

International IR Rectifier

IRG4PF50WD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

- Optimized for use in Welding and Switch-Mode Power Supply applications
- Industry benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest technology IGBT design offers tighter parameter distribution coupled with exceptional reliability
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package

Benefits

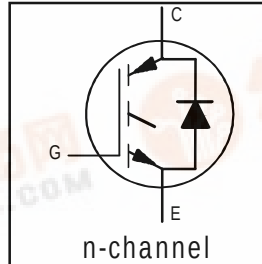
- Lower switching losses allow more cost-effective operation and hence efficient replacement of larger-die MOSFETs up to 100kHz
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses

Absolute Maximum Ratings

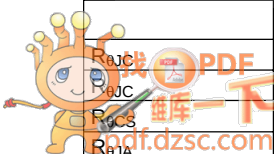
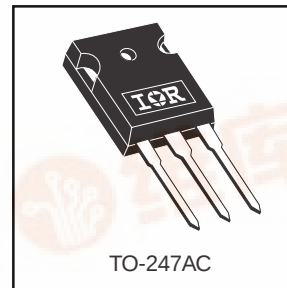
	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	900	V
$I_C @ T_C = 25^\circ\text{C}$	Continuous Collector Current	51	A
$I_C @ T_C = 100^\circ\text{C}$	Continuous Collector Current	28	
I_{CM}	Pulsed Collector Current ①	204	
I_{LM}	Clamped Inductive Load Current ②	204	
$I_F @ T_C = 100^\circ\text{C}$	Diode Continuous Forward Current	16	
I_{FM}	Diode Maximum Forward Current	204	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ\text{C}$	Maximum Power Dissipation	78	
T_J	Operating Junction and	-55 to + 150	$^\circ\text{C}$
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
R_{JC}	Junction-to-Case - IGBT	—	—	0.64	$^\circ\text{C}/\text{W}$
R_{JD}	Junction-to-Case - Diode	—	—	0.83	
R_{CS}	Case-to-Sink, flat, greased surface	—	0.24	—	
R_{JA}	Junction-to-Ambient, typical socket mount	—	—	40	
Wt	Weight	—	6 (0.21)	—	g (oz)



$V_{CES} = 900\text{V}$
$V_{CE(ON)} \text{ typ.} = 2.25\text{V}$
@ $V_{GE} = 15\text{V}$, $I_C = 28\text{A}$



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Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage ^③	900	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.295	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 3.5mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.25	2.7	V	$I_C = 28A, V_{GE} = 15V$
		—	2.74	—		$I_C = 60A$ See Fig. 2, 5
		—	2.12	—		$I_C = 28A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-13	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ^④	26	39	—	S	$V_{CE} = 50V, I_C = 28A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	500	μA	$V_{GE} = 0V, V_{CE} = 900V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	6.5	mA	$V_{GE} = 0V, V_{CE} = 900V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.5	V	$I_C = 16A$ See Fig. 13
		—	2.1	3.0		$I_C = 16A, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	160	240	nC	$I_C = 28A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	19	29		$V_{CC} = 400V$ See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	53	80		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	71	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	50	—		$I_C = 28A, V_{CC} = 720V$
$t_{d(off)}$	Turn-Off Delay Time	—	150	220		$V_{GE} = 15V, R_G = 5.0\Omega$
t_f	Fall Time	—	110	170		Energy losses include "tail" and diode reverse recovery.
E_{on}	Turn-On Switching Loss	—	2.63	—	mJ	See Fig. 9, 10, 18
E_{off}	Turn-Off Switching Loss	—	1.34	—		
E_{ts}	Total Switching Loss	—	3.97	5.3		
$t_{d(on)}$	Turn-On Delay Time	—	69	—	ns	$T_J = 150^\circ\text{C}$, See Fig. 11, 18
t_r	Rise Time	—	52	—		$I_C = 28A, V_{CC} = 720V$
$t_{d(off)}$	Turn-Off Delay Time	—	270	—		$V_{GE} = 15V, R_G = 5.0\Omega$
t_f	Fall Time	—	190	—		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	—	6.0	—	mJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	3300	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	200	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	45	—		$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	—	90	135	ns	$T_J = 25^\circ\text{C}$ See Fig. 14
		—	164	245		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Current	—	5.8	10	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		—	8.3	15		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	—	260	675	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		—	680	1838		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_r	—	120	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		—	76	—		$T_J = 125^\circ\text{C}$

