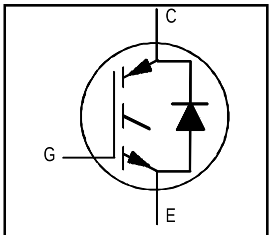
International
IOR Rectifier

IRG4PC40FD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT



V_{CES} = 600V

$V_{CE(on)\,typ.}$ = 1.50V

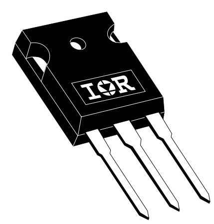
@V_{GE} = 15V, I_C = 27A

Features

- Fast: Optimized for medium operating frequencies (1-5 kHz in hard switching, >20 kHz in resonant mode).
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED^{TM} ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package

Benefits

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



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	49	A
I_C @ T_C = 100°C	Continuous Collector Current	27	
I_{CM}	Pulsed Collector Current ①	200	
I_{LM}	Clamped Inductive Load Current ②	200	
I_F @ T_C = 100°C	Diode Continuous Forward Current	15	
I_{FM}	Diode Maximum Forward Current	200	
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
	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	------	------	0.77	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	------	------	1.7	
$R_{\theta CS}$	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 Voltage③	600	----	----	V	V_{GE} = 0V, I_C = 250µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.70	----	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	1.50	1.7	V	I_C = 27A	V_{GE} = 15V
		----	1.85	----		I_C = 49A	See Fig. 2, 5
		----	1.56	----		I_C = 27A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.0	----	6.0		V_{CE} = V_{GE}, I_C = 250µA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-12	----	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance ④	9.2	12	----	S	V_{CE} = 100V, I_C = 27A	
I_{CES}	Zero Gate Voltage Collector Current	----	----	250	µA	V_{GE} = 0V, V_{CE} = 600V	
		----	----	3500		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	----	1.3	1.7	V	I_C = 15A	See Fig. 13
		----	1.2	1.6		I_C = 15A, 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 = 27A	
Qge	Gate - Emitter Charge (turn-on)	----	15	23		V_{CC} = 400V See Fig. 8	
Q_{gc}	Gate - Collector Charge (turn-on)	----	35	53		V_{GE} = 15V	
$t_{d(on)}$	Turn-On Delay Time	----	63	----	ns	T_J = 25°C	
t_r	Rise Time	----	32	----		I_C = 27A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	----	230	350		V_{GE} = 15V, R_G = 10Ω	
t_f	Fall Time	----	170	250		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	----	0.95	----	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	----	2.01	----		See Fig. 9, 10, 11, 18	
E_{ts}	Total Switching Loss	----	2.96	4.0			
$t_{d(on)}$	Turn-On Delay Time	----	63	----	ns	T_J = 150°C, See Fig. 9, 10, 11, 18	
t_r	Rise Time	----	33	----		I_C = 27A, V_{CC} = 480V	
$t_{d(off)}$	Turn-Off Delay Time	----	350	----		V_{GE} = 15V, R_G = 10Ω	
t_f	Fall Time	----	310	----		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	----	4.7	----	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	----	13	----	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	----	2200	----	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	----	140	----		V_{CC} = 30V See Fig. 7	
C_{res}	Reverse Transfer Capacitance	----	29	----		f = 1.0MHz	
t_{rr}	Diode Reverse Recovery Time	----	42	60	ns	T_J = 25°C See Fig.	
		----	74	120		T_J = 125°C 14	I_F = 15A
I_{rr}	Diode Peak Reverse Recovery Current	----	4.0	6.0	A	T_J = 25°C See Fig.	
		----	6.5	10		T_J = 125°C 15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	----	80	180	nC	T_J = 25°C See Fig.	
		----	220	600		T_J = 125°C 16	di/dt 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery	----	188	----	A/µs	T_J = 25°C See Fig.	
	During t_b	----	160	----		T_J = 125°C 17	

