International
IOR Rectifier

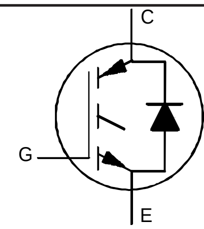
IRG4PH40UD2-E

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



n-channel

$V_{CES} = 1200V$

$V_{CE(on)\,typ.} = 2.43V$

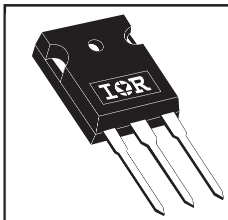
$@V_{GE} = 15V, I_C = 21A$

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



TO-247AD

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	41	A
I_C @ T_C = 100°C	Continuous Collector Current	21	
I_{CM}	Pulse Collector Current ①	82	
I_{LM}	Clamped Inductive Load current ②	82	
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.)

Electrical Characteristics @ T_J = 25°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 = 250µA
$V_{(BR)ECS}$	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/°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°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	—	-11	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
gfe	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°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°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)	—	100	150	nC	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	
t_r	Rise time	—	26	—		I_C = 21A, V_{CC} = 800V
$t_{d(off)}$	Turn-Off delay time	—	100	140		V_{GE} = 15V, R_G = 10Ω
t_f	Fall time	—	200	300		Energy losses include "tail" and
E_{on}	Turn-On Switching Loss	—	1950	—	µJ	diode reverse recovery.
E_{off}	Turn-Off Switching Loss	—	1710	—		See Fig. 9, 10, 11, 18
E_{tot}	Total Switching Loss	—	3660	4490		
$t_{d(on)}$	Turn-On delay time	—	21	—	ns	T_J = 150°C, See Fig. 9, 10, 11, 18
t_r	Rise time	—	25	—		I_C = 21A, V_{CC} = 800V
$t_{d(off)}$	Turn-Off delay time	—	220	—		V_{GE} = 15V, R_G = 10Ω
t_f	Fall time	—	380	—		Energy losses include "tail" and
E_{TS}	Total Switching Loss	—	6220	—	µJ	diode reverse recovery.
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, See Fig.7
C_{res}	Reverse Transfer Capacitance	—	12	—		f = 1.0MHz
t_{rr}	Diode Reverse Recovery Time	—	50	76	ns	T_J=25°C See Fig
		—	72	110		T_J=125°C 14; I_F = 8.0A
I_{rr}	Diode Peak Reverse Recovery Current	—	4.4	7.0	A	T_J=25°C See Fig
		—	5.9	8.8		T_J=125°C 15; V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	130	200	nC	T_J=25°C See Fig
		—	250	380		T_J=125°C 16; di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	210	—	A/µs	T_J=25°C See Fig
		—	180	—		T_J=125°C 17

