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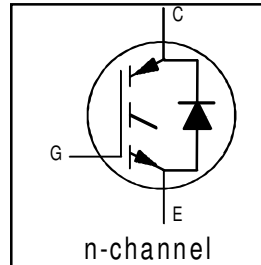
IRG4PC40FD

INSULATED GATE BIPOLAR TRANSISTOR WITH
 ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT

Features

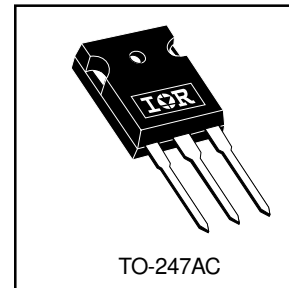
- Fast: Optimized for medium operating frequencies (1-5 kHz in hard switching, >20 kHz in resonant mode).
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for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



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.50V$
@ $V_{GE} = 15V, I_C = 27A$

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



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	49	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	27	
I_{CM}	Pulsed Collector Current ①	200	
I_{LM}	Clamped Inductive Load Current ②	200	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
I_{FM}	Diode Maximum Forward Current	200	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
T_J	Operating Junction and Storage Temperature Range	-55 to +150	°C
T_{STG}			
	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 Voltage ^③	600	----	----	V	V _{GE} = 0V, I _C = 250μA
ΔV _{(BR)CES} /ΔT _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
ΔV _{GE(th)} /ΔT _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 V _{CC} = 400V See Fig. 8 V _{GE} = 15V
Q _{ge}	Gate - Emitter Charge (turn-on)	----	15	23		
Q _{gc}	Gate - Collector Charge (turn-on)	----	35	53		
t _{d(on)}	Turn-On Delay Time	----	63	----	ns	T _J = 25°C I _C = 27A, V _{CC} = 480V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
t _r	Rise Time	----	32	----		
t _{d(off)}	Turn-Off Delay Time	----	230	350		
t _f	Fall Time	----	170	250		
E _{on}	Turn-On Switching Loss	----	0.95	----	mJ	T _J = 150°C, See Fig. 9, 10, 11, 18 I _C = 27A, V _{CC} = 480V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
E _{off}	Turn-Off Switching Loss	----	2.01	----		
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 I _C = 27A, V _{CC} = 480V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery.
t _r	Rise Time	----	33	----		
t _{d(off)}	Turn-Off Delay Time	----	350	----		
t _f	Fall Time	----	310	----		
E _{ts}	Total Switching Loss	----	4.7	----	mJ	
L _E	Internal Emitter Inductance	----	13	----	nH	Measured 5mm from package
C _{ies}	Input Capacitance	----	2200	----	pF	V _{GE} = 0V V _{CC} = 30V See Fig. 7 f = 1.0MHz
C _{oes}	Output Capacitance	----	140	----		
C _{res}	Reverse Transfer Capacitance	----	29	----		
t _{rr}	Diode Reverse Recovery Time	----	42	60	ns	T _J = 25°C See Fig. 14
		----	74	120		T _J = 125°C
I _{rr}	Diode Peak Reverse Recovery Current	----	4.0	6.0	A	T _J = 25°C See Fig. 15
		----	6.5	10		T _J = 125°C
Q _{rr}	Diode Reverse Recovery Charge	----	80	180	nC	T _J = 25°C See Fig. 16
		----	220	600		T _J = 125°C
di _(rec) M/dt	Diode Peak Rate of Fall of Recovery During t _b	----	188	----	A/μs	T _J = 25°C See Fig. 17
		----	160	----		T _J = 125°C

