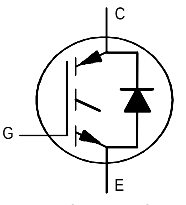
International
IOR Rectifier

IRG4PC50KD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast IGBT

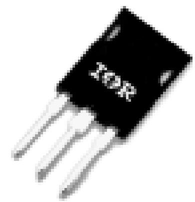


n-channel

V_{CES} = 600V

$V_{CE(on)\ typ.}$ = 1.84V

@V_{GE} = 15V, I_C = 30A


TO-247AC

Features

- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz, and Short Circuit Rated to 10µs @125°C, V_{GE} = 15V
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package

Benefits

- Generation 4 IGBTs offer highest efficiencies available
- HEXFRED diodes optimized for performance with IGBTs. Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBTs

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	52	A
I_C @ T_C = 100°C	Continuous Collector Current	30	
I_{CM}	Pulsed Collector Current ①	104	
I_{LM}	Clamped Inductive Load Current ②	104	
I_F @ T_C = 100°C	Diode Continuous Forward Current	25	
I_{FM}	Diode Maximum Forward Current	280	
t_{sc}	Short Circuit Withstand Time	10	µs
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 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw.	10 lbf•in (1.1 N•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)

12/3/98

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage ③	600	—	—	V	V_{GE} = 0V, I_C = 250µA
$DV_{(BR)CES}/DT_J$	Temperature Coeff. of Breakdown Voltage	—	0.47	—	V/°C	V_{GE} = 0V, I_C = 1.0mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.84	2.2	V	I_C = 30A; V_{GE} = 15V
		—	2.19	—		I_C = 52A; see figures 2, 5
		—	1.79	—		I_C = 25A, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA
$DV_{GE(th)}/DT_J$	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
g_{fe}	Forward Transconductance ④	17	24	—	S	V_{CE} = 100V, I_C = 30A
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 600V
		—	—	6500		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	1.3	1.7	V	I_C = 25A; see figure 13
		—	1.2	1.5		I_C = 25A, 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)	—	200	300	nC	I_C = 30A	
Q_{ge}	Gate - Emitter Charge (turn-on)	—	25	38		V_{CC} = 400V see figure 8	
Q_{gc}	Gate - Collector Charge (turn-on)	—	85	127		V_{GE} = 15V	
$t_{d(on)}$	Turn-On Delay Time	—	63	—	ns		
t_r	Rise Time	—	49	—		T_J = 25°C	
$t_{d(off)}$	Turn-Off Delay Time	—	150	220		I_C = 30A, V_{CC} = 480V	
t_f	Fall Time	—	95	140		V_{GE} = 15V, R_G = 5.0W	
E_{on}	Turn-On Switching Loss	—	1.61	—	mJ	Energy losses include "tail"	
E_{off}	Turn-Off Switching Loss	—	0.84	—		and diode reverse recovery	
E_{ts}	Total Switching Loss	—	2.45	3.0		see figures 9,10,18	
t_{sc}	Short Circuit Withstand Time	10	—	—	µs	V_{CC} = 360V, T_J = 125°C V_{GE} = 15V, R_G = 10W , V_{CPK} < 500V	
$t_{d(on)}$	Turn-On Delay Time	—	61	—	ns	T_J = 150°C, see figures 11,18	
t_r	Rise Time	—	46	—		I_C = 30A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	—	310	—		V_{GE} = 15V, R_G = 5.0W	
t_f	Fall Time	—	170	—		Energy losses include "tail"	
E_{ts}	Total Switching Loss	—	3.53	—	mJ	and diode reverse recovery	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	3200	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	370	—		V_{CC} = 30V see figure 7	
C_{res}	Reverse Transfer Capacitance	—	95	—		ƒ = 1.0MHz	
t_{rr}	Diode Reverse Recovery Time	—	50	75	ns	T_J = 25°C see figure	
		—	105	160		T_J = 125°C 14	I_F = 25A
I_{rr}	Diode Peak Reverse Recovery Current	—	4.5	10	A	T_J = 25°C see figure	
		—	8.0	15		T_J = 125°C 15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	112	375	nC	T_J = 25°C see figure	
		—	420	1200		T_J = 125°C 16	di/dt 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	—	250	—	A/µs	T_J = 25°C see figure	
	During t_b	—	160	—		T_J = 125°C 17	