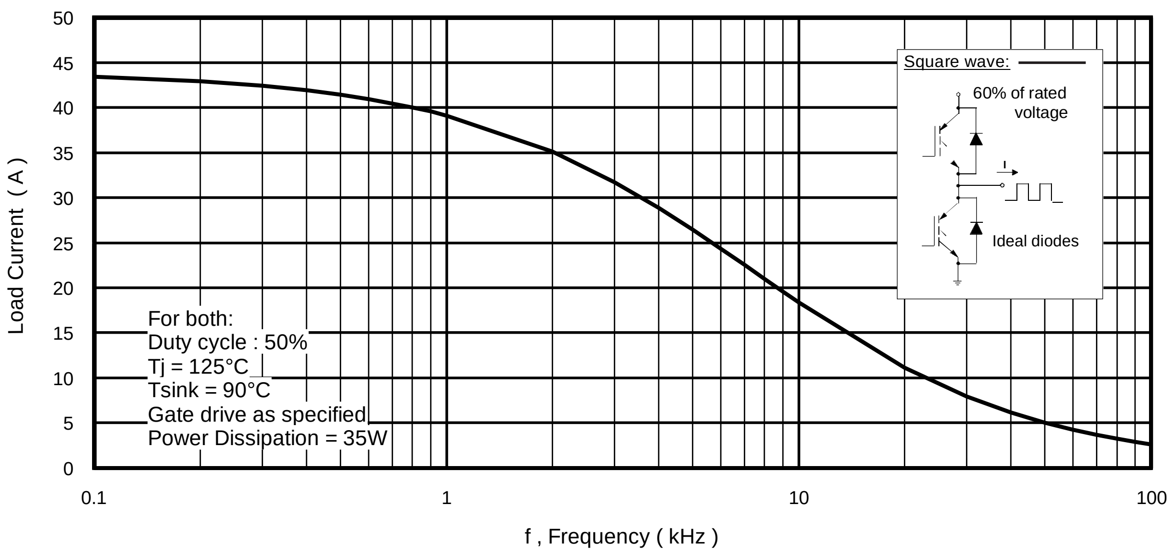


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

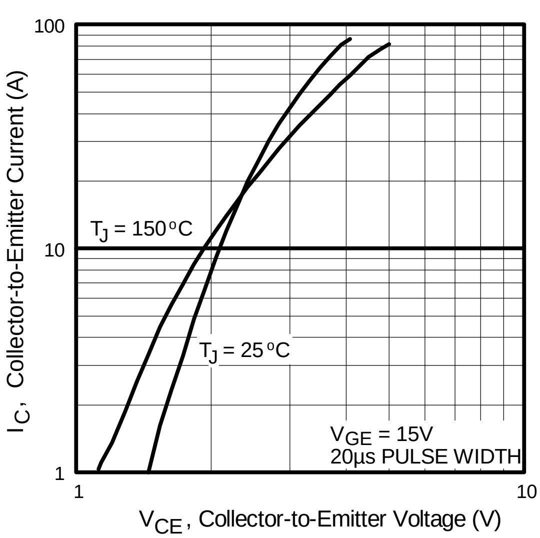


Fig. 2 - Typical Output Characteristics

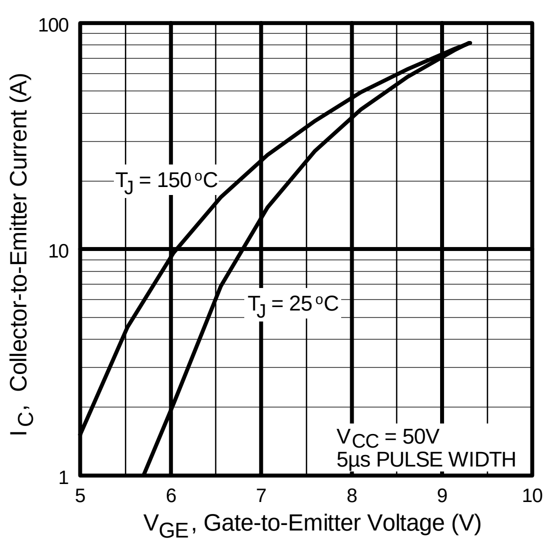


Fig. 3 - Typical Transfer Characteristics

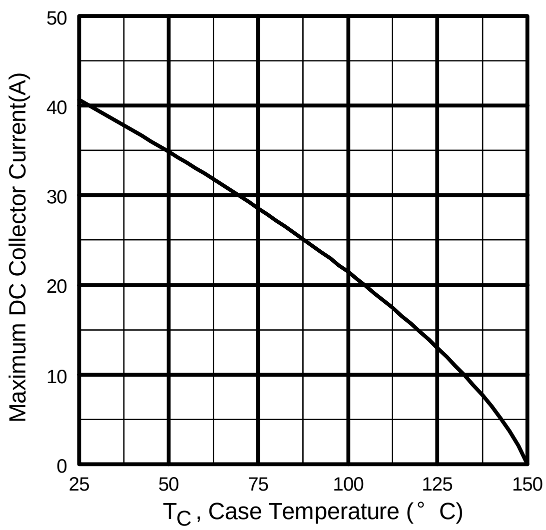


Fig. 4 - Maximum Collector Current vs. Case Temperature

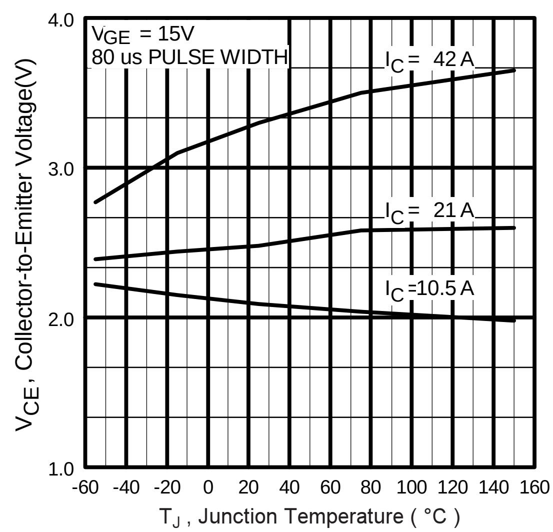