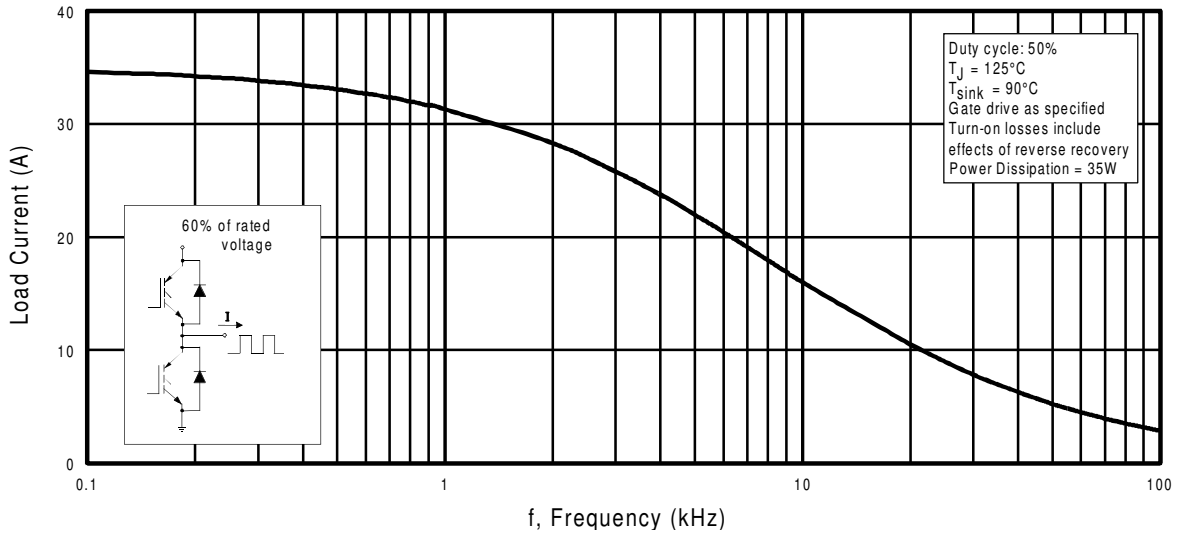


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

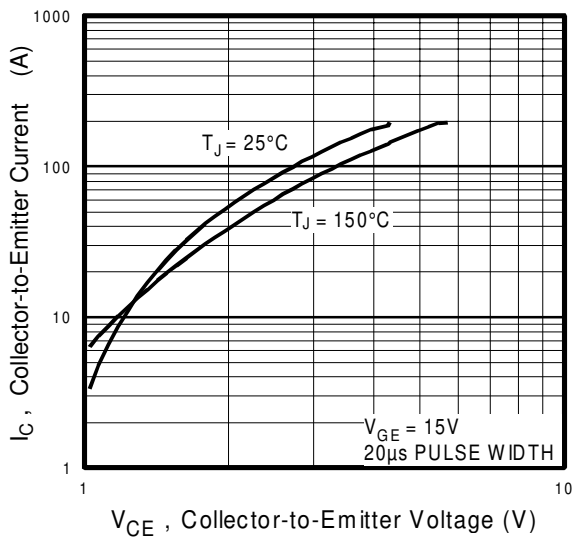


Fig. 2 - Typical Output Characteristics

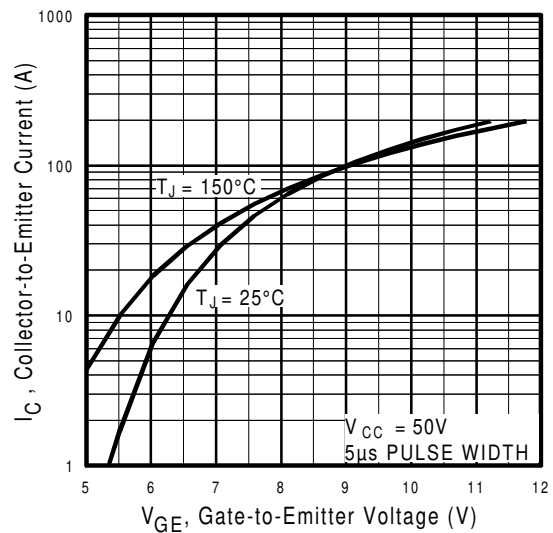


Fig. 3 - Typical Transfer Characteristics

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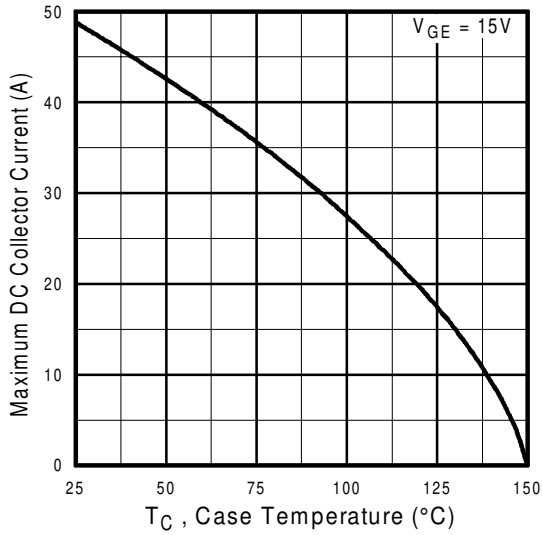


