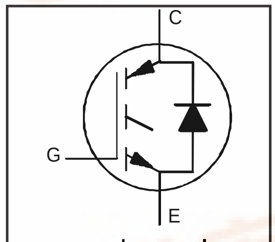
PD - 95239

International
IOR Rectifier

IRG4PH40UD2-EP

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast CoPack IGBT



$V_{CES} = 1200V$

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

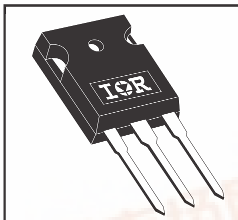
$@V_{GE} = 15V, I_C = 21A$

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
- Lead-Free

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


TO-247AD

Applications

- Induction cooking systems
- Microwave Ovens
- Resonant Circuits

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.)

7/27/04

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	—	210	—	A/µs	T_J=25°C	See Fig	
	During t_b	—	180	—		T_J=125°C	17	

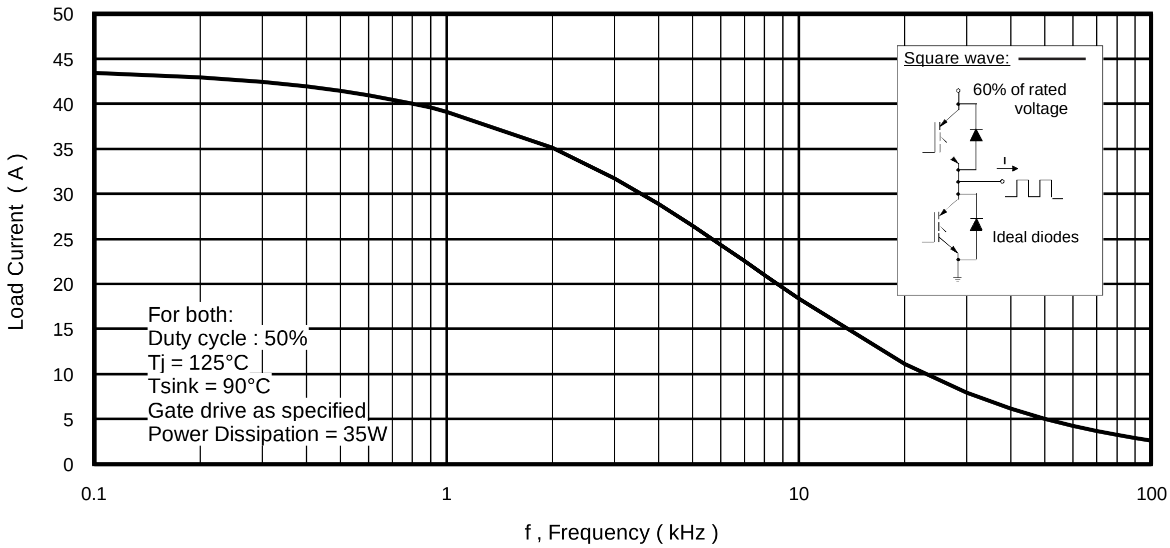


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

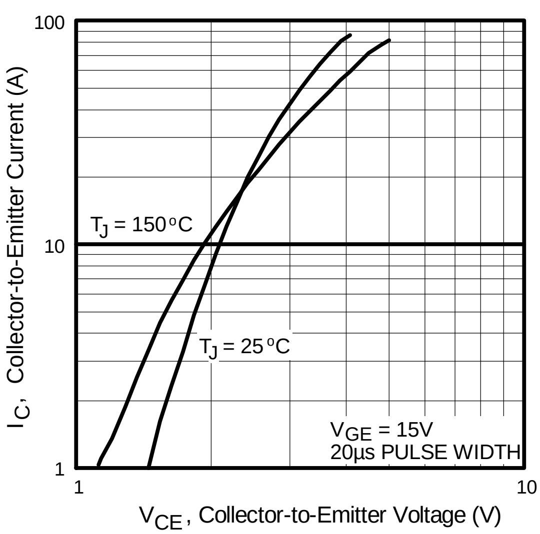


Fig. 2 - Typical Output Characteristics

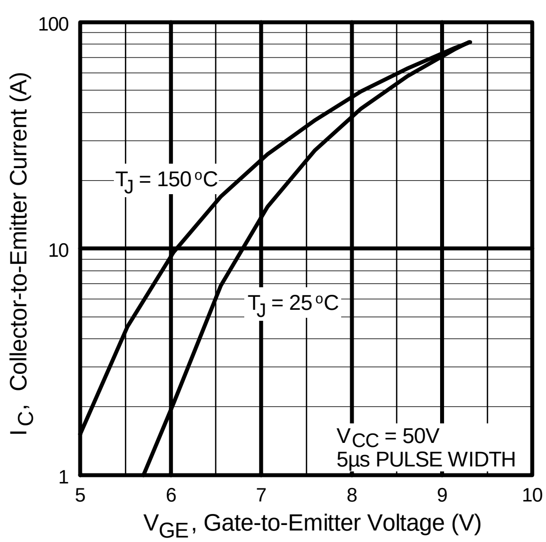


Fig. 3 - Typical Transfer Characteristics