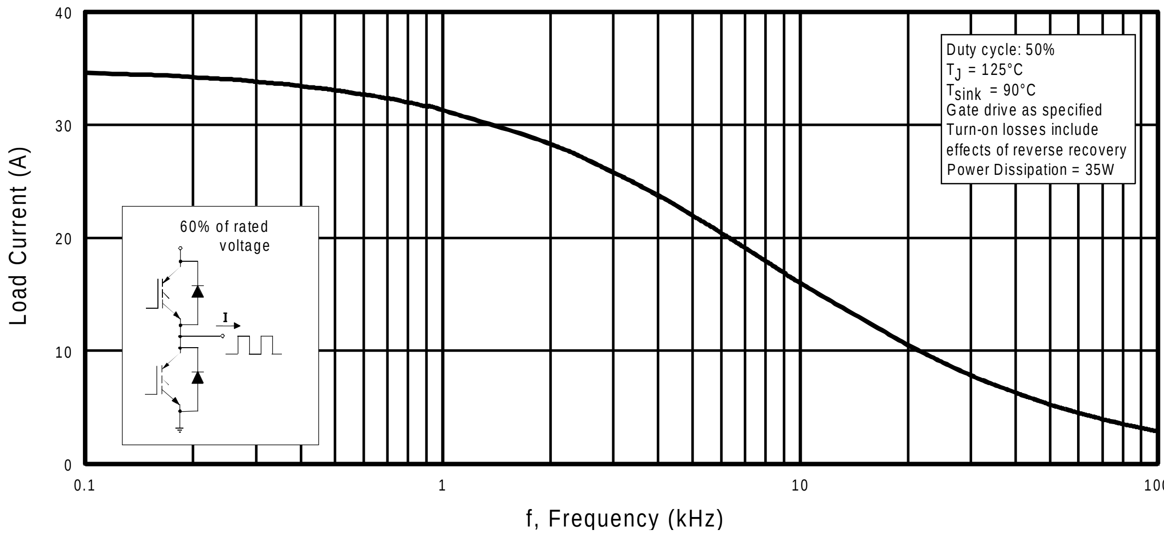


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

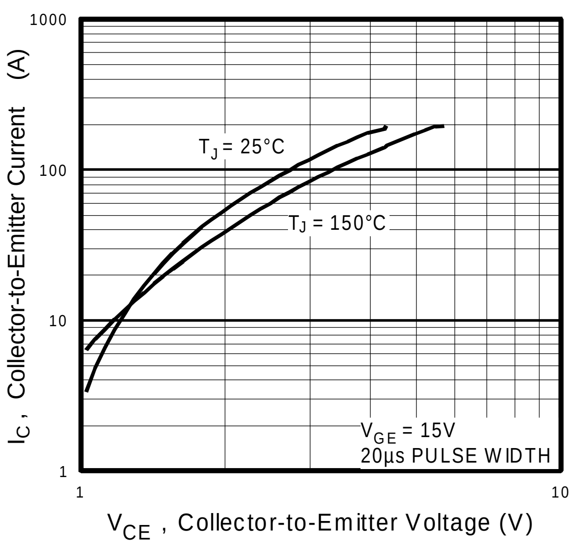


Fig. 2 - Typical Output Characteristics

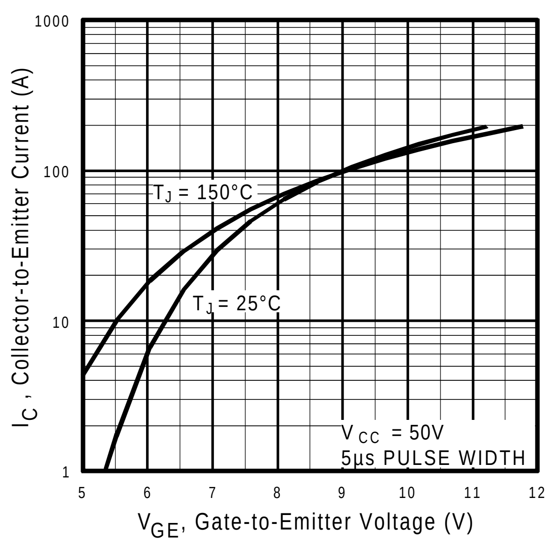


Fig. 3 - Typical Transfer Characteristics

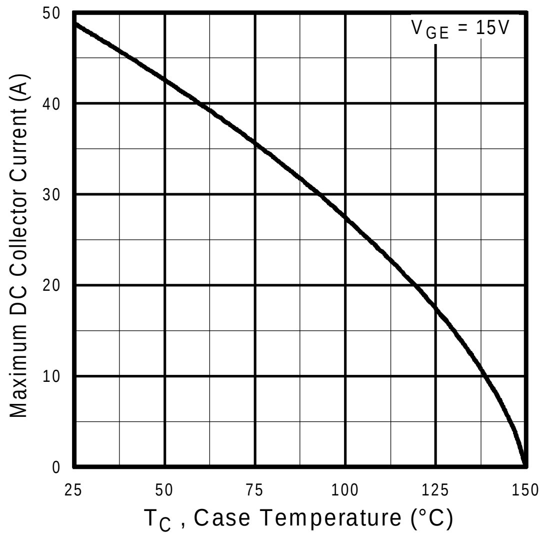


Fig. 4 - Maximum Collector Current vs. Case Temperature