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

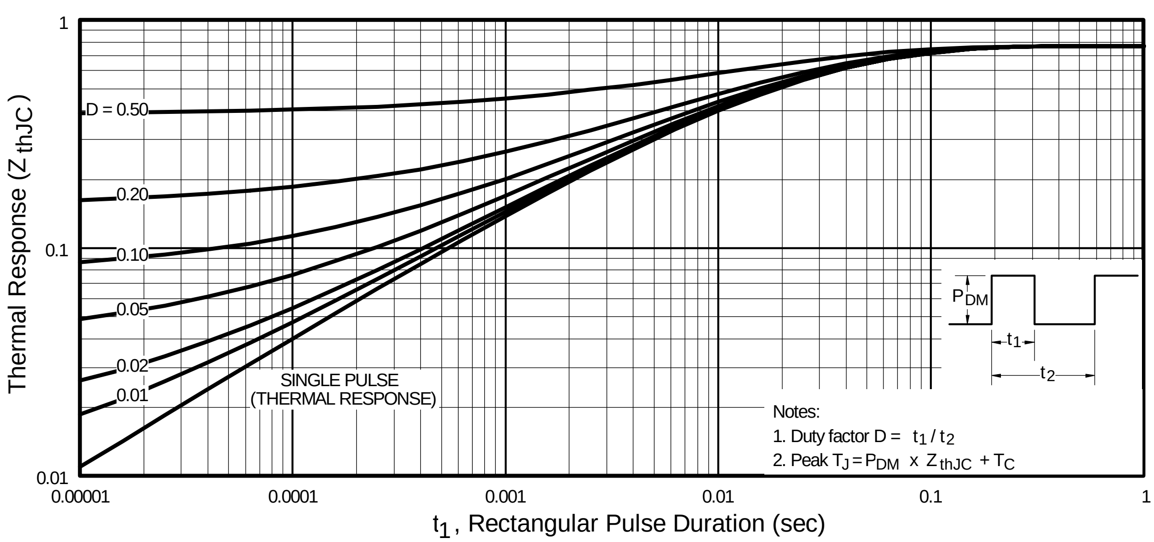


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

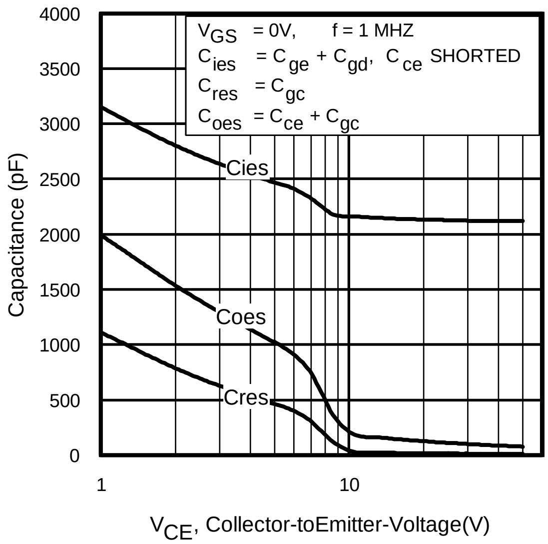


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

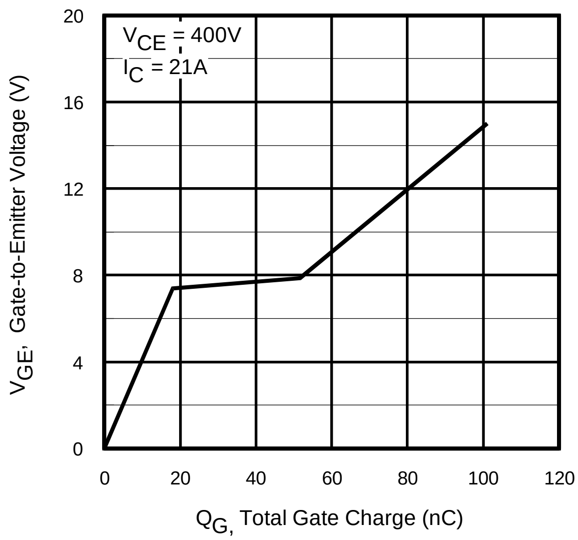


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