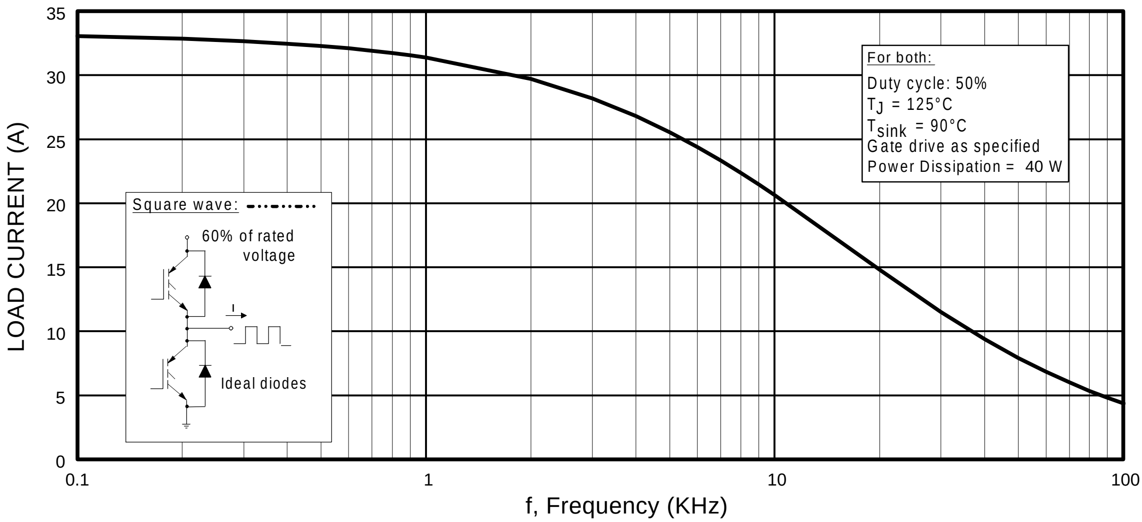


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

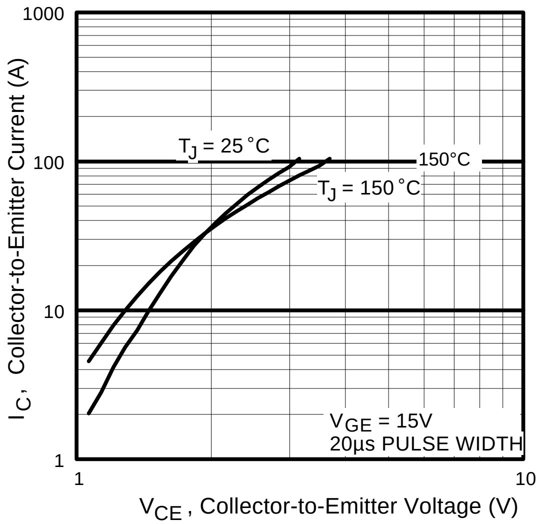


Fig. 2 - Typical Output Characteristics

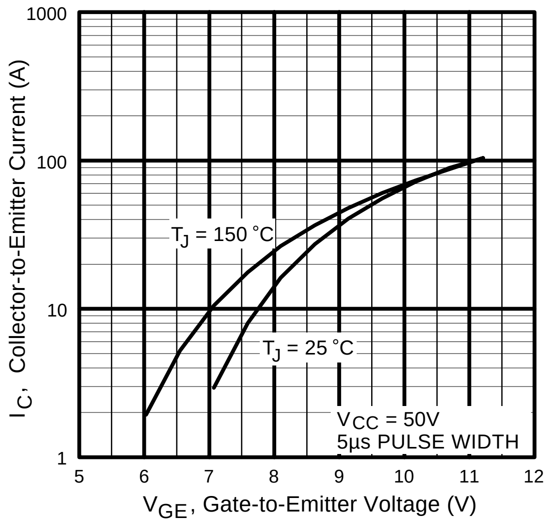


Fig. 3 - Typical Transfer Characteristics

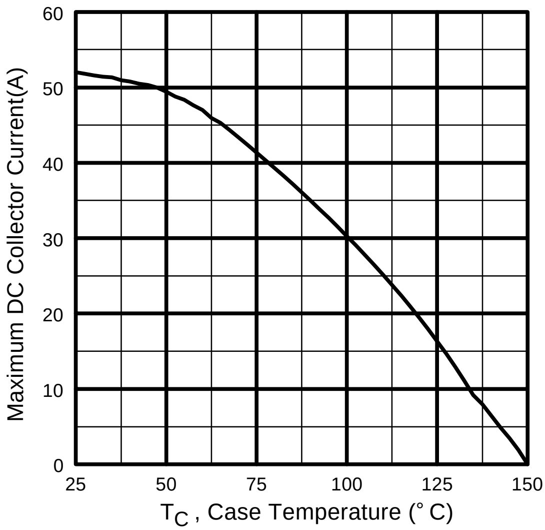


