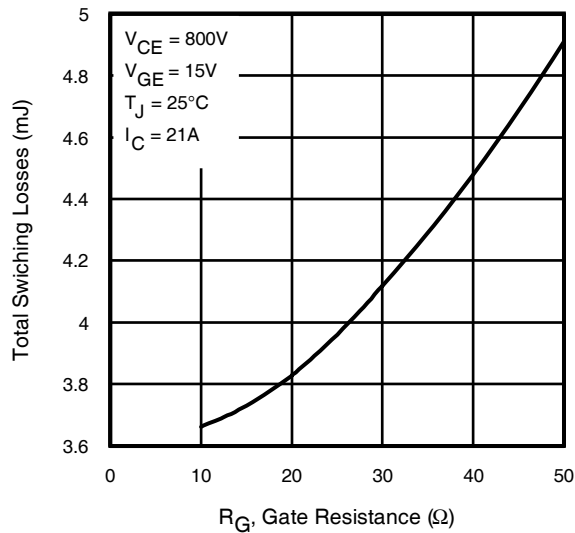


Fig. 9 - Typical Switching Losses vs. Gate Resistance

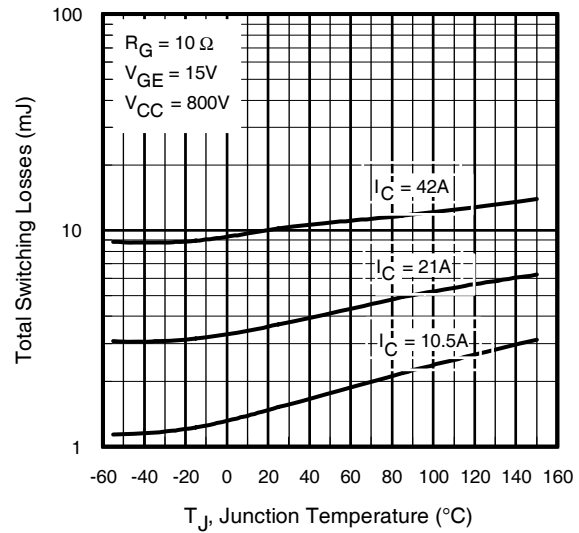


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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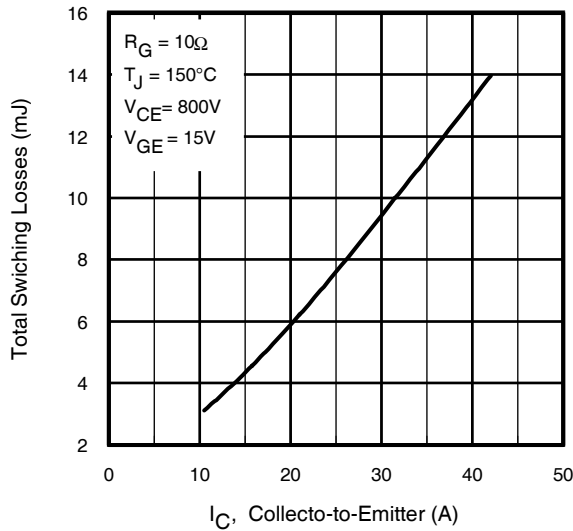