Fig. 4 - Maximum Collector Current vs. Case Temperature

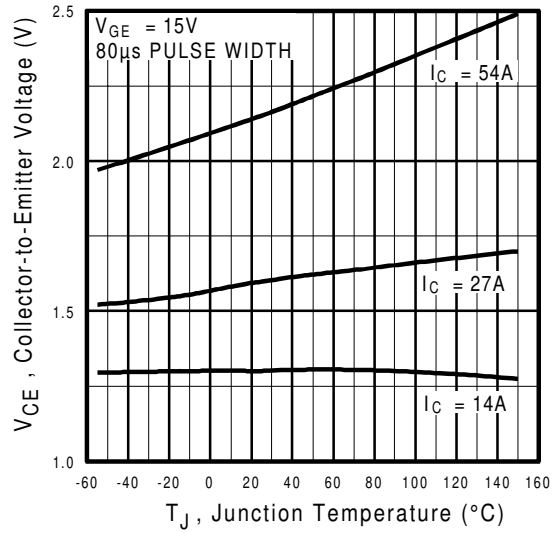


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

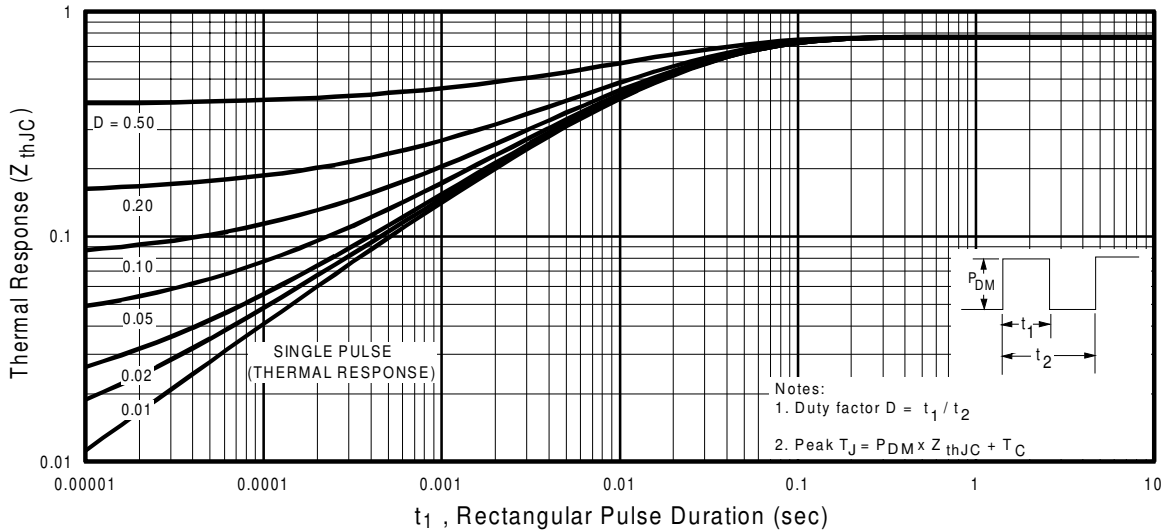


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

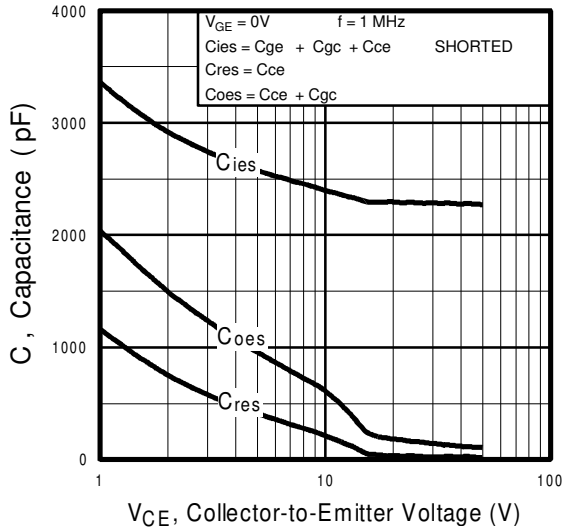


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