Fig. 4 - Maximum Collector Current vs. Case Temperature

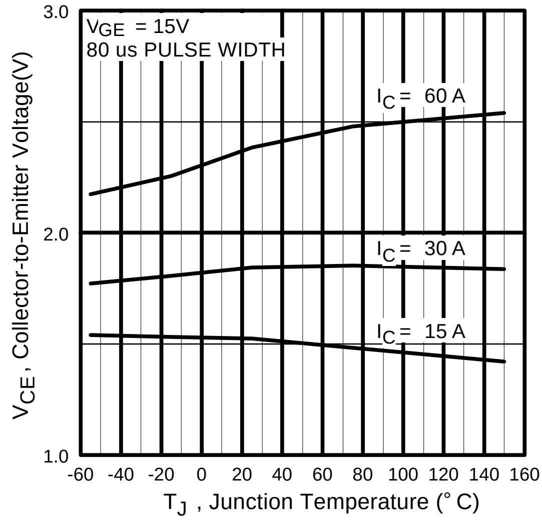


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

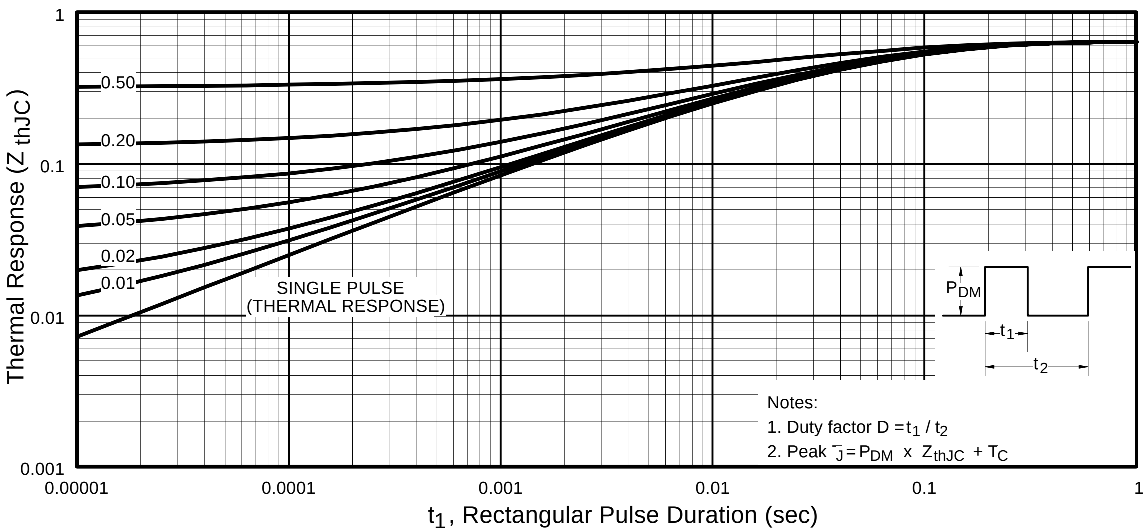


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

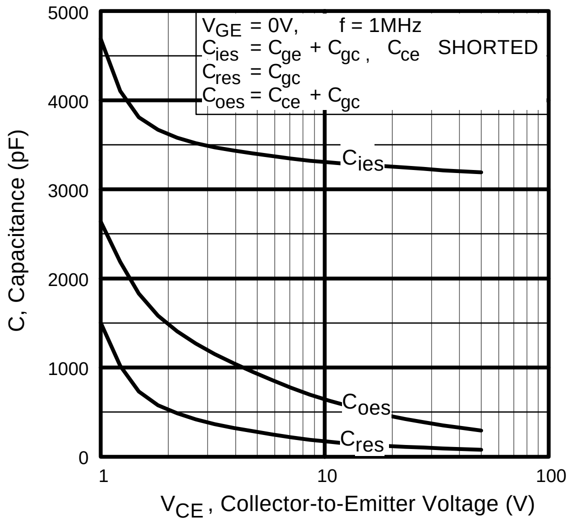


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