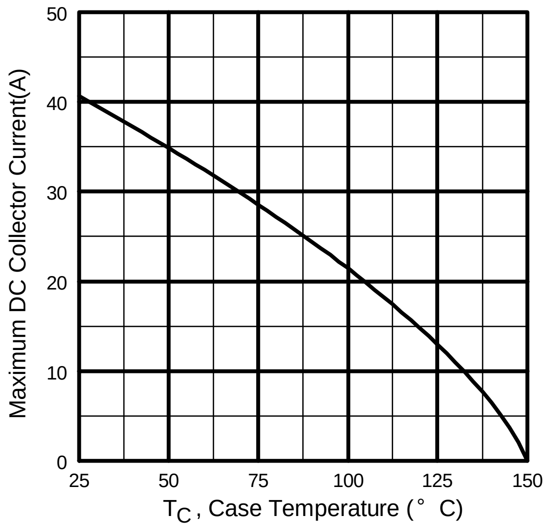


Fig. 4 - Maximum Collector Current vs. Case Temperature

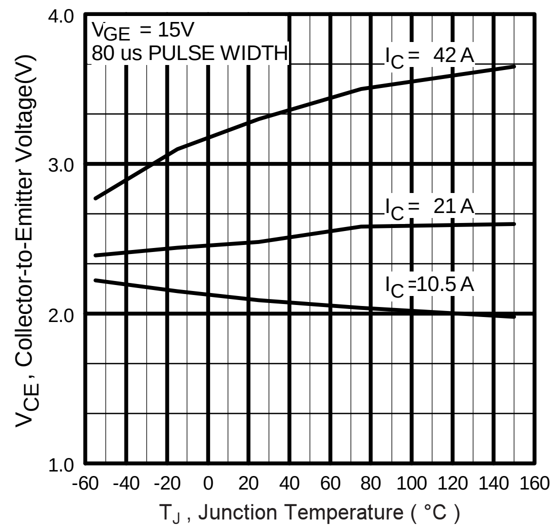


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

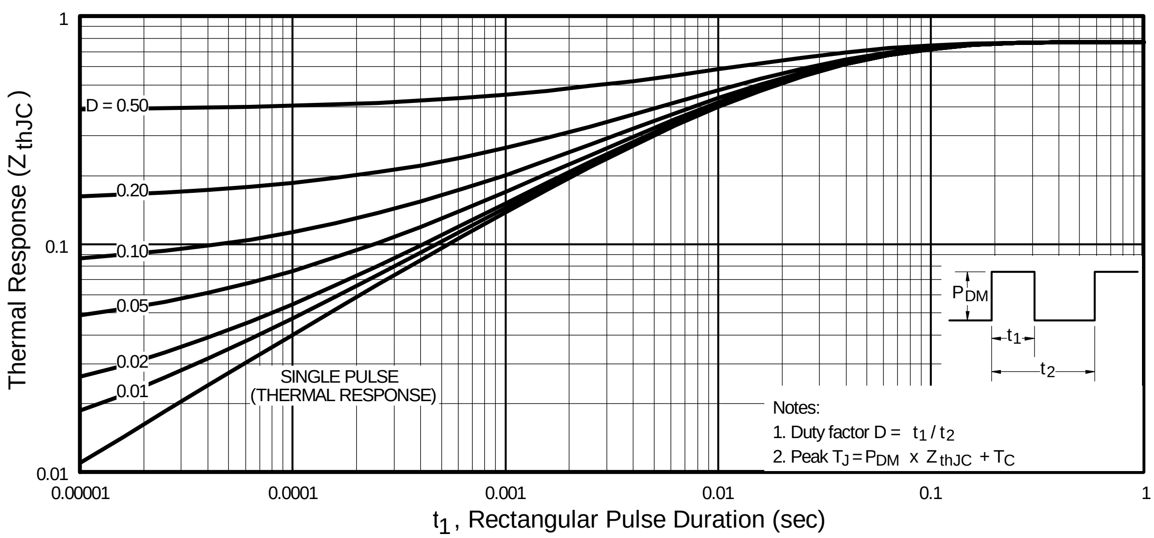


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

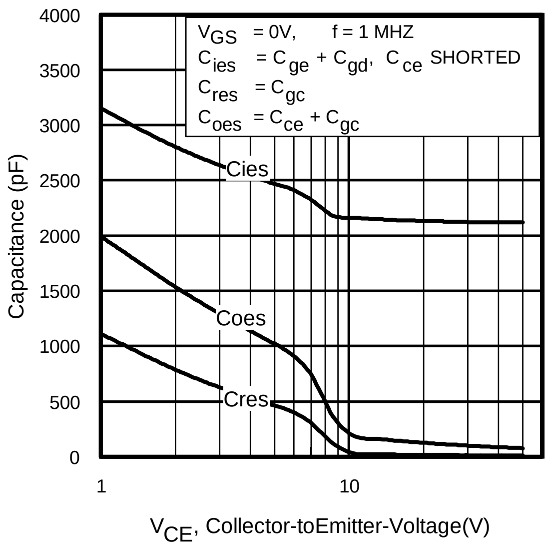


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

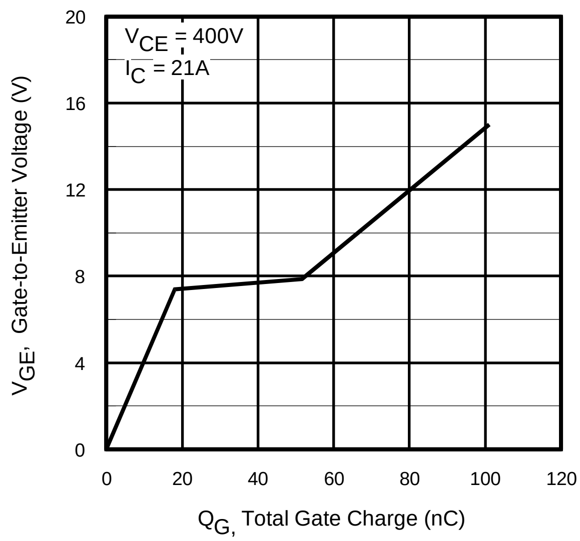


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

