

IRG4BC20MDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

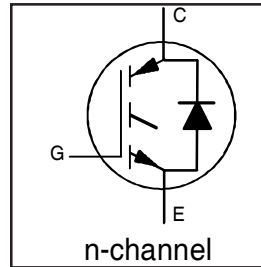
Short Circuit Rated
Fast IGBT

Features

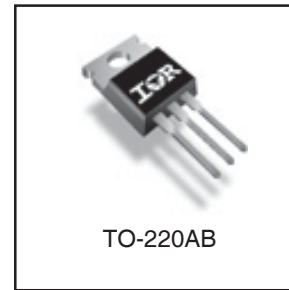
- Rugged: 10μsec short circuit capable at $V_{GS}=15V$
- Low $V_{CE(on)}$ for 4 to 10kHz applications
- IGBT Co-packaged with ultra-soft-recovery antiparallel diode
- Industry standard TO-220AB package
- Lead-Free

Benefits

- Offers highest efficiency and short circuit capability for intermediate applications
- Provides best efficiency for the mid range frequency (4 to 10kHz)
- Optimized for Appliance Motor Drives, Industrial (Short Circuit Proof) Drives and Intermediate Frequency Range Drives
- High noise immune "Positive Only" gate drive- Negative bias gate drive not necessary
- For Low EMI designs- requires little or no snubbing
- Single Package switch for bridge circuit applications
- Compatible with high voltage Gate Driver IC's
- Allows simpler gate drive



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 1.85V$
@ $V_{GE} = 15V, I_C = 11A$



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	18	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	11	
I_{CM}	Pulsed Collector Current ①	36	
I_{LM}	Clamped Inductive Load Current ②	36	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	7.0	
t_{sc}	Short Circuit Withstand Time	10	μs
I_{FM}	Diode Maximum Forward Current	36	A
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	24	
T_J	Operating Junction and	-55 to +150	°C
T_{STG}	Storage Temperature Range		
	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	-----	-----	2.1	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	-----	-----	2.5	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	-----	0.50	-----	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	-----	-----	80	
Wt	Weight	-----	2 (0.07)	-----	g (oz)

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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	600	----	----	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.67	----	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	1.85	2.1	V	$I_C = 11A, V_{GE} = 15V$
		----	2.46	----		$I_C = 18A, V_{GE} = 15V$
		----	2.07	----		$I_C = 11A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	----	6.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-11	----	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ^④	3.0	3.6	----	S	$V_{CE} = 100V, I_C = 11A$
I_{CES}	Zero Gate Voltage Collector Current	----	----	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		----	----	2500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	----	1.4	1.7	V	$I_C = 8.0A$ See Fig. 13
		----	1.3	1.6		$I_C = 8.0A, T_J = 150^\circ\text{C}$
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)	----	39	59	nC	$I_C = 11A$
Q_{ge}	Gate - Emitter Charge (turn-on)	----	5.3	8.0		$V_{CC} = 400V$ See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	----	20	30		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	----	21	----	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	----	37	----		$I_C = 11A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	----	463	690		$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	----	340	510		Energy losses include "tail" and diode reverse recovery.
E_{on}	Turn-On Switching Loss	----	0.41	----	mJ	See Fig. 9, 10, 11, 18
E_{off}	Turn-Off Switching Loss	----	2.03	----		
E_{ts}	Total Switching Loss	----	2.44	3.7		
$t_{d(on)}$	Turn-On Delay Time	----	19	----	ns	$T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18
t_r	Rise Time	----	41	----		$I_C = 6.5A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	----	590	----		$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	----	600	----		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	----	3.49	----	mJ	
L_E	Internal Emitter Inductance	----	7.5	----	nH	Measured 5mm from package
C_{ies}	Input Capacitance	----	460	----	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	----	54	----		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	----	14	----		$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	----	37	55	ns	$T_J = 25^\circ\text{C}$ See Fig. 14
		----	55	90		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Current	----	3.5	5.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		----	4.5	8.0		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	----	65	138	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		----	124	360		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	----	240	----	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		----	210	----		$T_J = 125^\circ\text{C}$