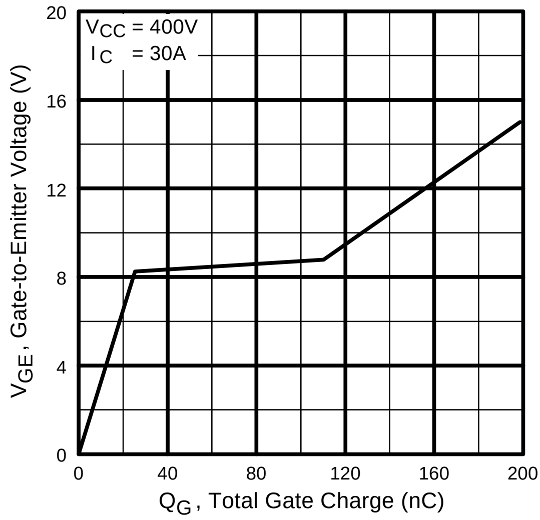


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

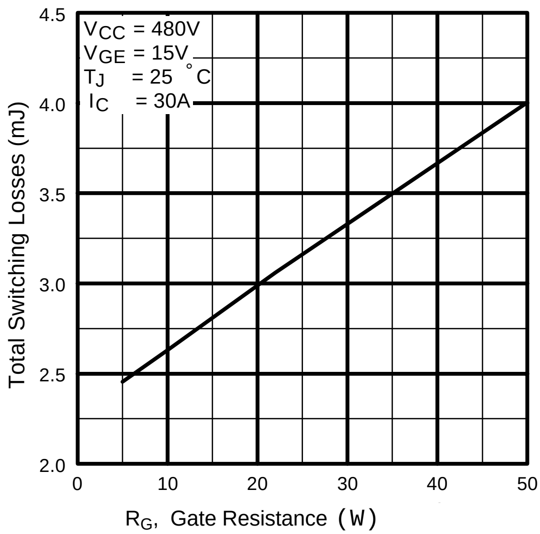


Fig. 9 - Typical Switching Losses vs. Gate Resistance

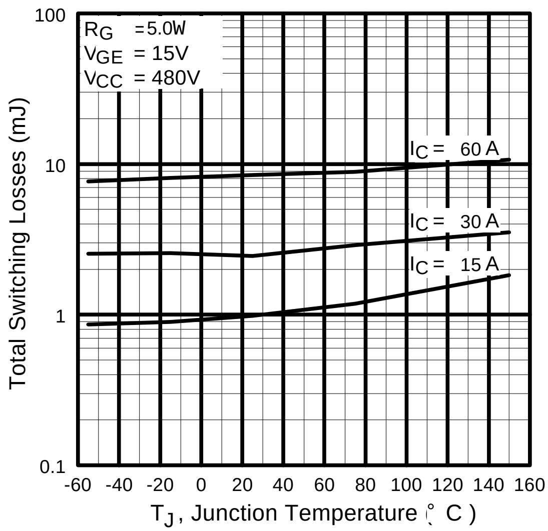


Fig. 10 - Typical Switching Losses vs. Junction Temperature

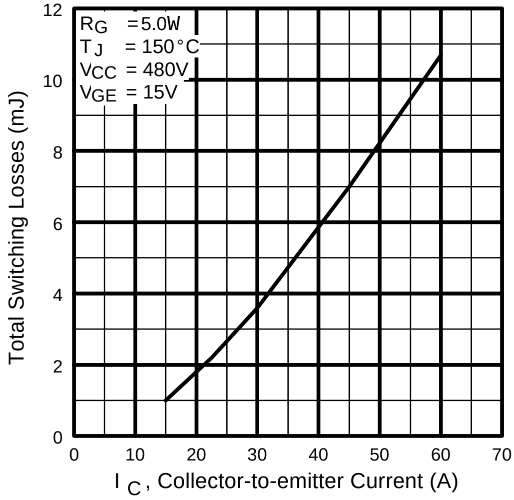