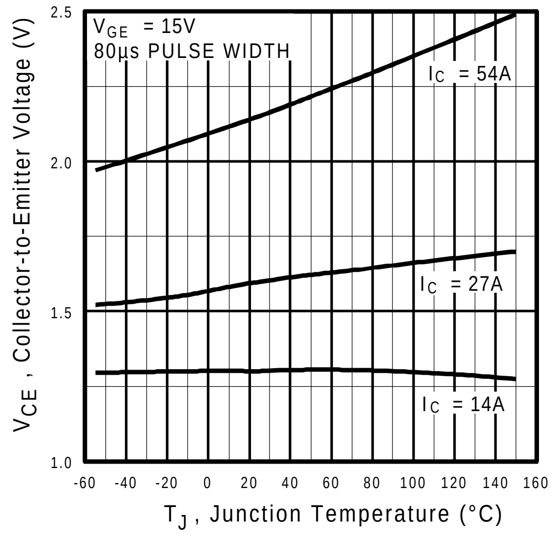


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

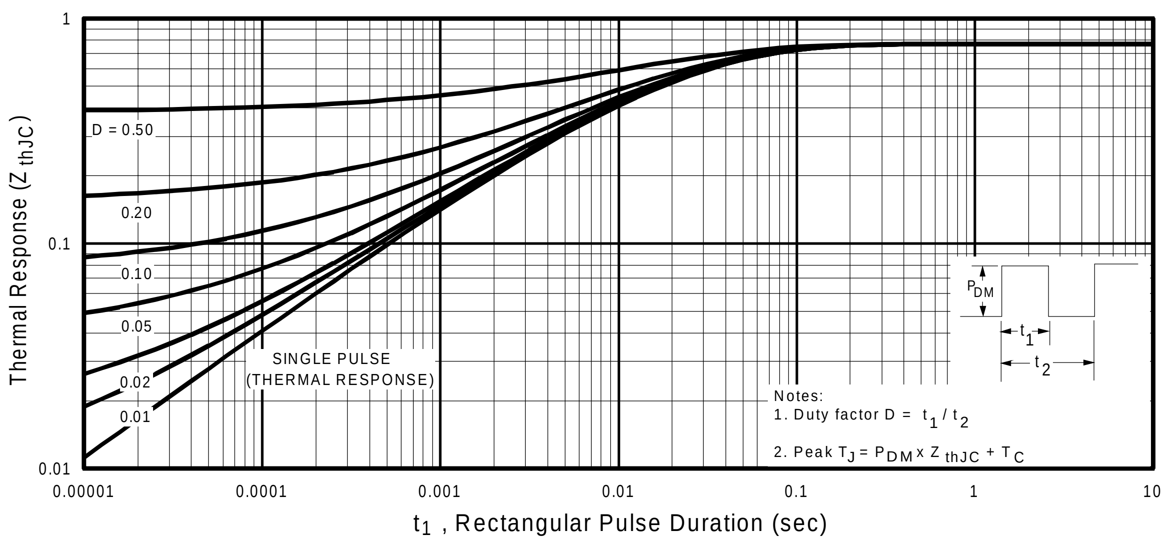


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

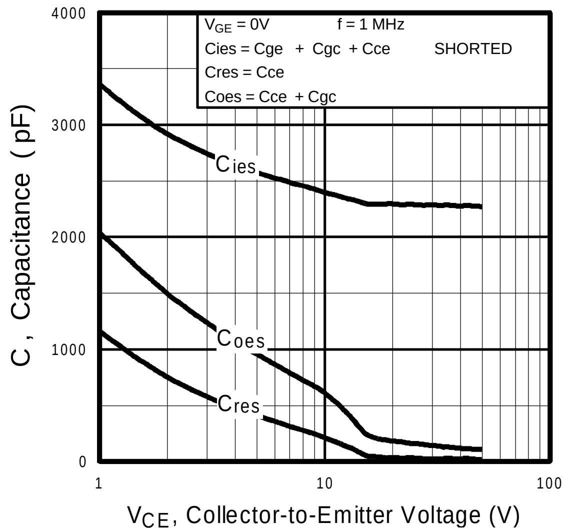


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

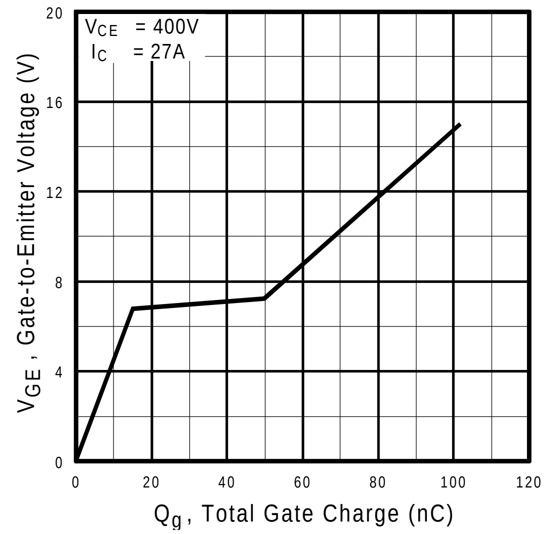


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