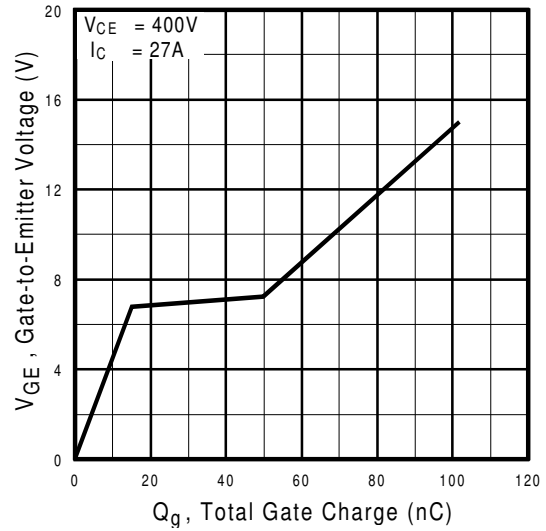


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

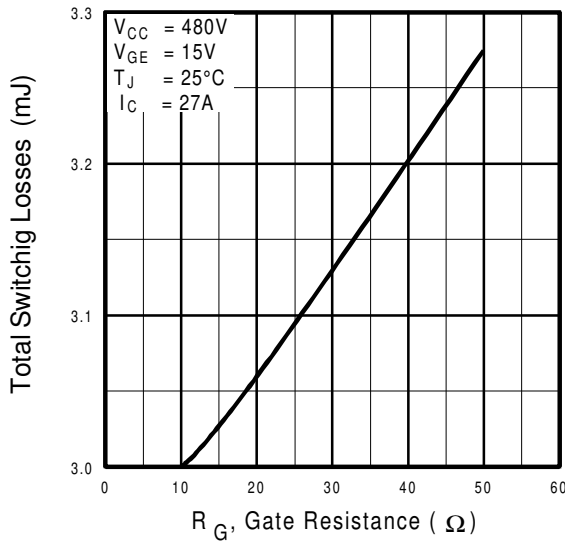


Fig. 9 - Typical Switching Losses vs. Gate Resistance

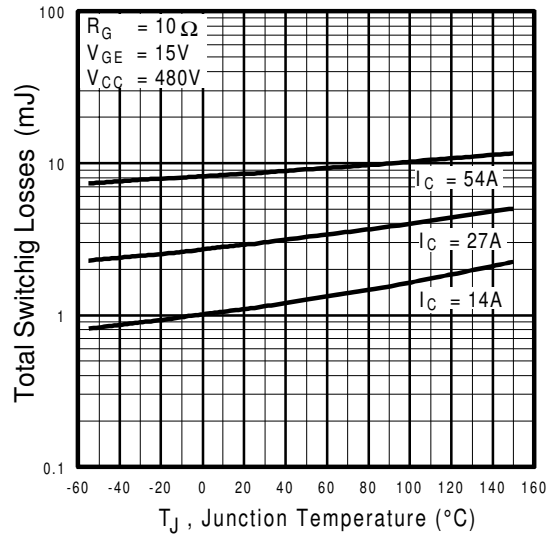


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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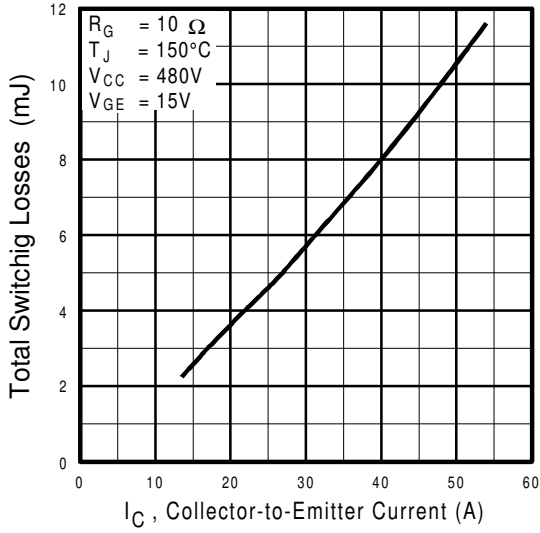