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

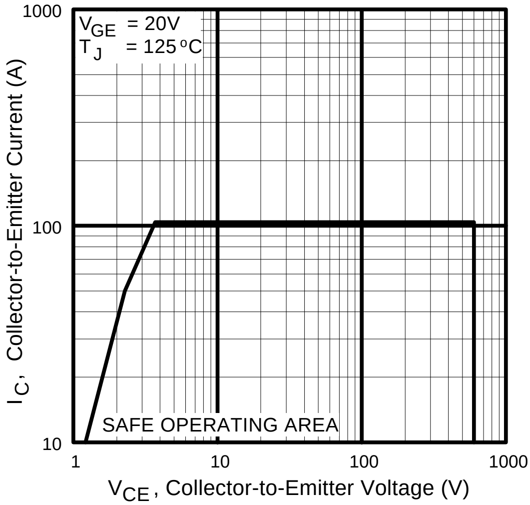


Fig. 12 - Turn-Off SOA

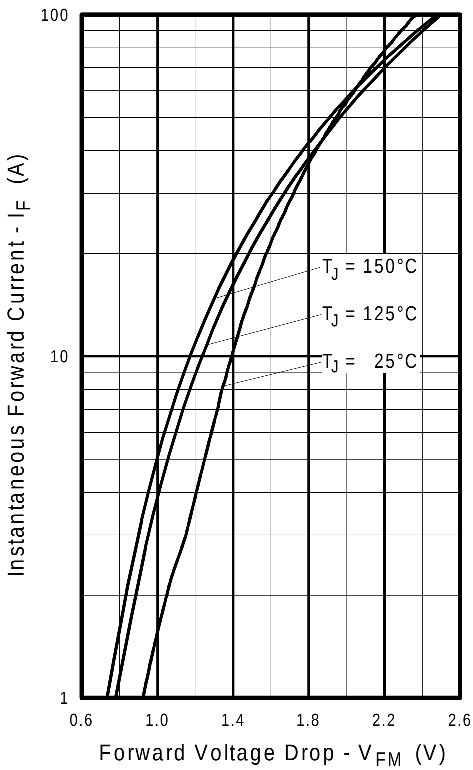


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

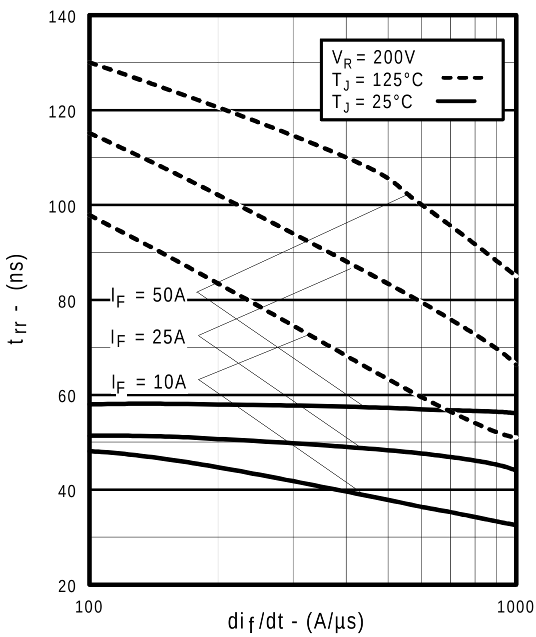


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

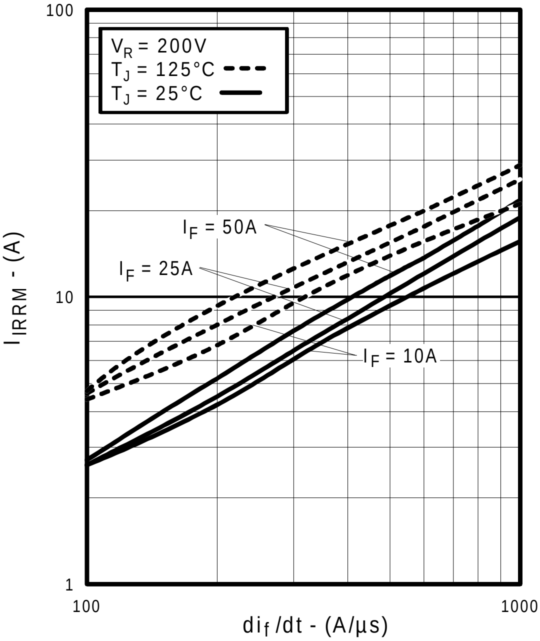