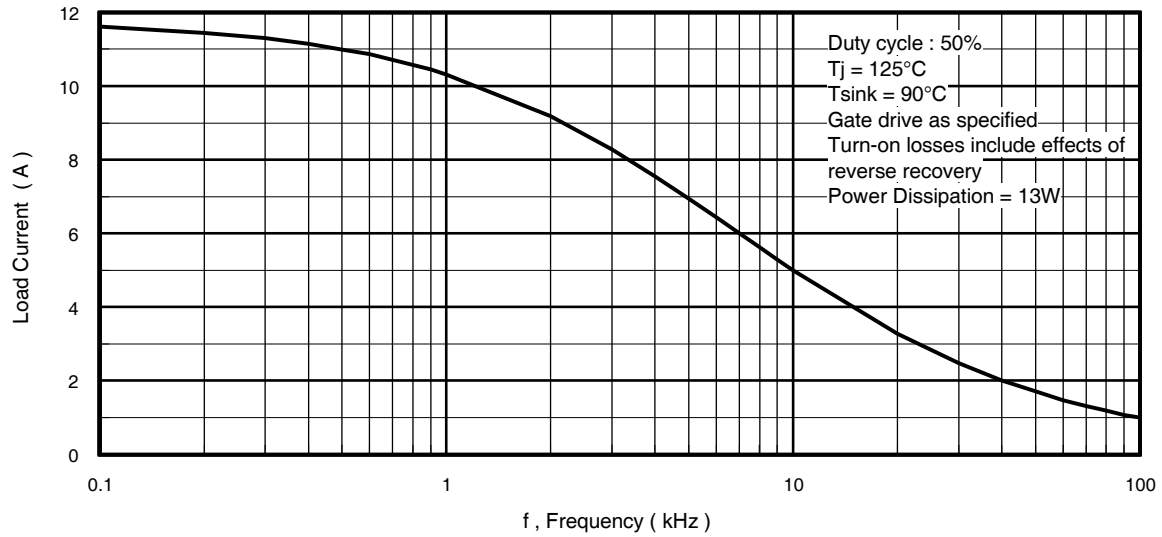


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

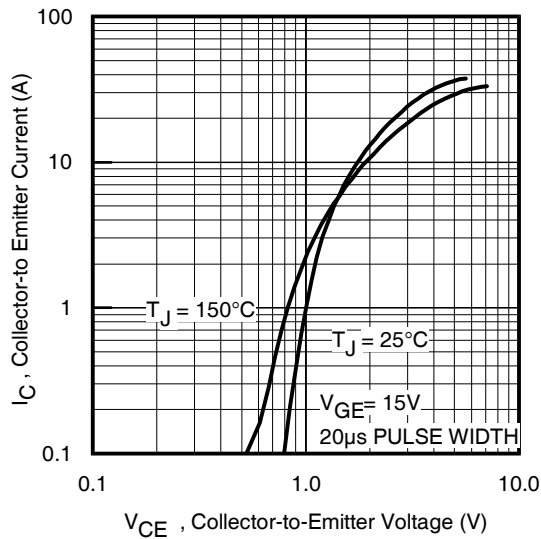


Fig. 2 - Typical Output Characteristics

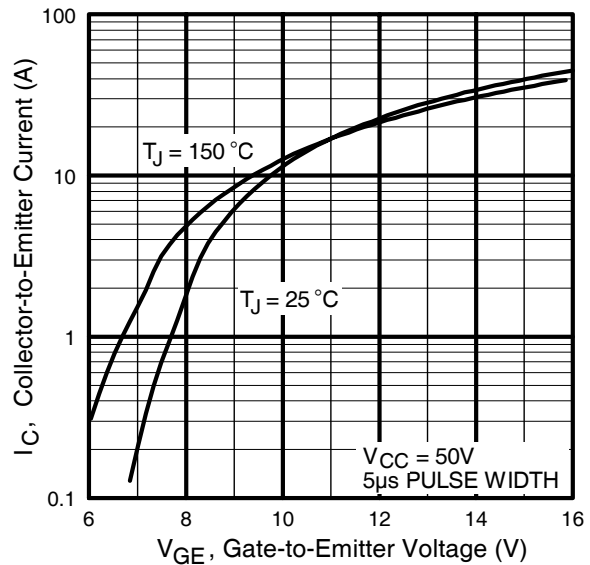


Fig. 3 - Typical Transfer Characteristics

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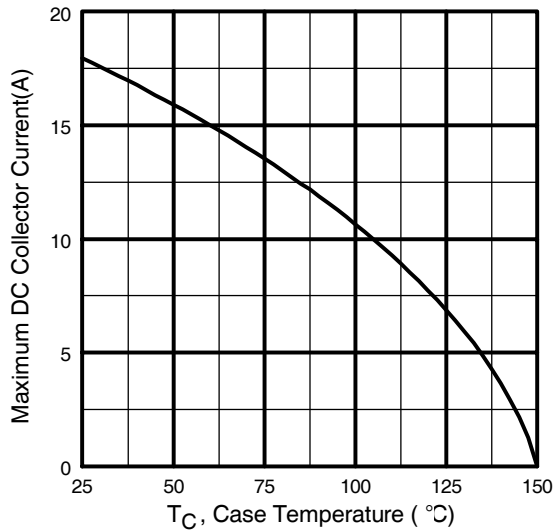