$I_F = 16A$
 $V_R = 200V$
 $di/dt = 200A/\mu s$

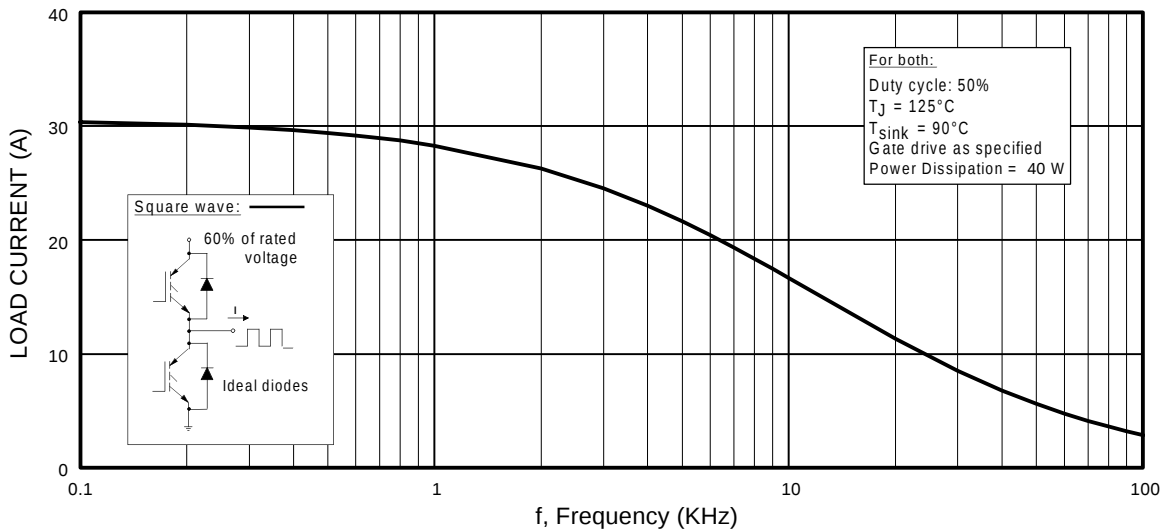


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

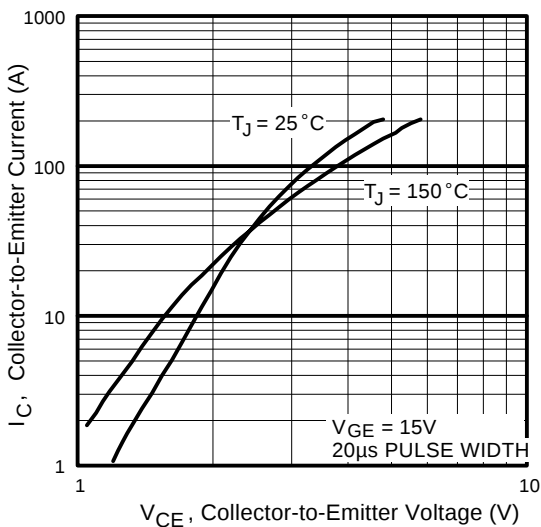


Fig. 2 - Typical Output Characteristics

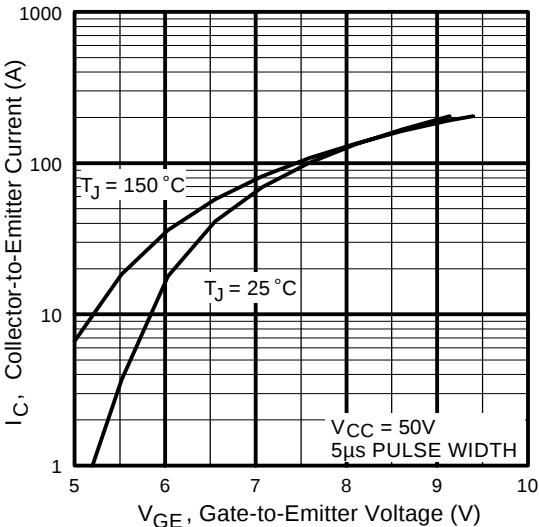


Fig. 3 - Typical Transfer Characteristics

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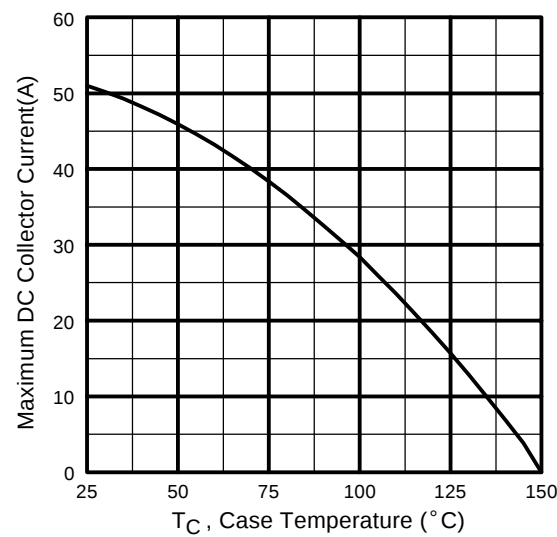