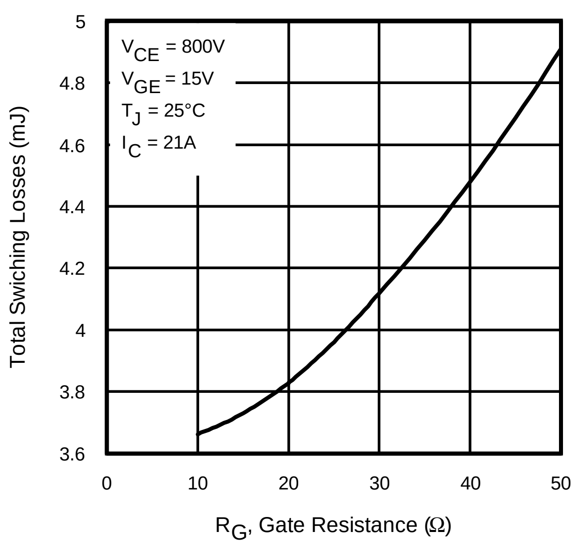


Fig. 9 - Typical Switching Losses vs. Gate Resistance

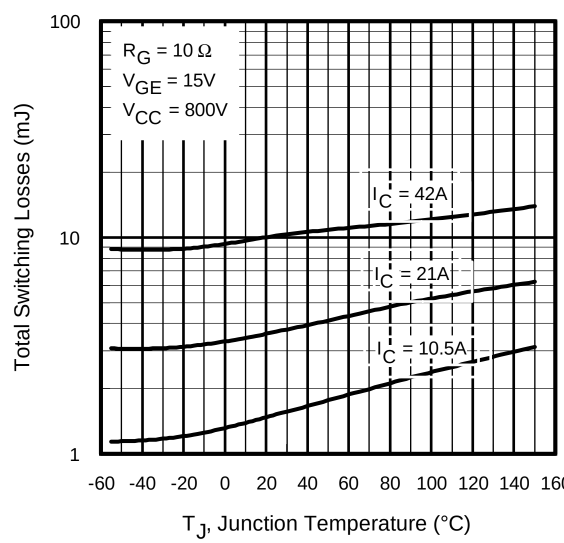


Fig. 10 - Typical Switching Losses vs. Junction Temperature

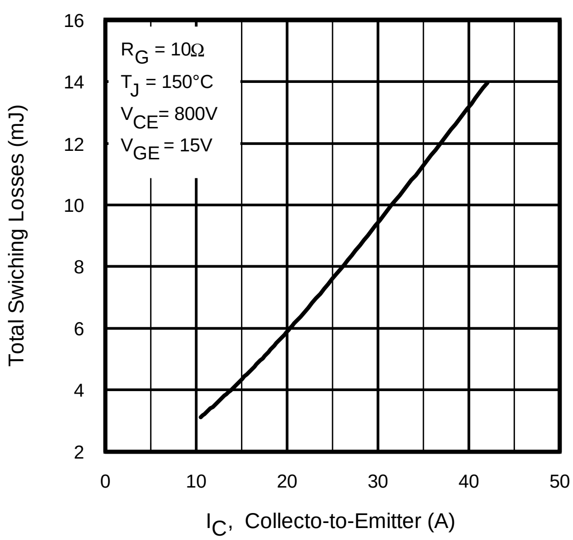


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

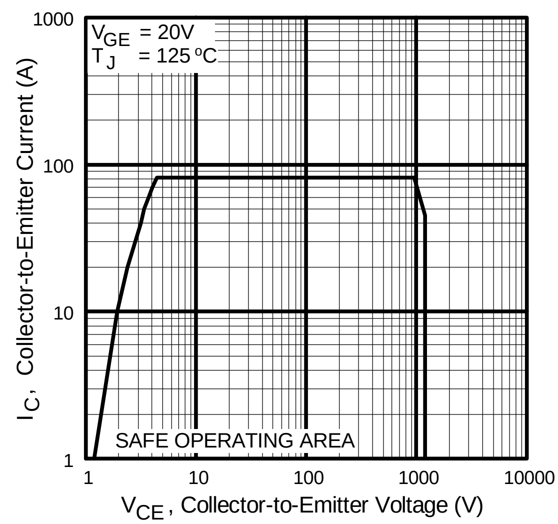


Fig. 12 - Turn-Off SOA

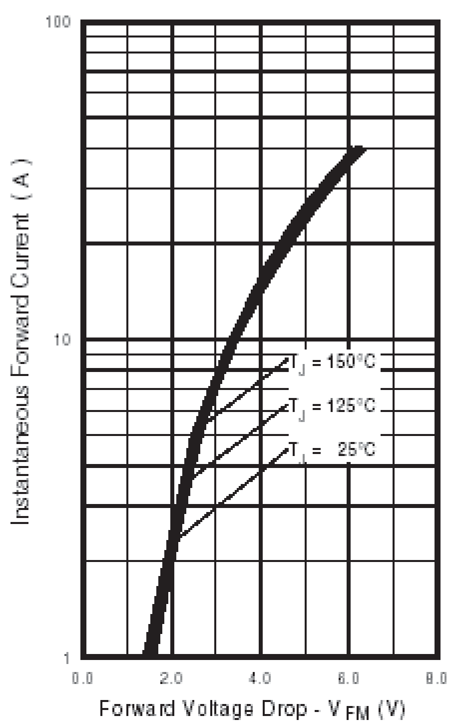


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