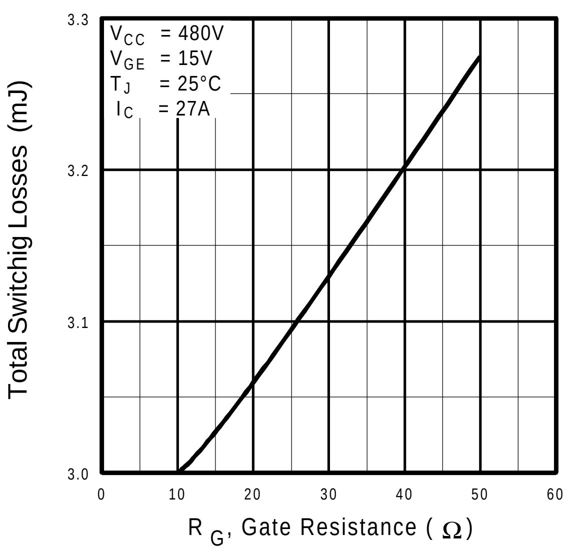


Fig. 9 - Typical Switching Losses vs. Gate Resistance

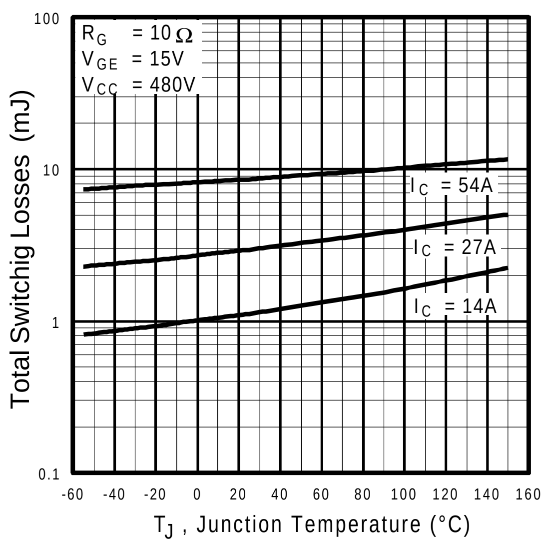


Fig. 10 - Typical Switching Losses vs. Junction Temperature

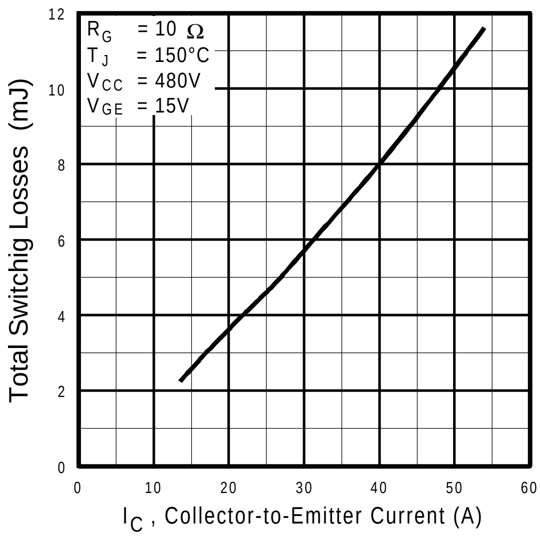


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

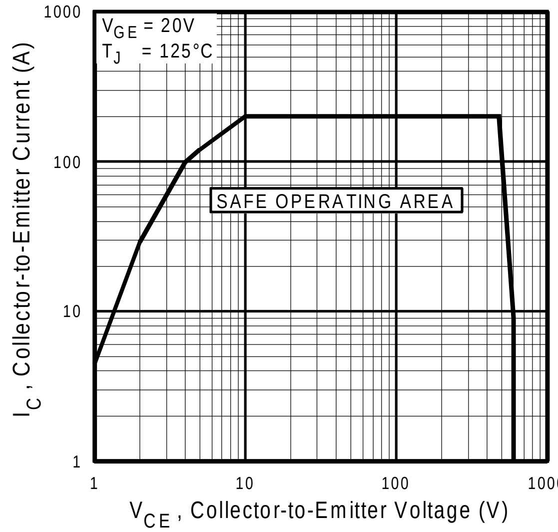


Fig. 12 - Turn-Off SOA