Fig. 15 - Typical Recovery Current vs. di_f/dt

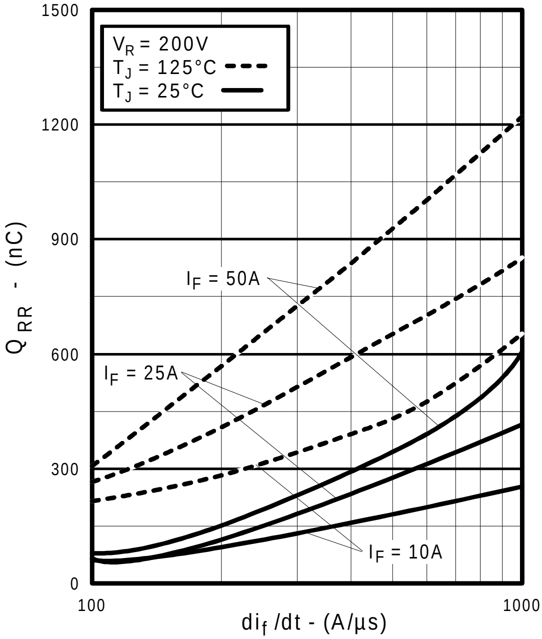


Fig. 16 - Typical Stored Charge vs. di_f/dt

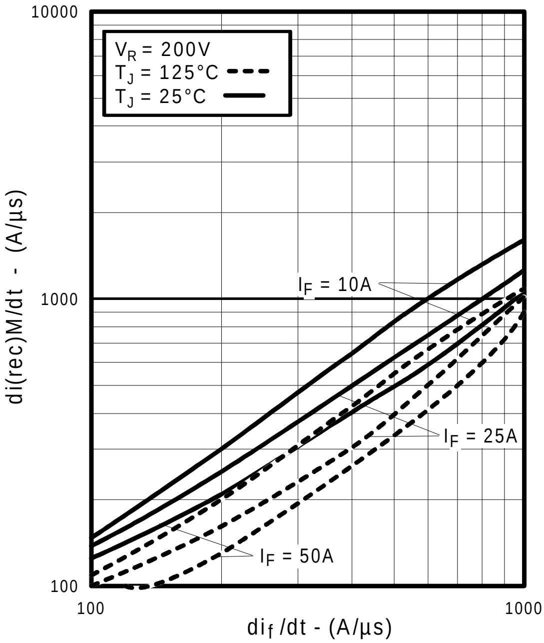


Fig. 17 - Typical $di_{(rec)M}$/dt vs. di_f/dt

Mechanical drawings, Appendix A
Test Circuit diagrams, Appendix B
Switching Loss Waveforms, Appendix C