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

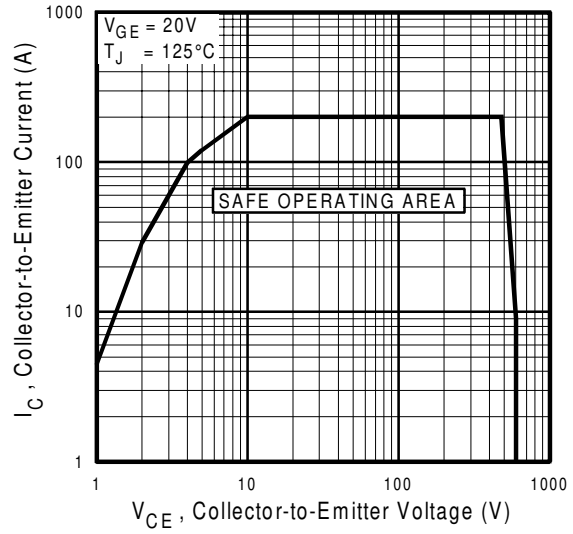


Fig. 12 - Turn-Off SOA

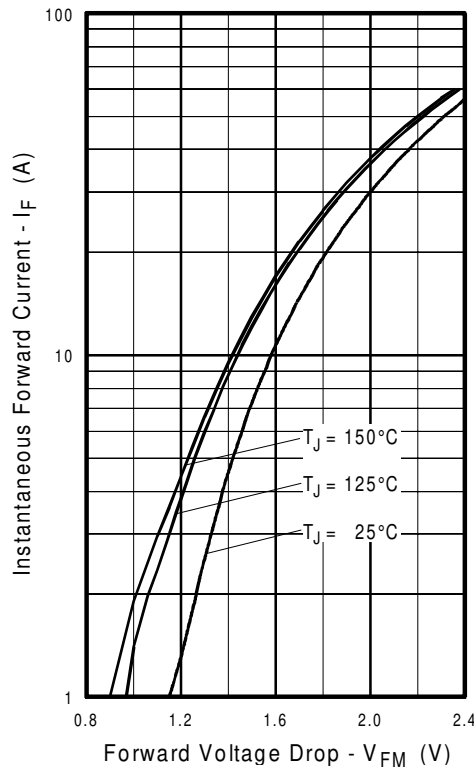


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

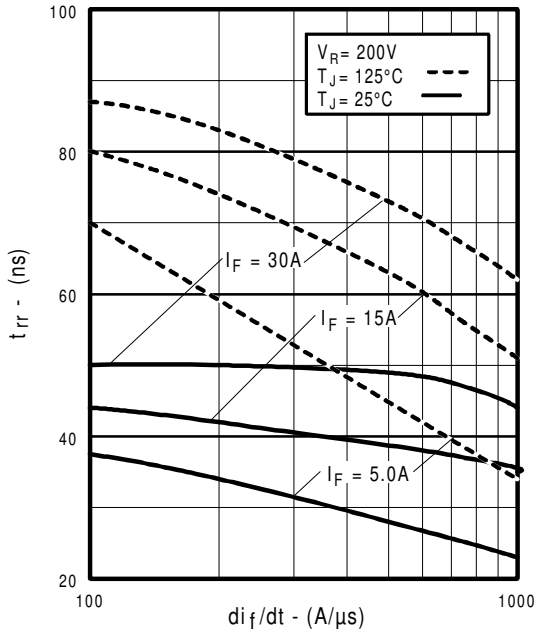


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

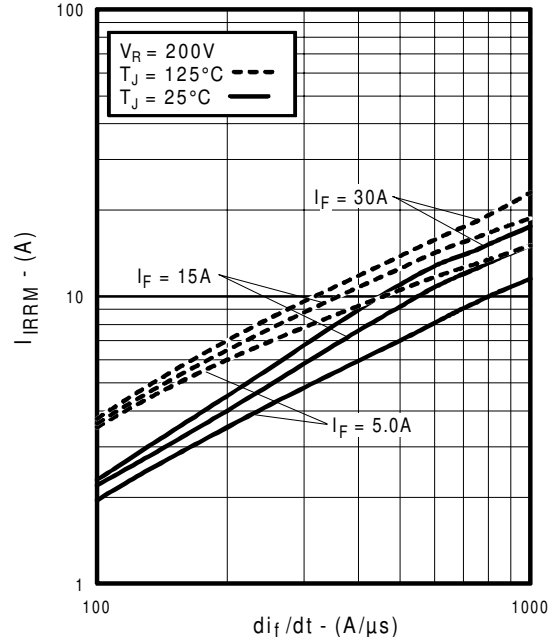