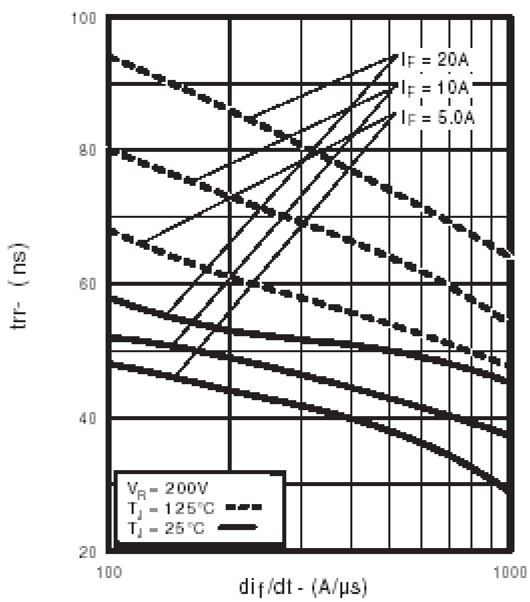


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

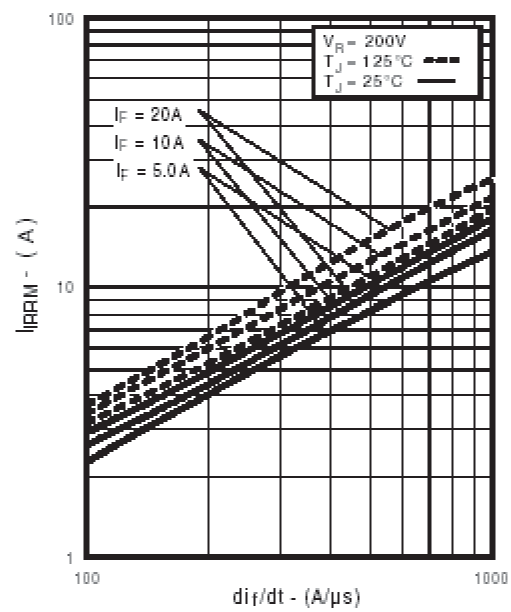


Fig. 15 - Typical Recovery Current vs. di_f/dt

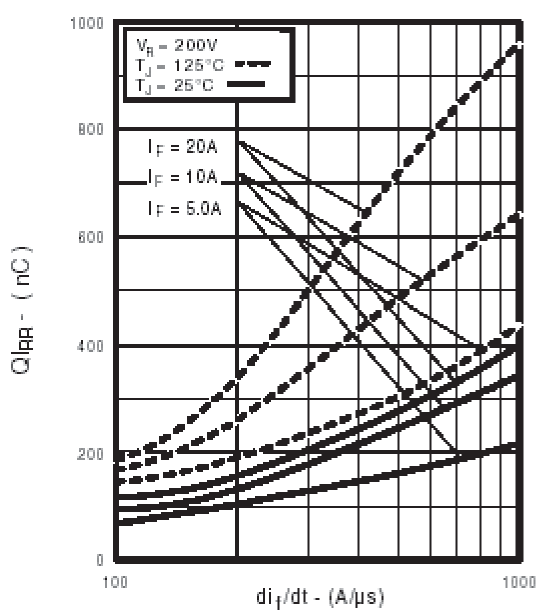


Fig. 16 - Typical Stored Charge vs. di_f/dt

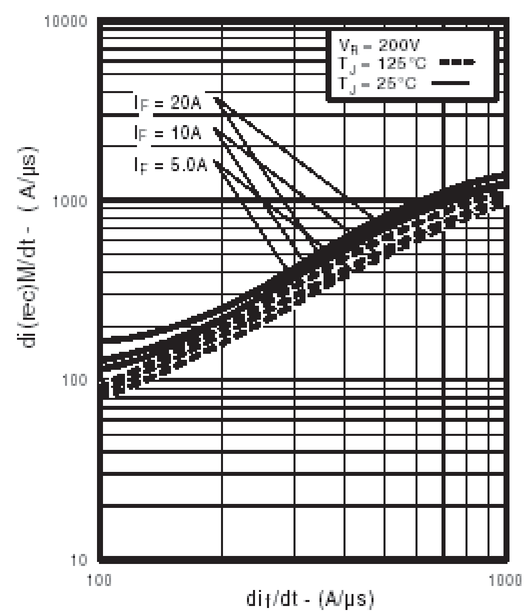


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

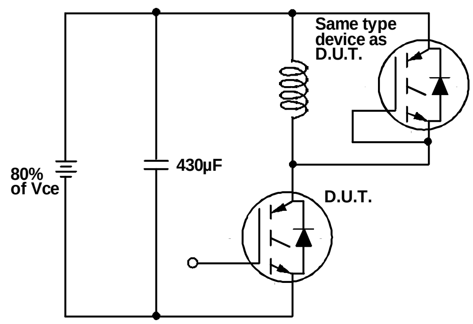


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