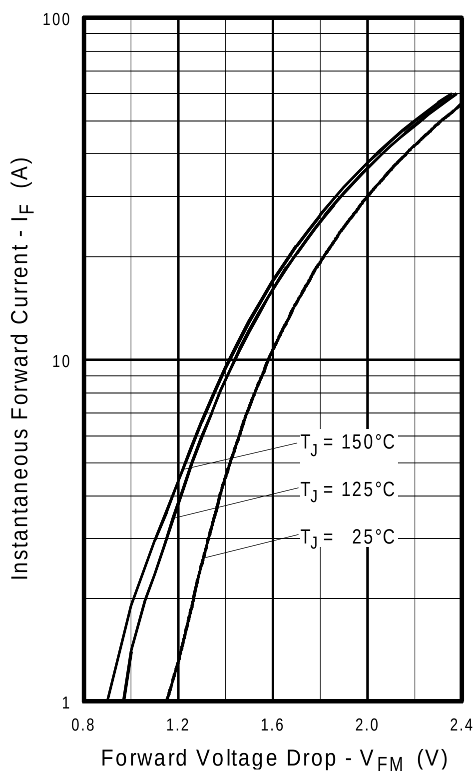


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

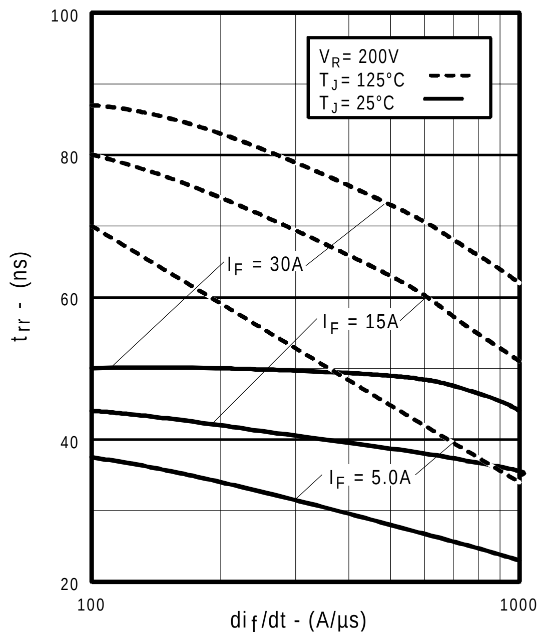


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

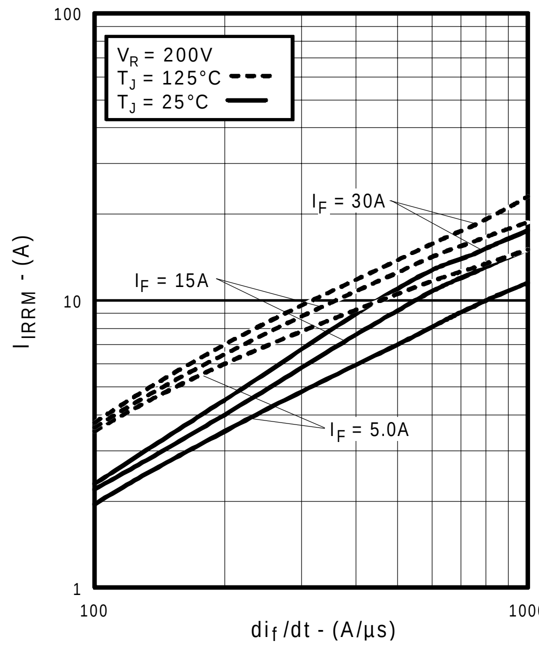


Fig. 15 - Typical Recovery Current vs. di_f/dt

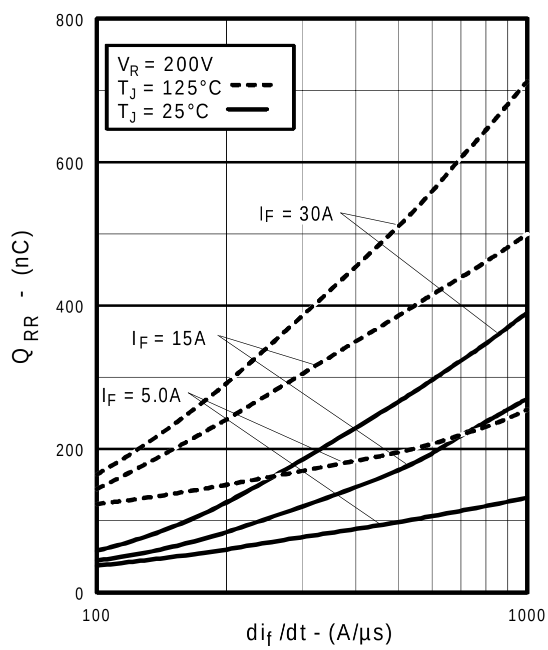


Fig. 16 - Typical Stored Charge vs. di_f/dt