Fig. 4 - Maximum Collector Current vs. Case Temperature

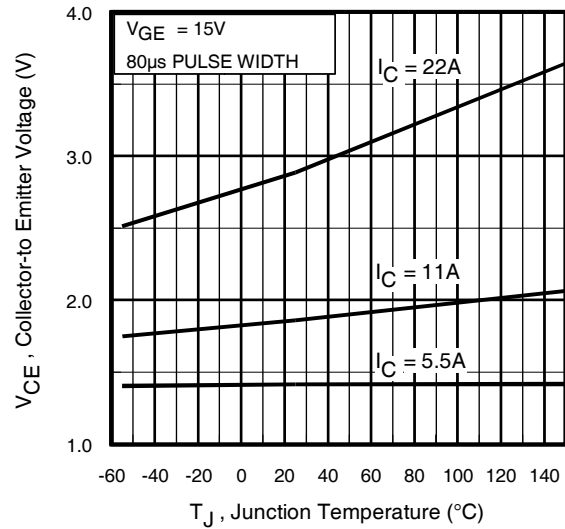


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

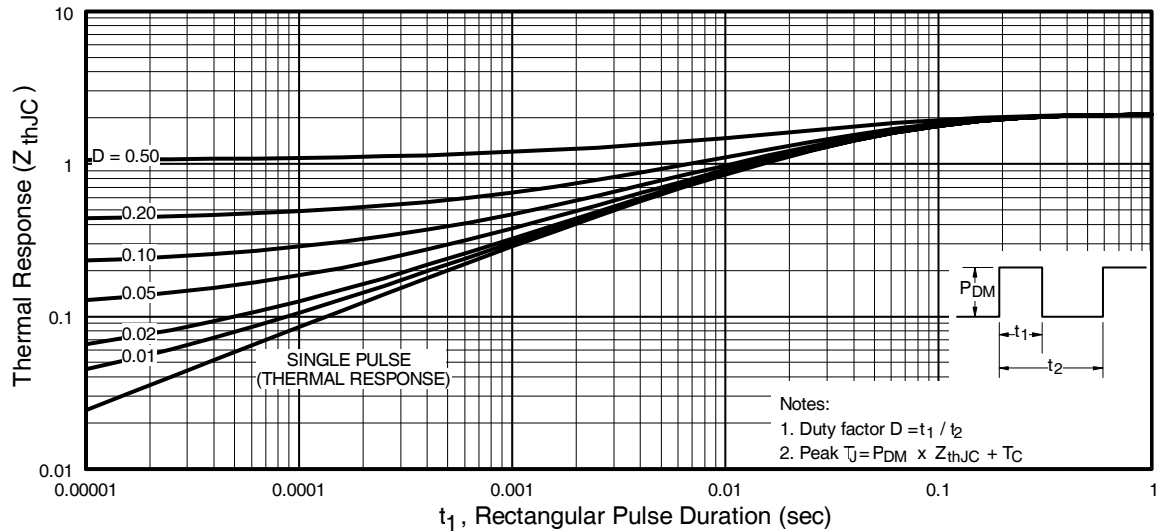


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

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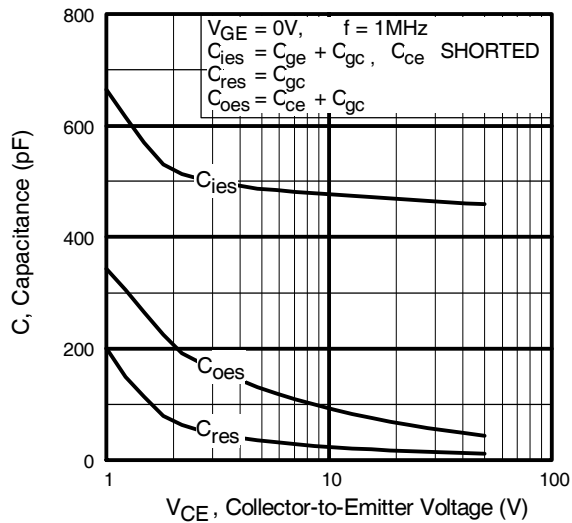