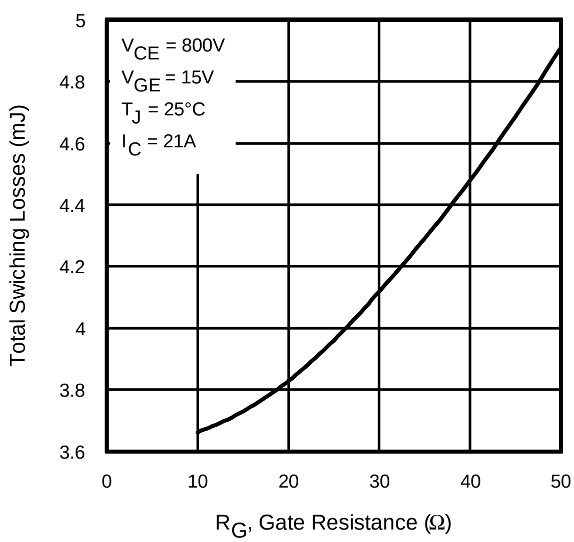


Fig. 9 - Typical Switching Losses vs. Gate Resistance

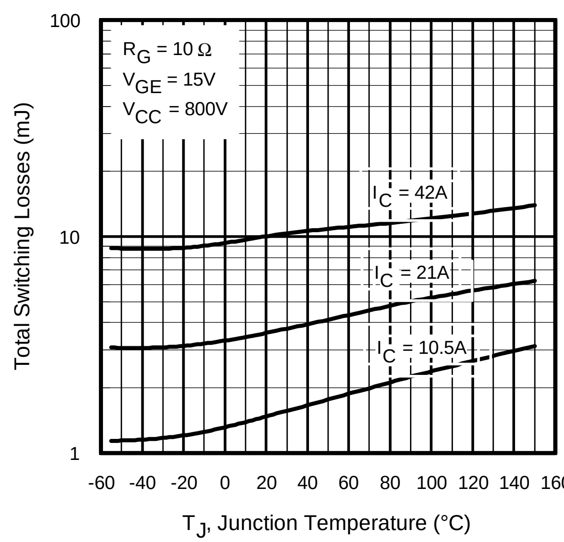


Fig. 10 - Typical Switching Losses vs. Junction Temperature

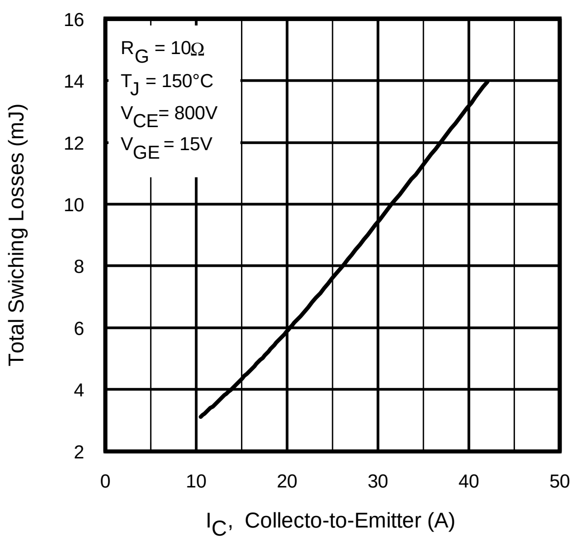


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

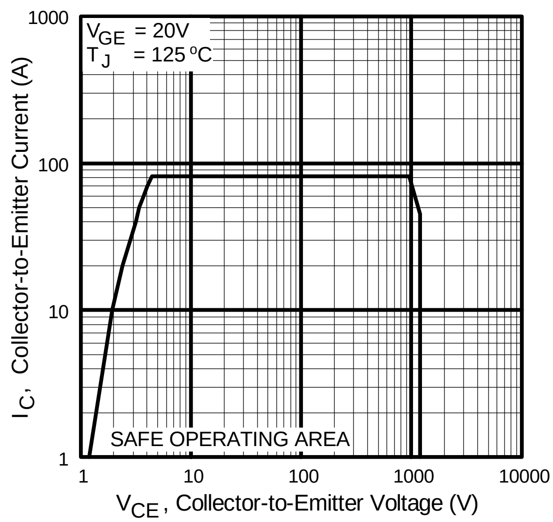


Fig. 12 - Turn-Off SOA

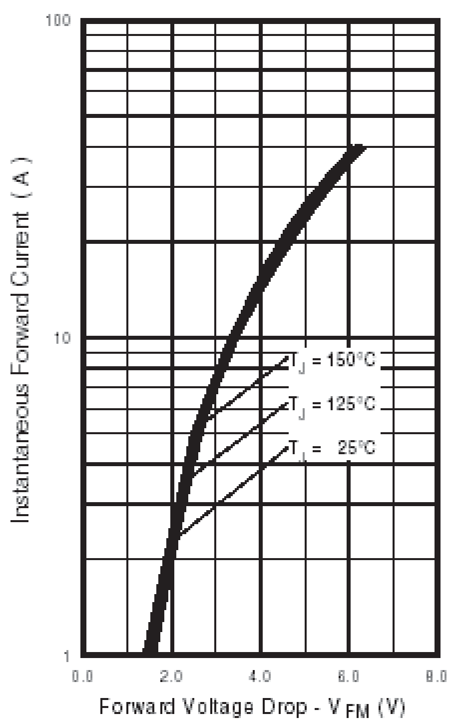