Fig. 4 - Maximum Collector Current vs. Case Temperature

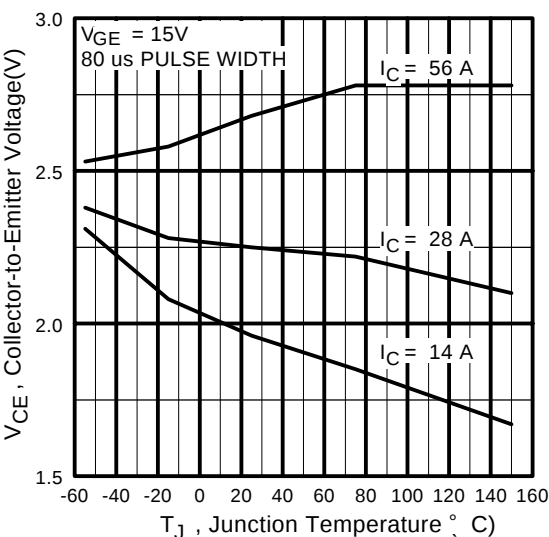


Fig. 5 - Collector-to-Emitter Voltage vs. Junction Temperature

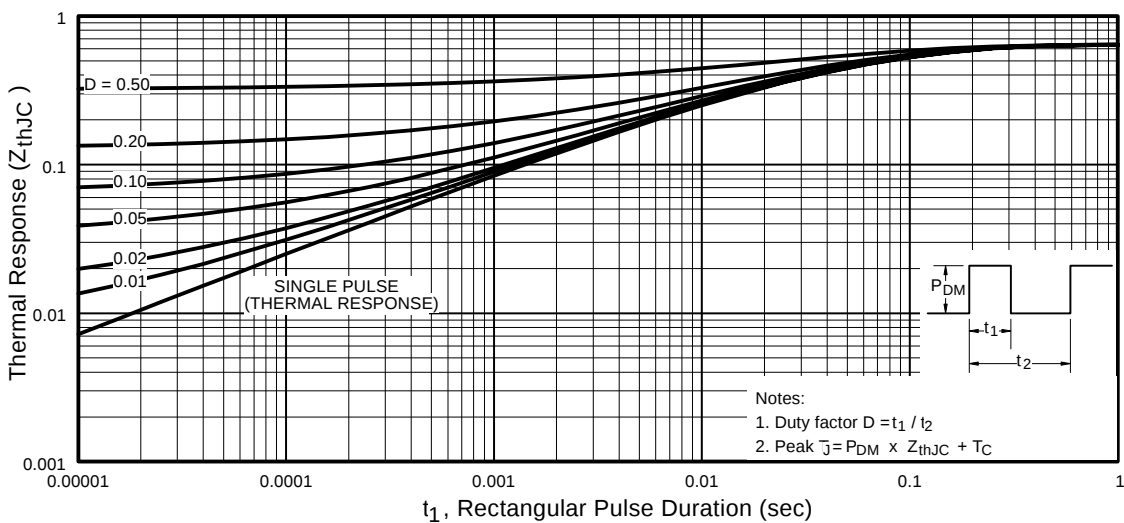


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

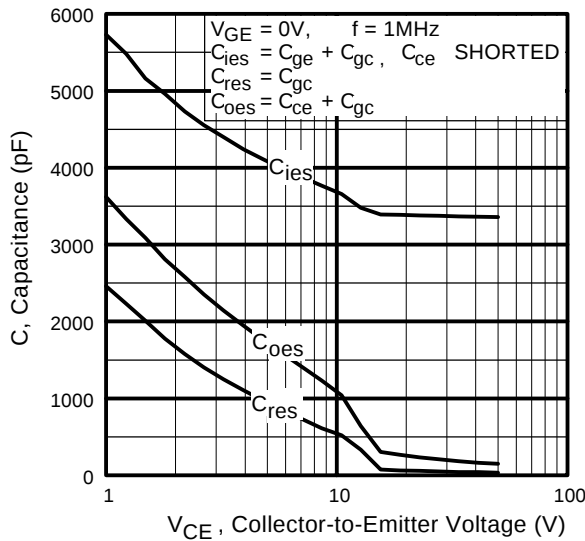


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