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

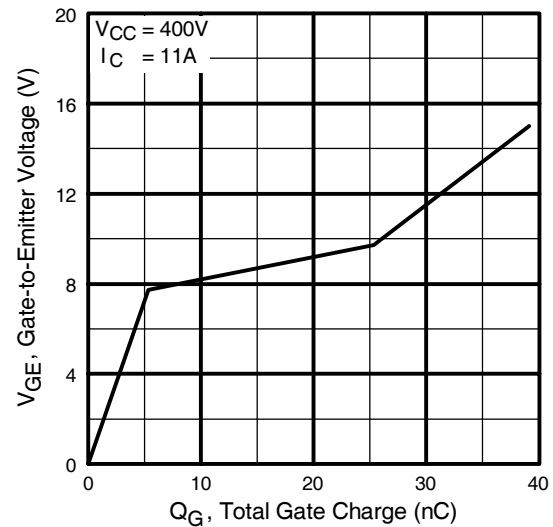


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

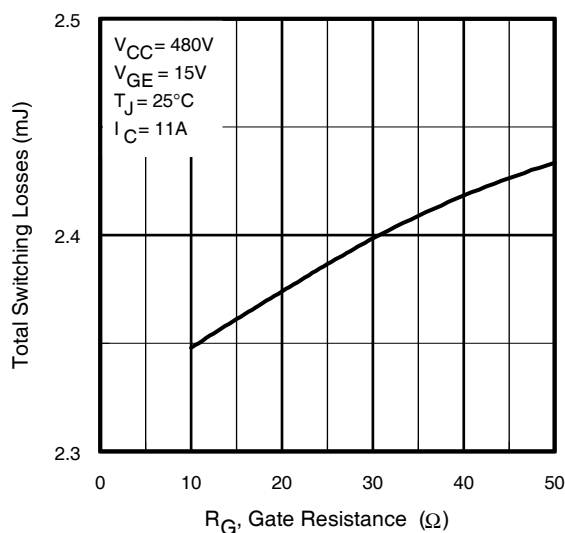


Fig. 9 - Typical Switching Losses vs. Gate Resistance

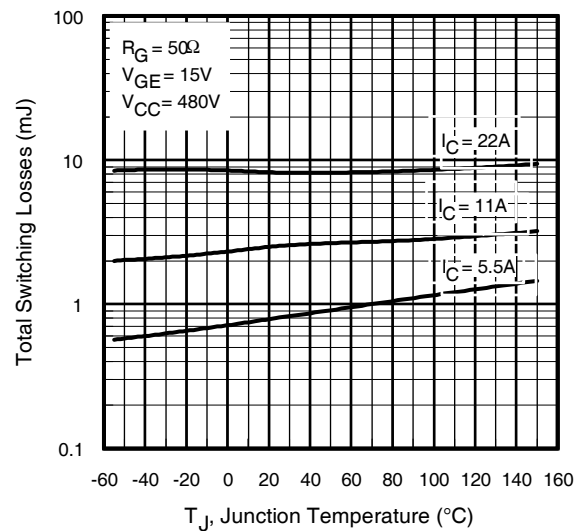


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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