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

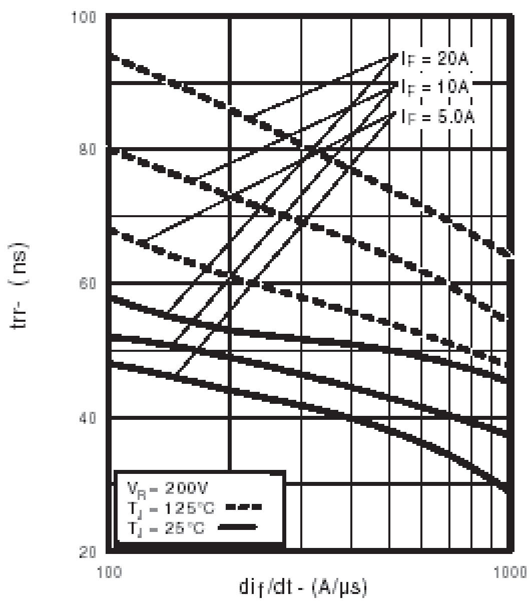


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

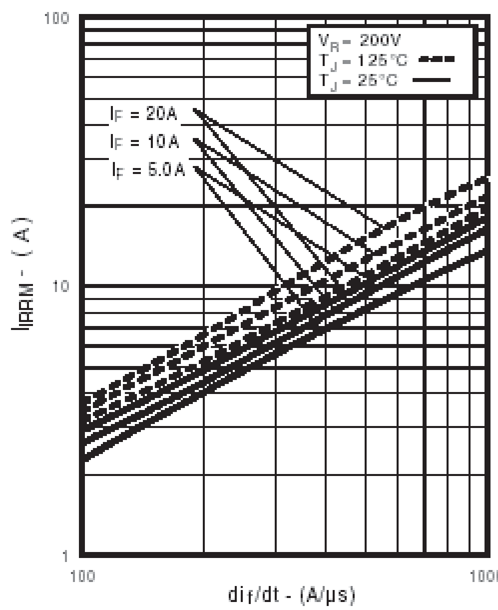


Fig. 15 - Typical Recovery Current vs. di_f/dt

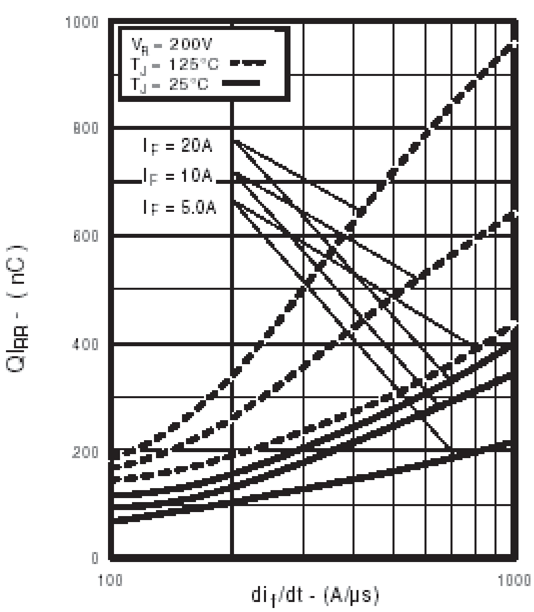


Fig. 16 - Typical Stored Charge vs. di_f/dt

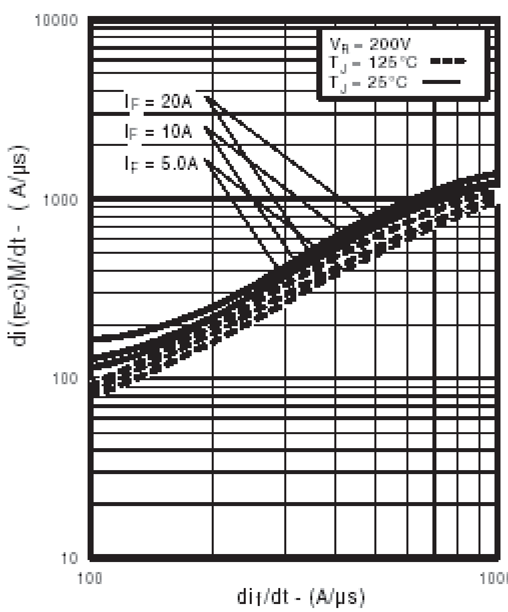