Fig. 15 - Typical Recovery Current vs. di_f/dt

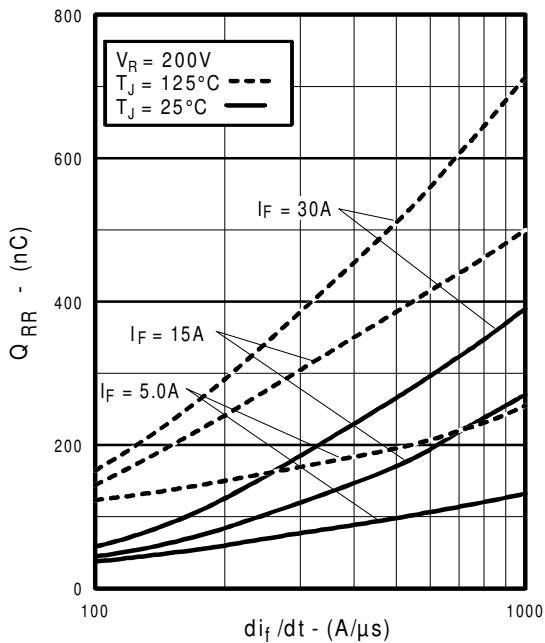


Fig. 16 - Typical Stored Charge vs. di_f/dt

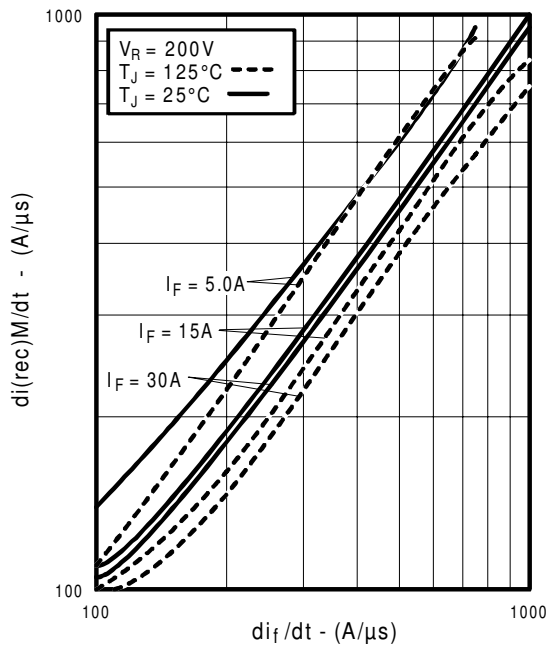


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

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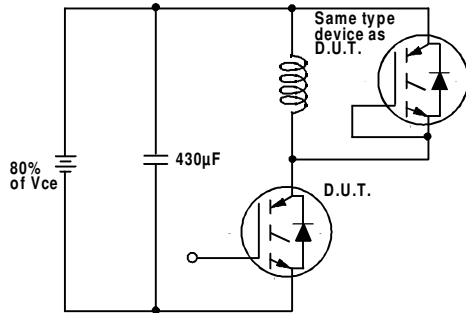