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

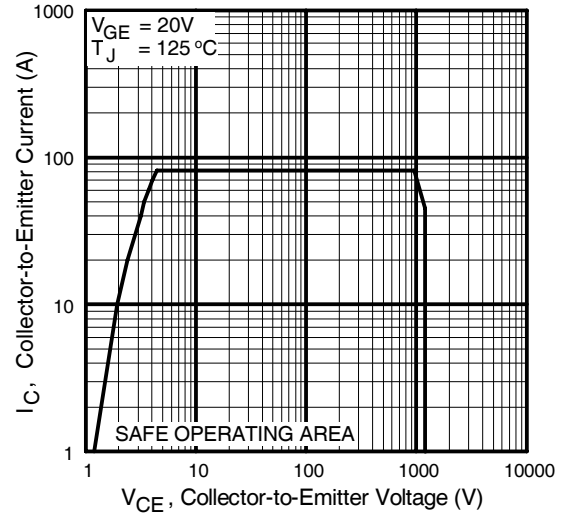


Fig. 12 - Turn-Off SOA

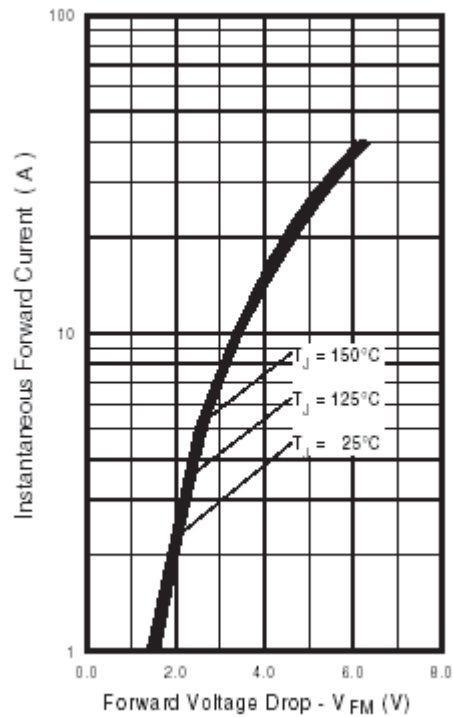


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

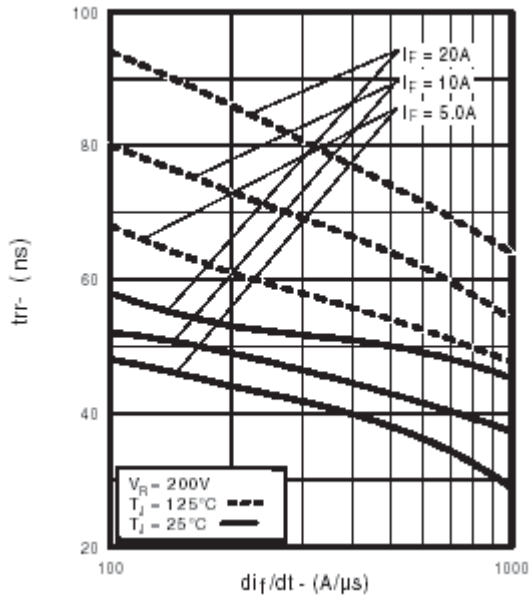


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

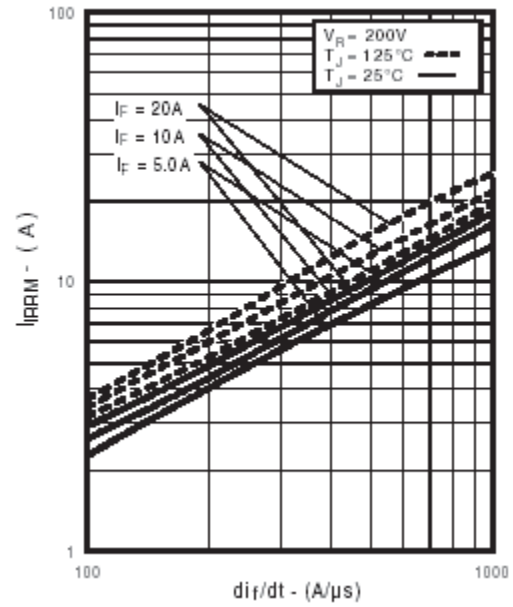


Fig. 15 - Typical Recovery Current vs. di_f/dt

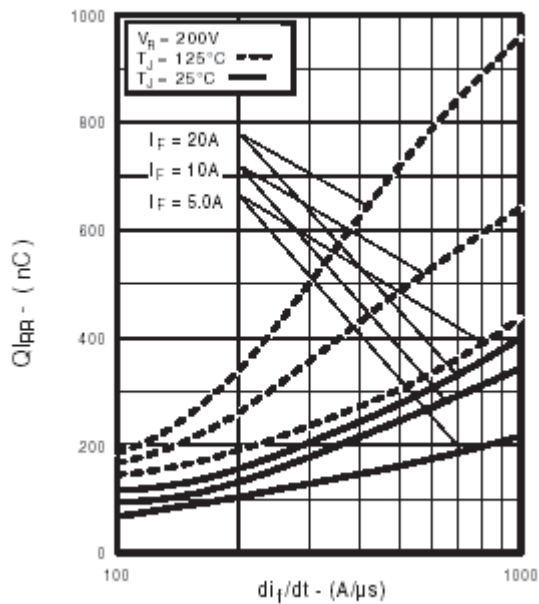


Fig. 16 - Typical Stored Charge vs. di_f/dt
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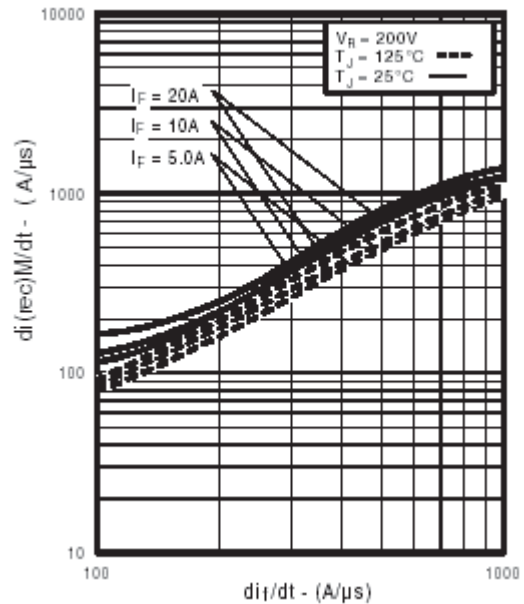


Fig. 17 - Typical $di_{(rec)}M/dt$ vs. di_f/dt

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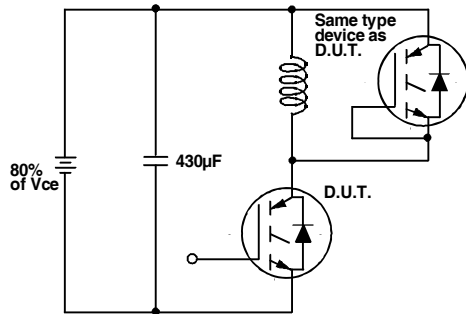


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off(diode)}$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