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

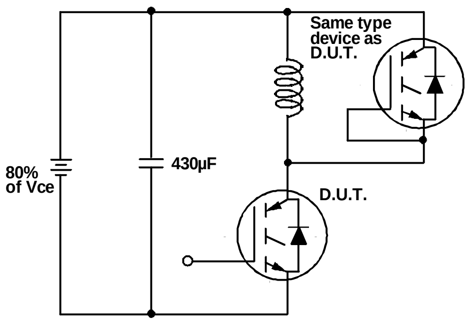


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

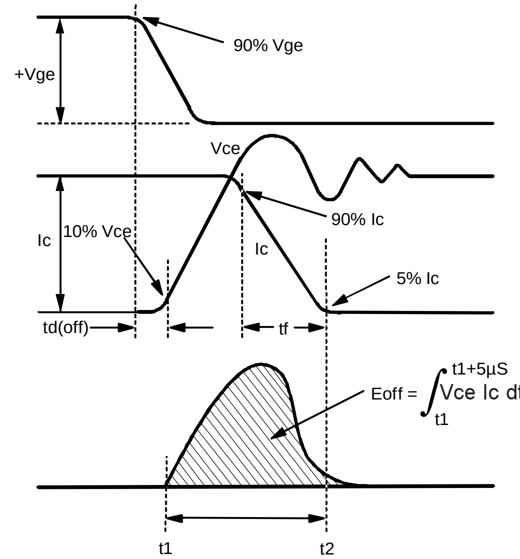


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

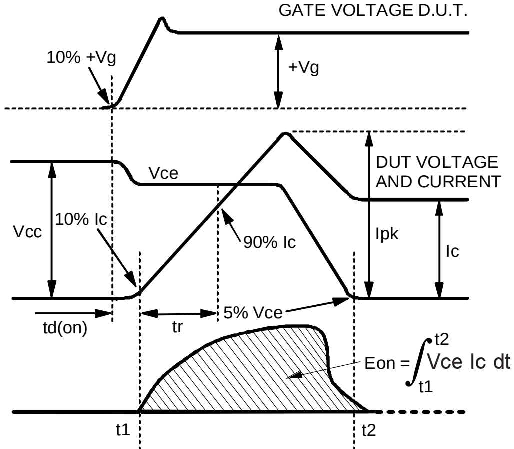


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

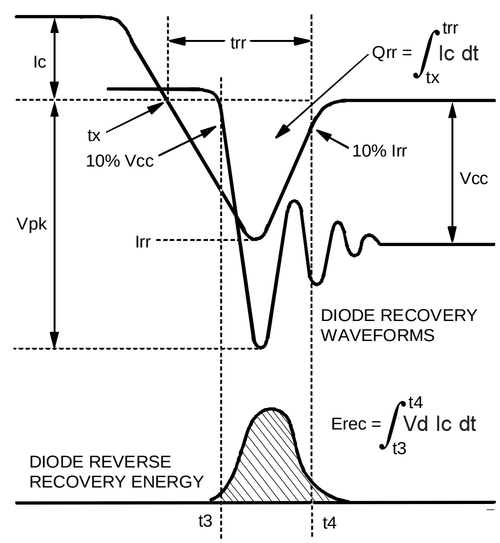