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

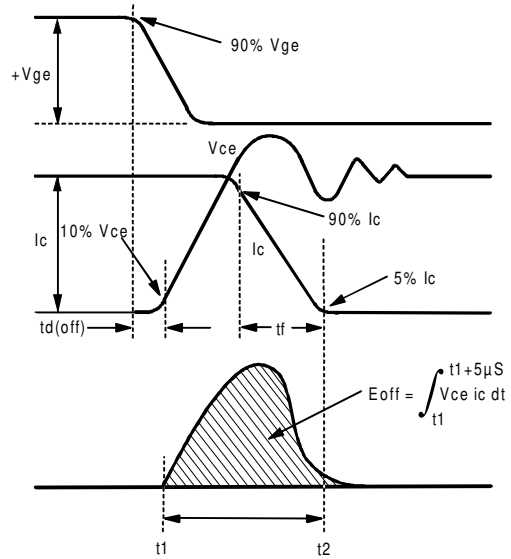


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

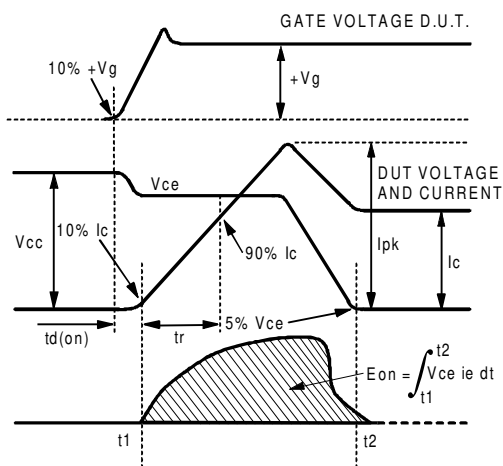


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

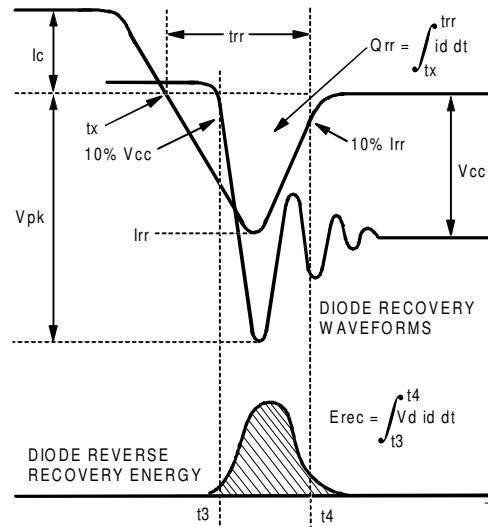


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

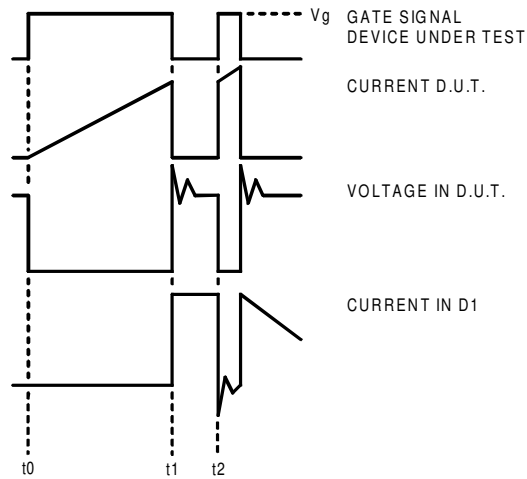


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