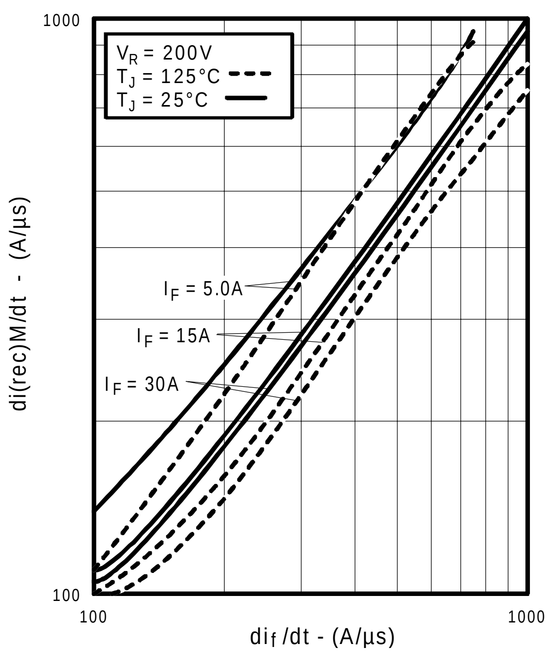


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

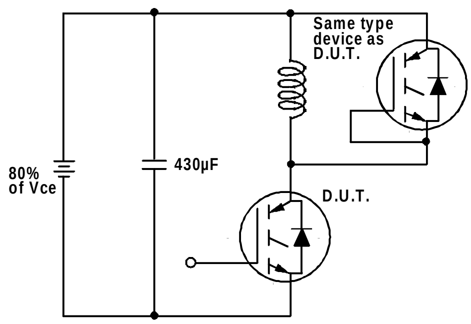


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

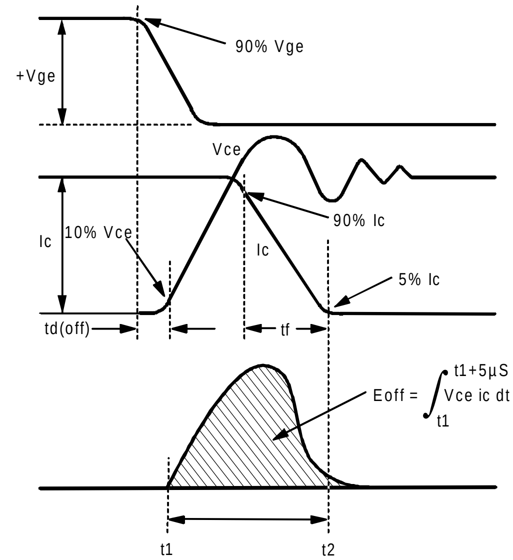


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

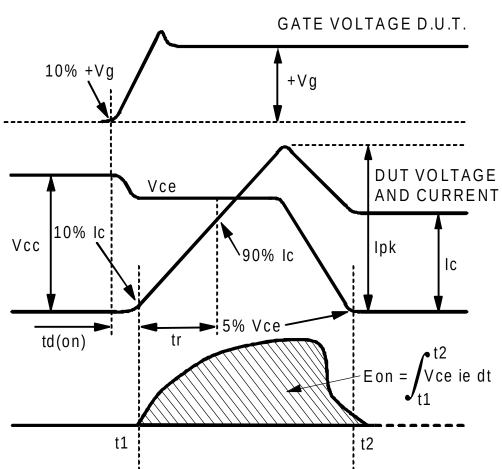


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