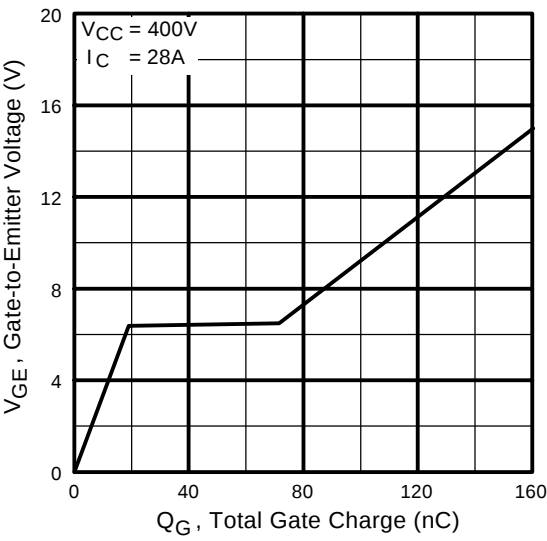


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

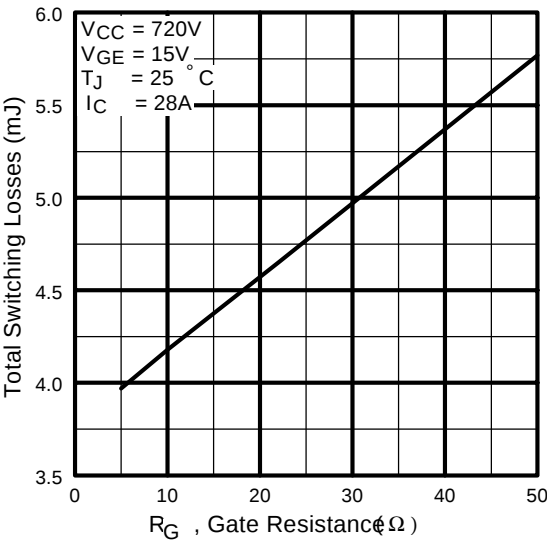


Fig. 9 - Typical Switching Losses vs. Gate Resistance

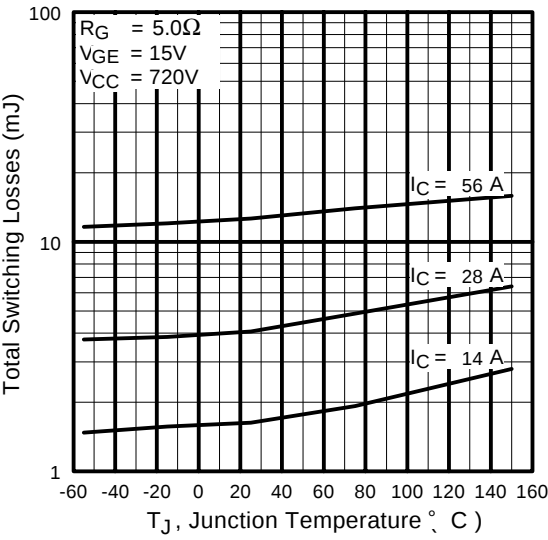


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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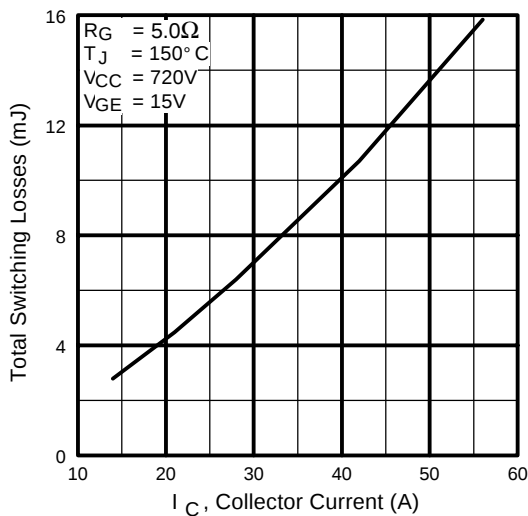