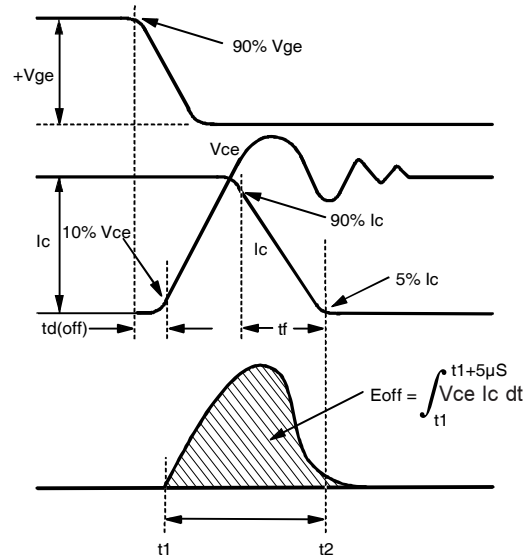


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

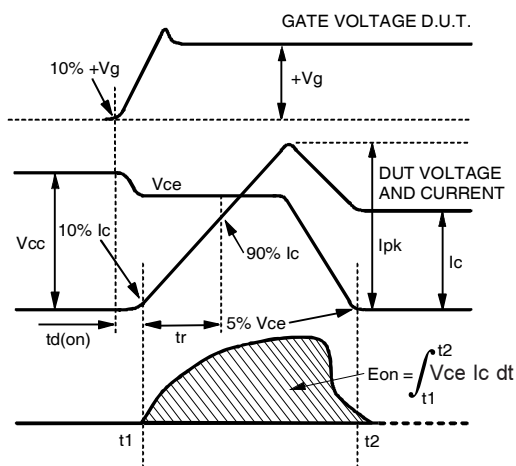


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

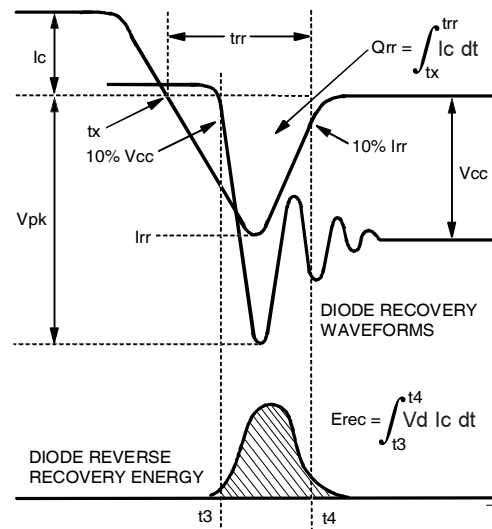


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

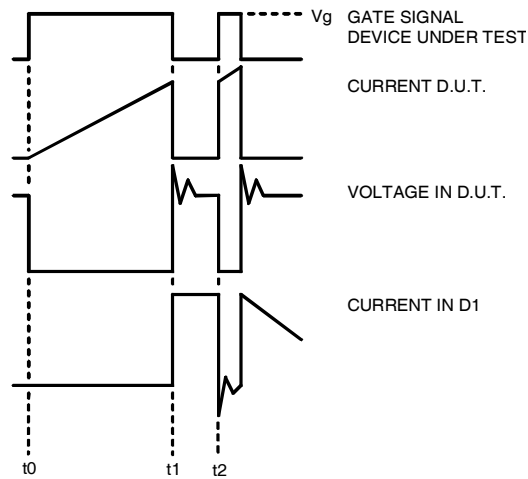


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

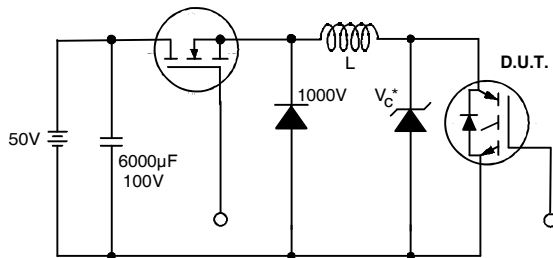


Figure 19. Clamped Inductive Load Test Circuit

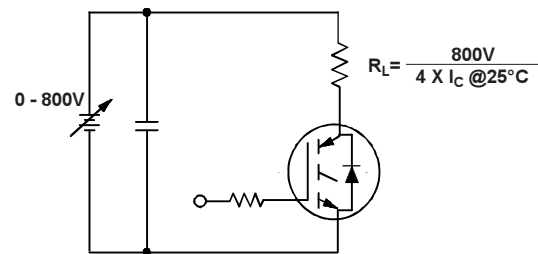


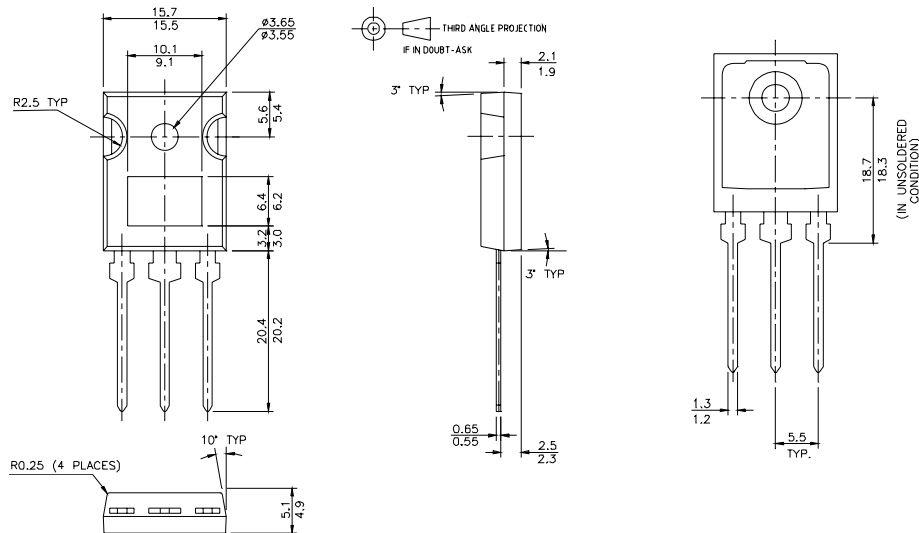
Figure 20. Pulsed Collector Current Test Circuit

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TO-247AD Package Outline

Dimensions are shown in millimeters (inches)

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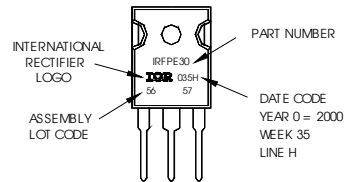


TO-247AD Part Marking Information

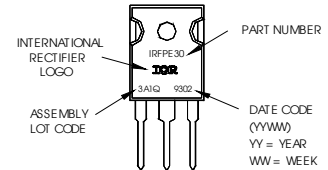
Notes: This part marking information applies to devices produced after 02/26/2001

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

EXAMPLE: THIS IS AN IRFPE30
WITH ASSEMBLY
LOT CODE 5667
ASSEMBLED ON WW35, 2000
IN THE ASSEMBLY LINE "H"



EXAMPLE: THIS IS AN IRFPE30
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-247AD 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.

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