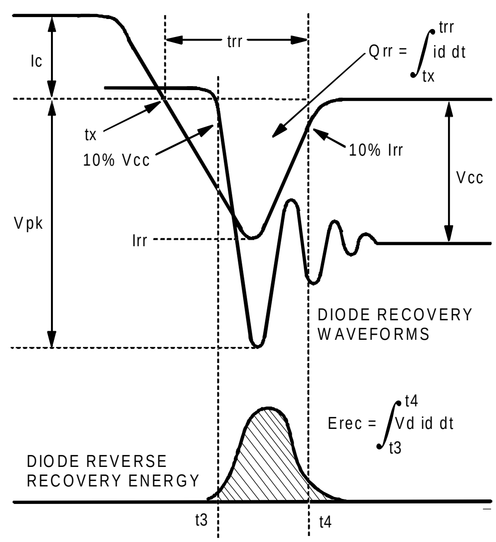


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

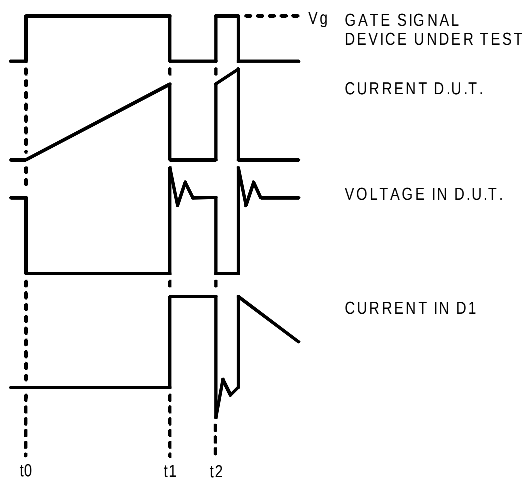


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

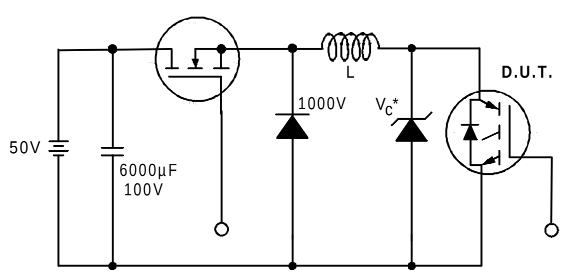


Figure 19. Clamped Inductive Load Test Circuit

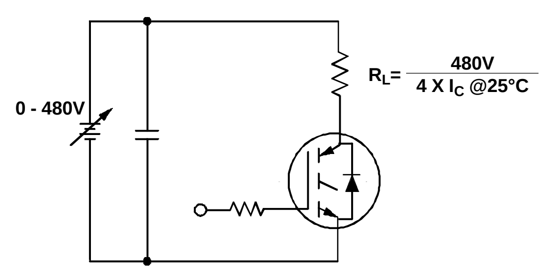


Figure 20. Pulsed Collector Current Test Circuit