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

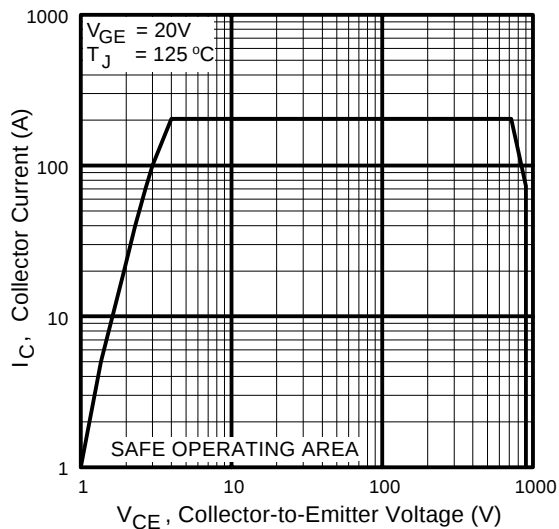


Fig. 12 - Turn-Off SOA

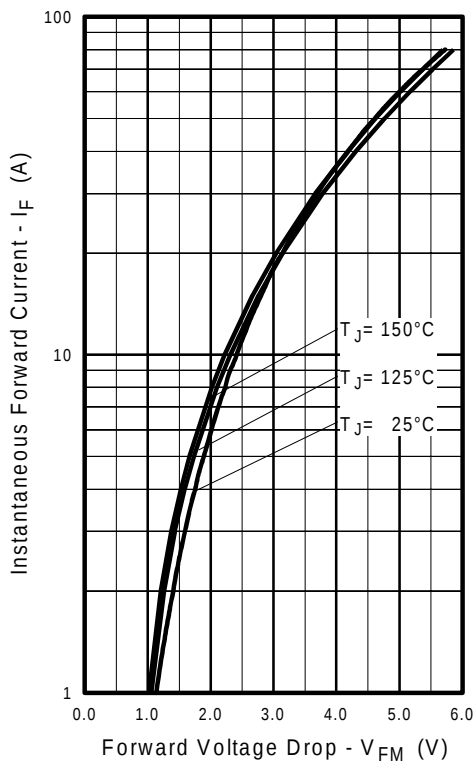


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

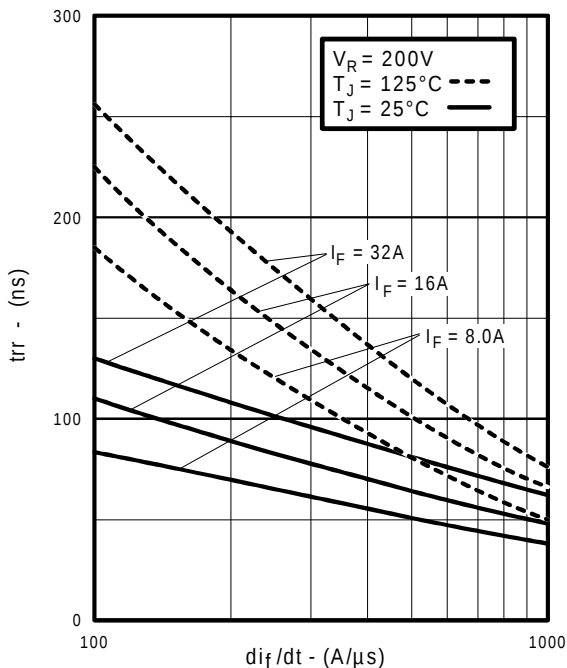


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

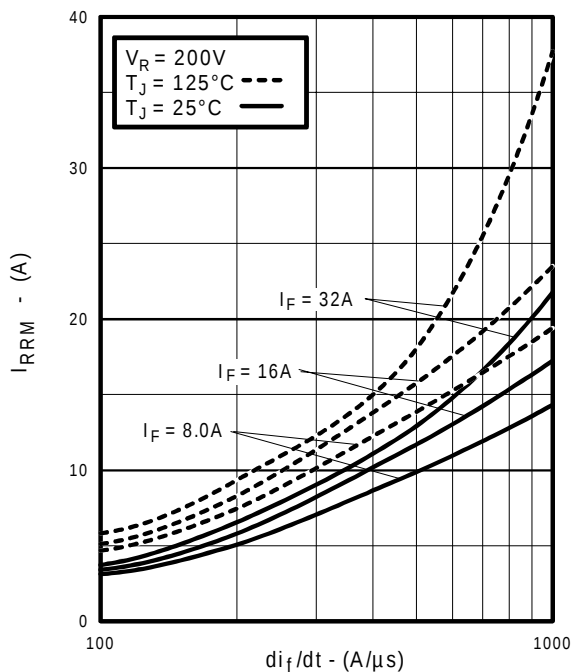


Fig. 15 - Typical Recovery Current vs. di_f/dt