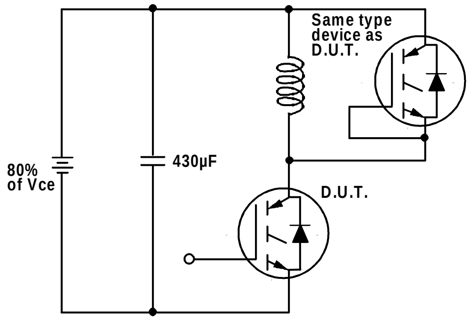


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

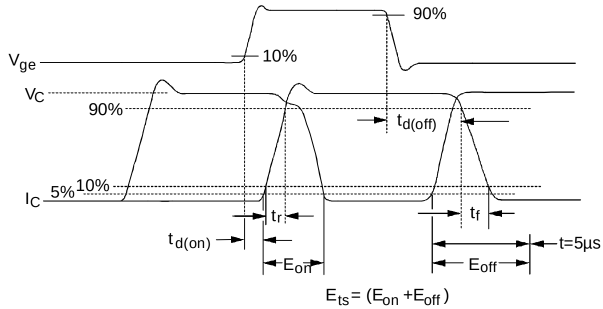


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

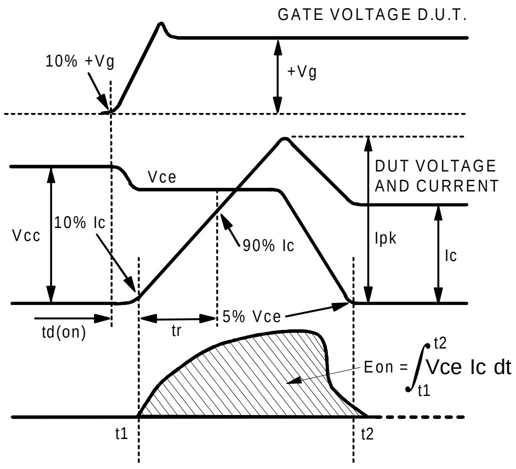


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

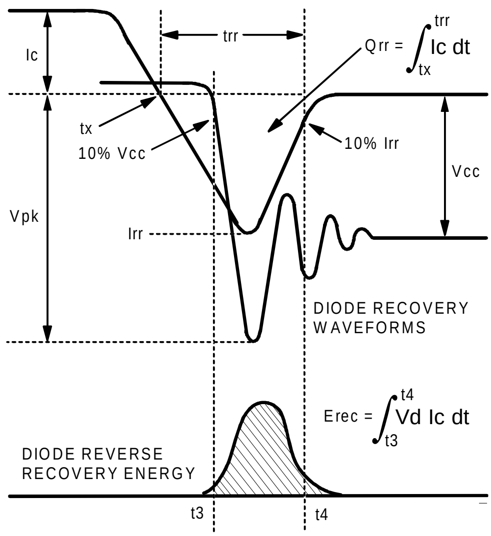


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

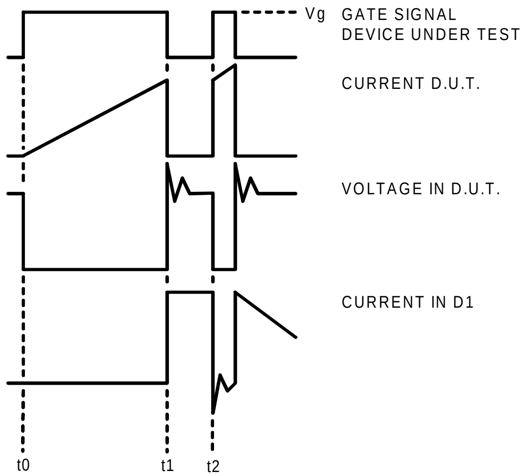


Figure 18e. *Macro Waveforms for Figure 18a's Test Circuit*

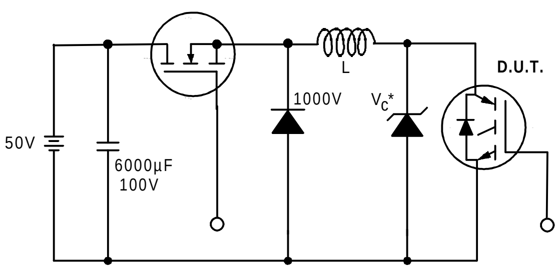


Figure 19. *Clamped Inductive Load Test Circuit*

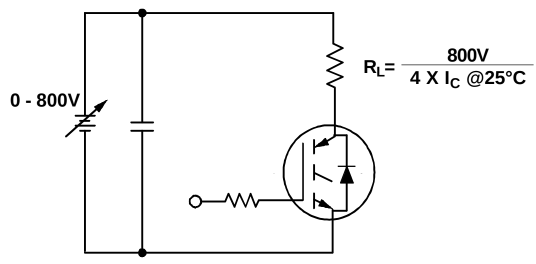


Figure 20. *Pulsed Collector Current Test Circuit*

Notes:

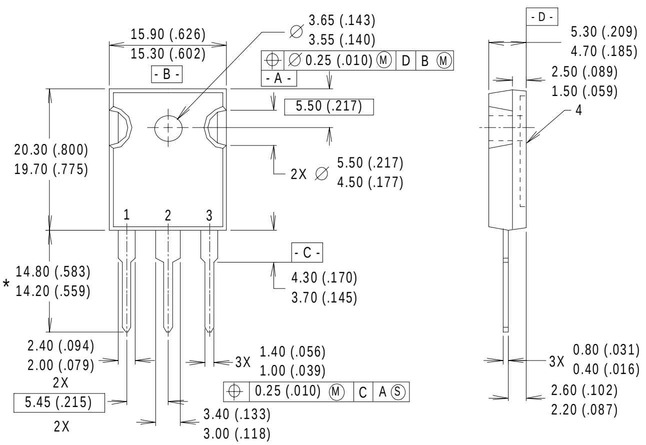
① Repetitive rating: V_{GE}=20V; pulse width limited by maximum junction temperature (figure 20)

② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G = 5.0W (figure 19)

③ Pulse width £ 80µs; duty factor £ 0.1%.

④ Pulse width 5.0µs, single shot.

Case Outline — TO-247AC



NOTES:
1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
4 CONFORMS TO JEDEC OUTLINE TO-247AC.

LEAD ASSIGNMENTS
1 - GATE
2 - COLLECTOR
3 - EMITTER
4 - COLLECTOR

* LONGER LEADED (20mm) VERSION AVAILABLE (TO-247AD) TO ORDER ADD "-E" SUFFIX TO PART NUMBER

CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)
Dimensions in Millimeters and (Inches)

International
IOR Rectifier

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