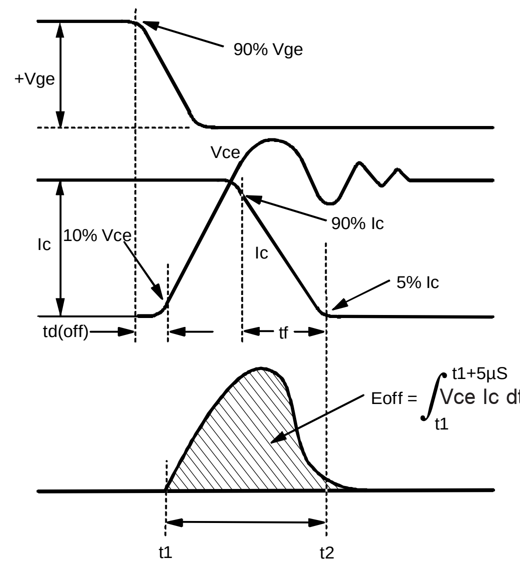


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

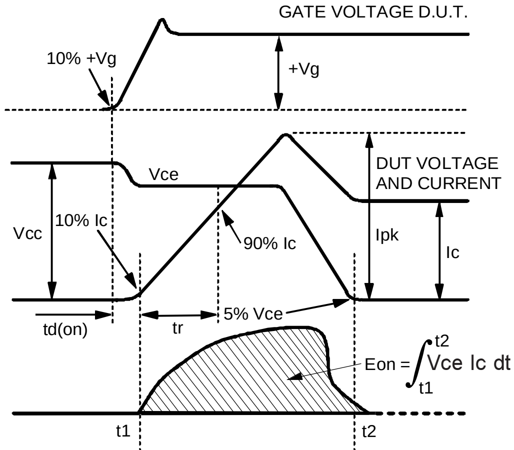


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

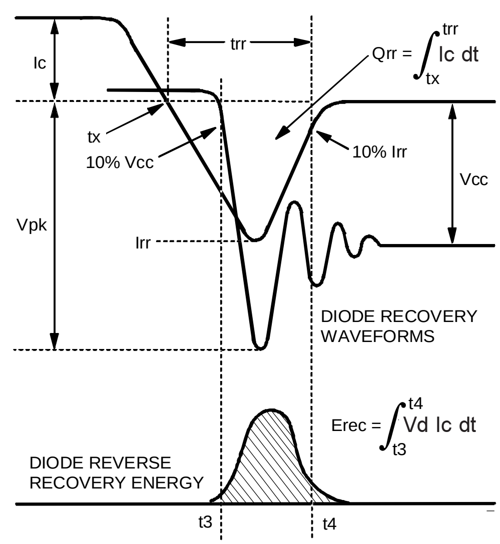


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

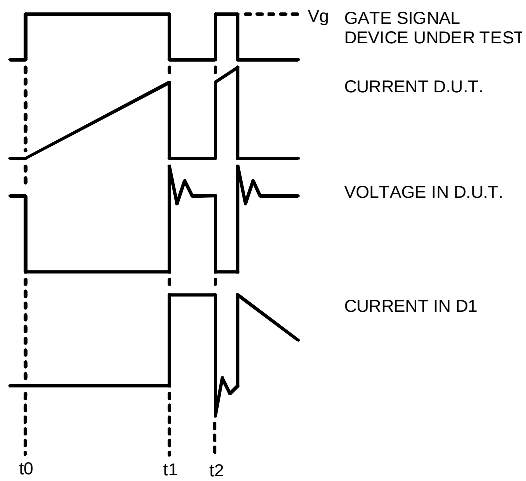


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

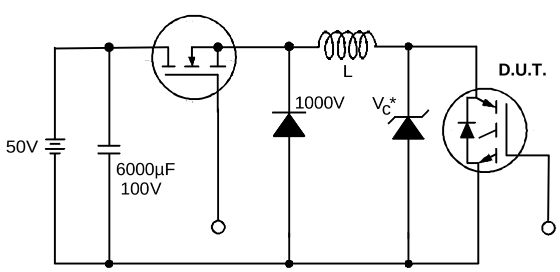


Figure 19. Clamped Inductive Load Test Circuit