Notes:

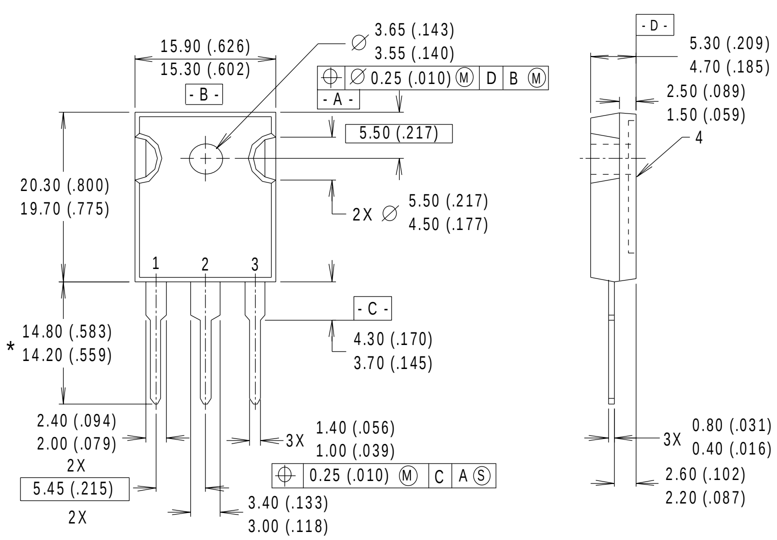
① Repetitive rating: V_{GE}=20V; pulse width limited by maximum junction temperature (figure 20)

② V_{CC}=80%(V_{CES}), V_{GE}=20V, L=10µH, R_G = 10Ω (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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Data and specifications subject to change without notice. 12/00