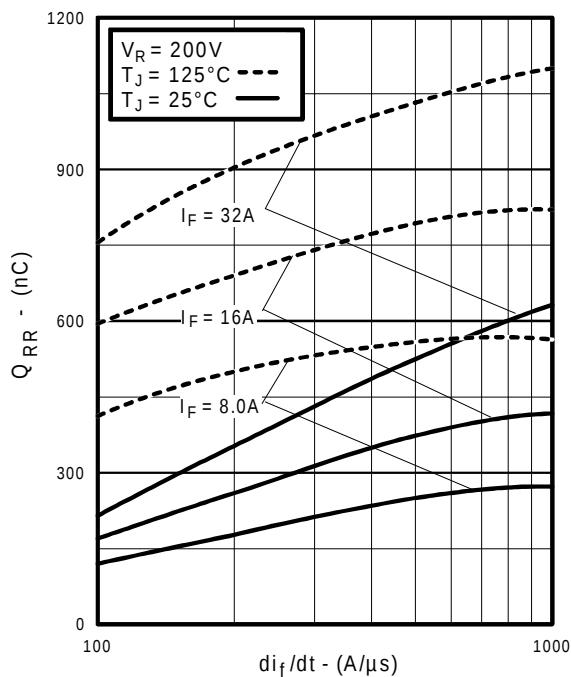


Fig. 16 - Typical Stored Charge vs. di_f/dt

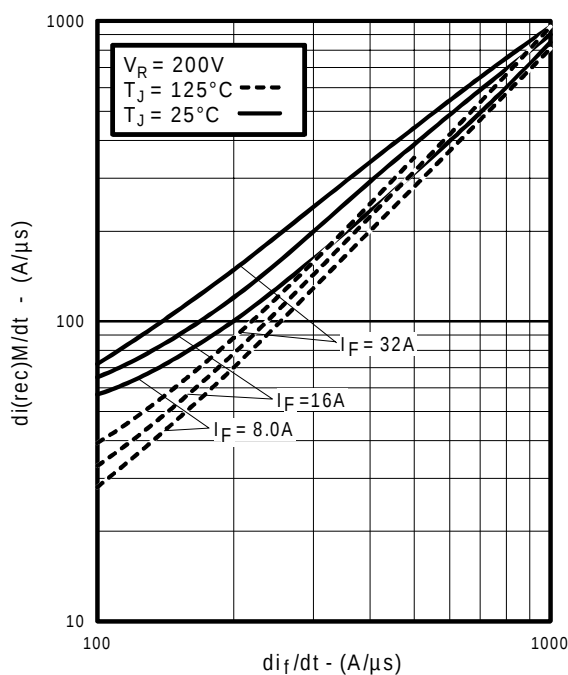


Fig. 17 - Typical $di_{(rec)}M/dt$ vs. di_f/dt

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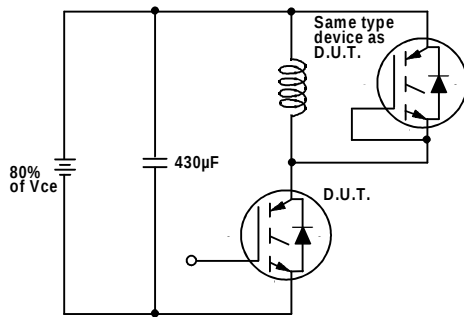


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_d(\text{on})$, t_r , $t_d(\text{off})$, t_f