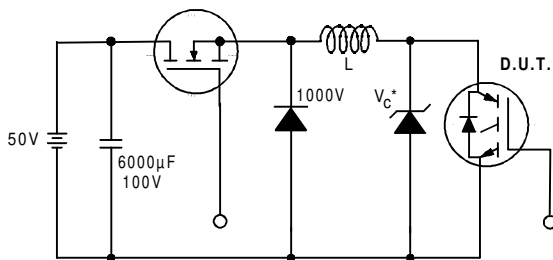


Figure 19. Clamped Inductive Load Test Circuit

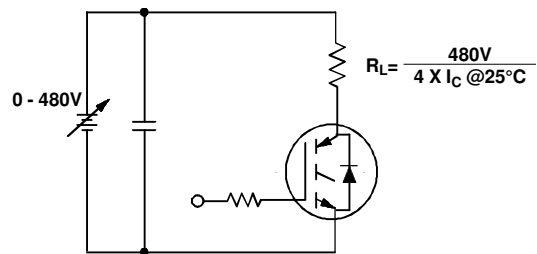


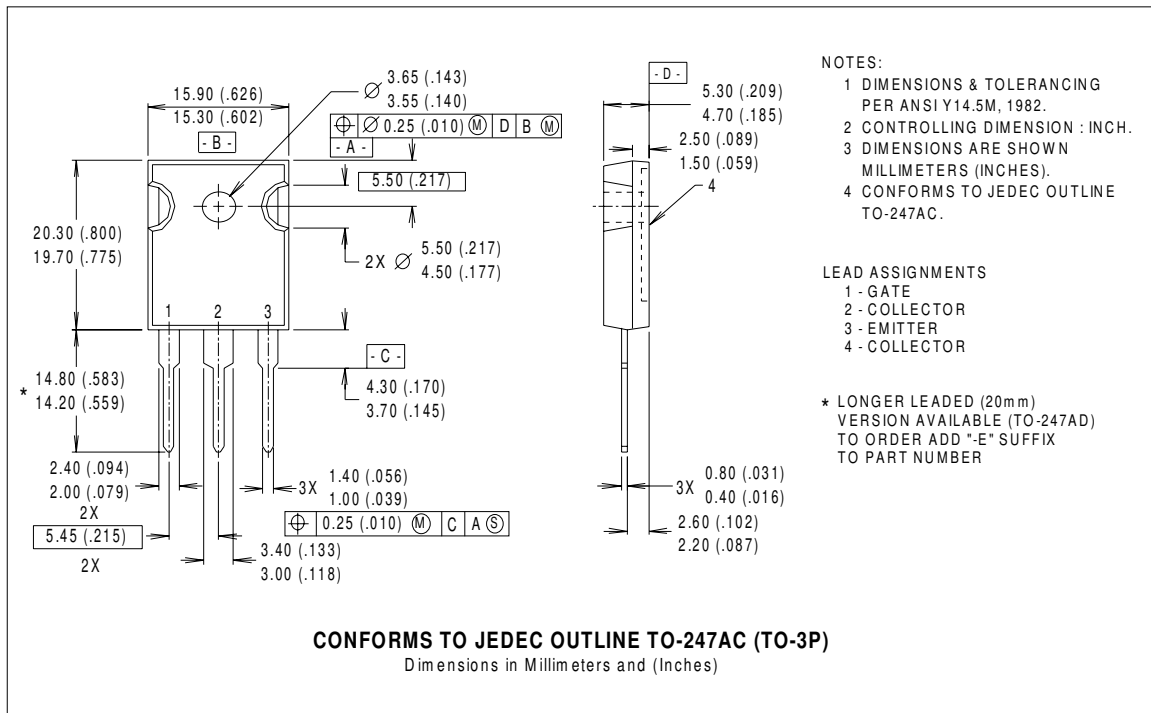
Figure 20. Pulsed Collector Current Test Circuit

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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.

Case Outline — TO-247AC



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