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

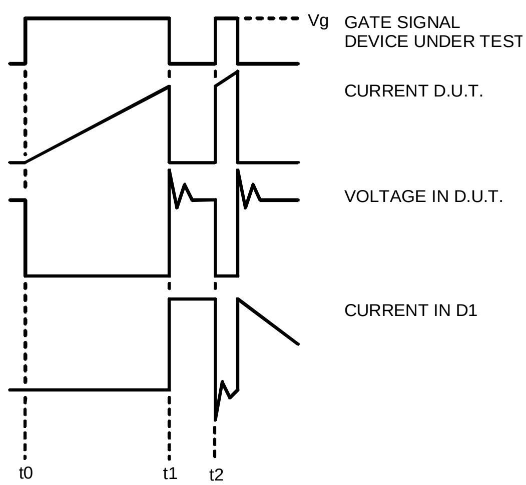


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

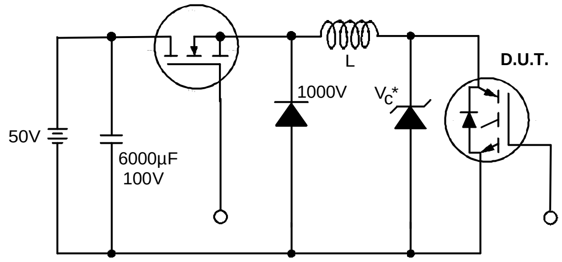


Figure 19. Clamped Inductive Load Test Circuit

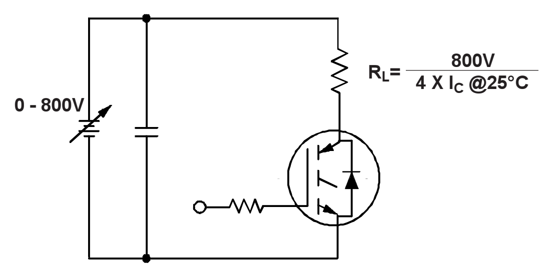
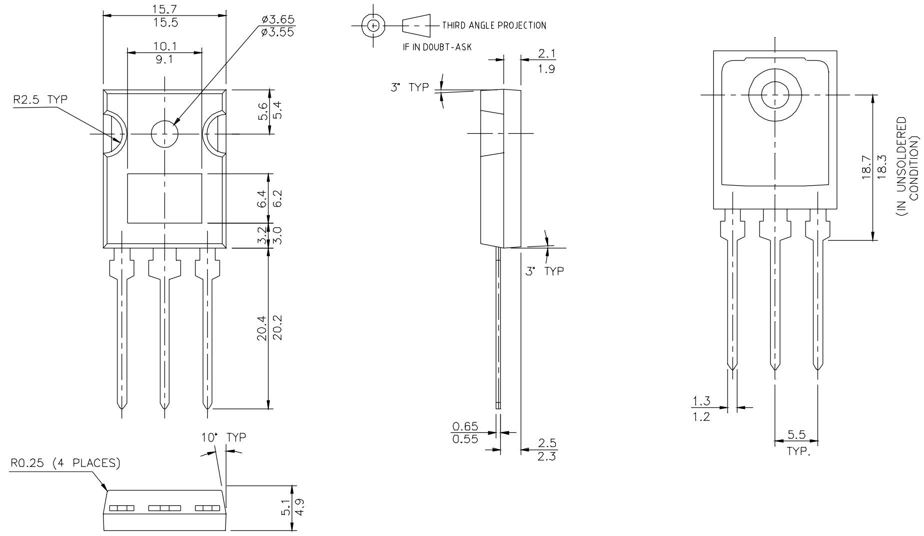


Figure 20. Pulsed Collector Current Test Circuit

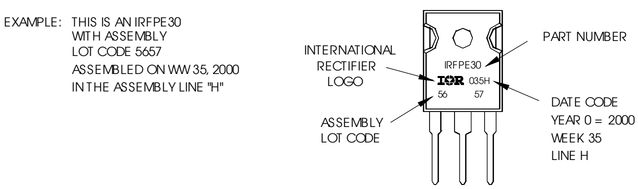
TO-247AD Package Outline

Dimensions are shown in millimeters (inches)

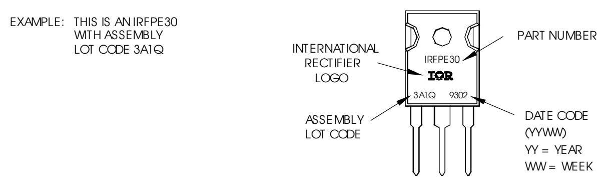


TO-247AD Part Marking Information

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.



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.

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

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