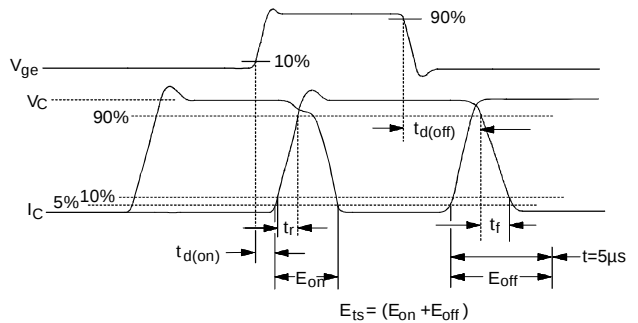


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_d(\text{off})$, t_f

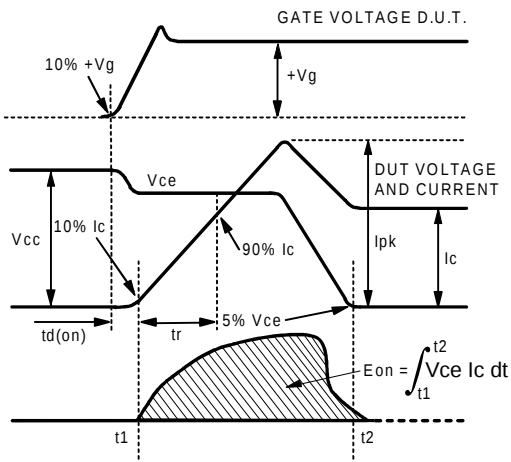


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_d(\text{on})$, t_r

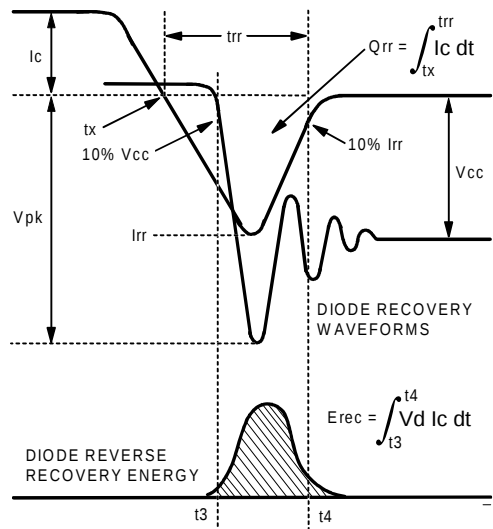


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

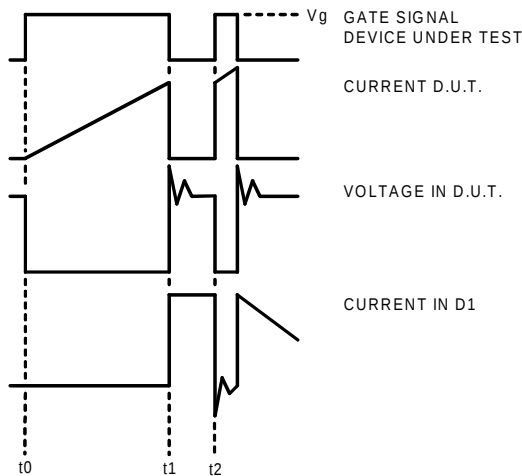


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

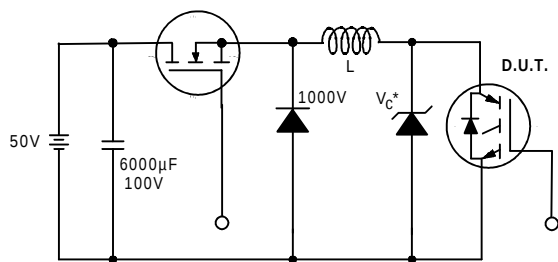