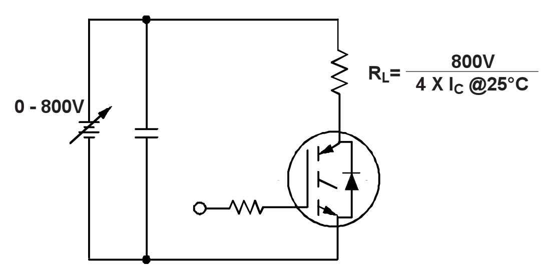


Figure 20. Pulsed Collector Current Test Circuit

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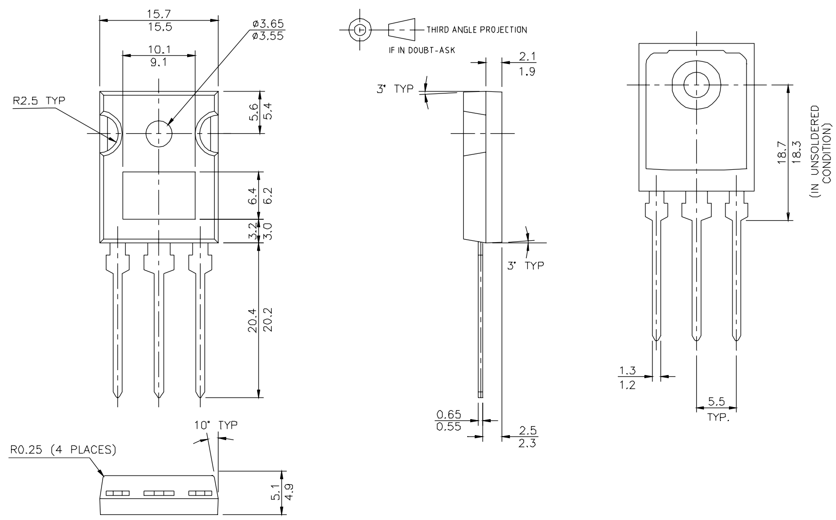
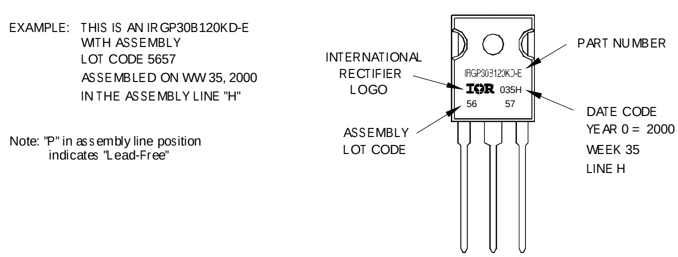
TO-247AD Package Outline

Dimensions are shown in millimeters (inches)



TO-247AD Part Marking Information



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.

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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