Figure 19. Clamped Inductive Load Test Circuit

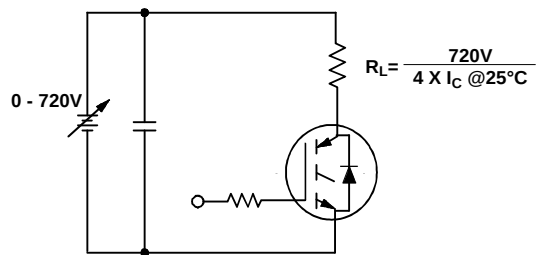
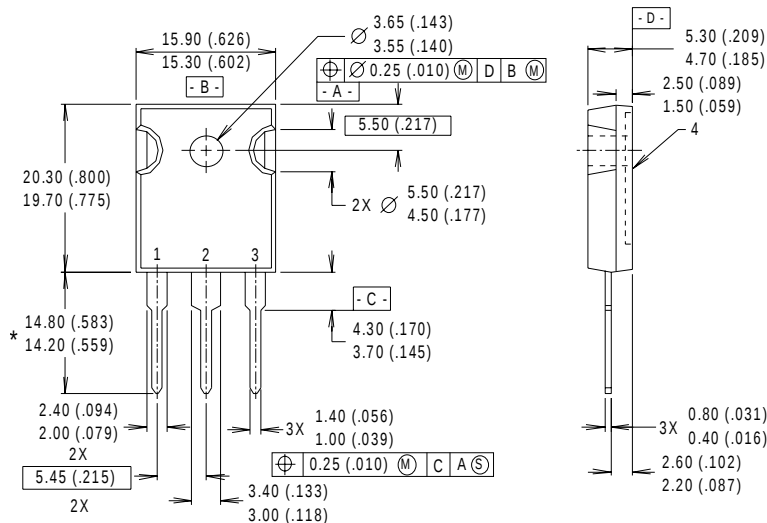


Figure 20. Pulsed Collector Current
Test Circuit

Notes:

- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=5.0\Omega$ (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 and Dimensions — 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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