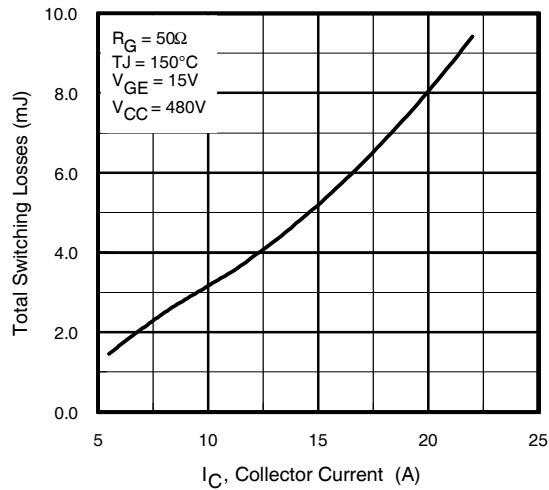


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

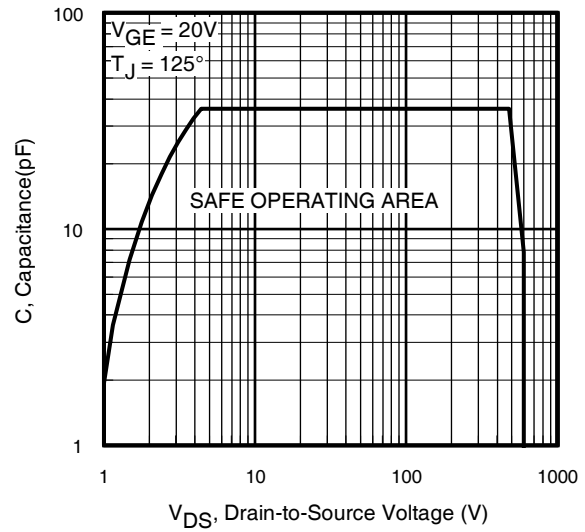


Fig. 12 - Turn-Off SOA

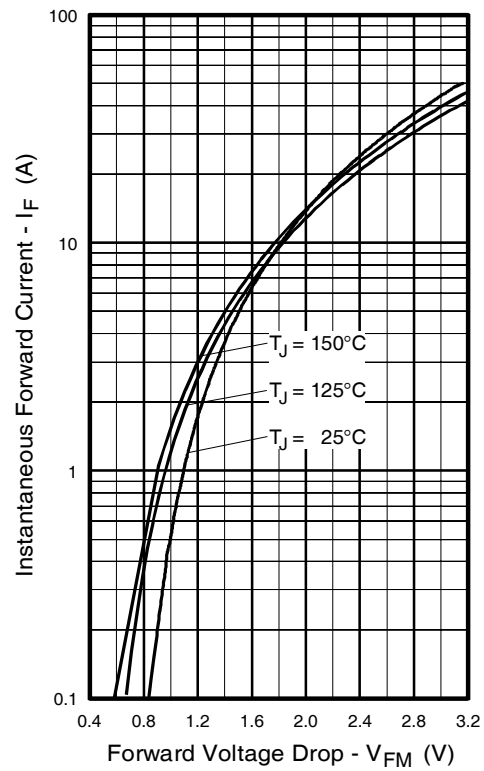


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

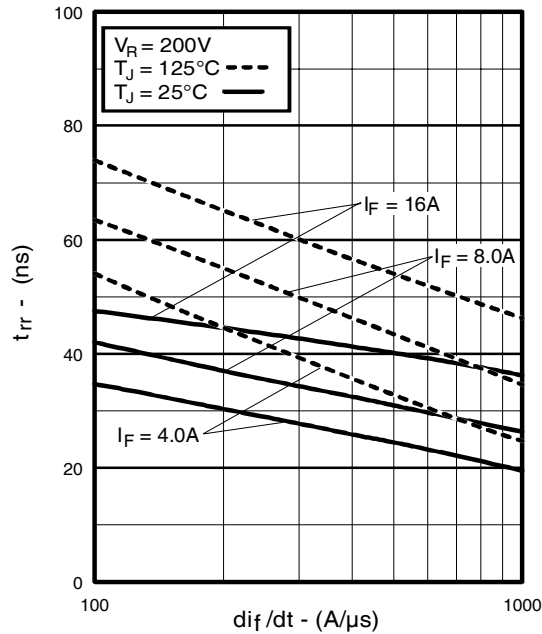


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

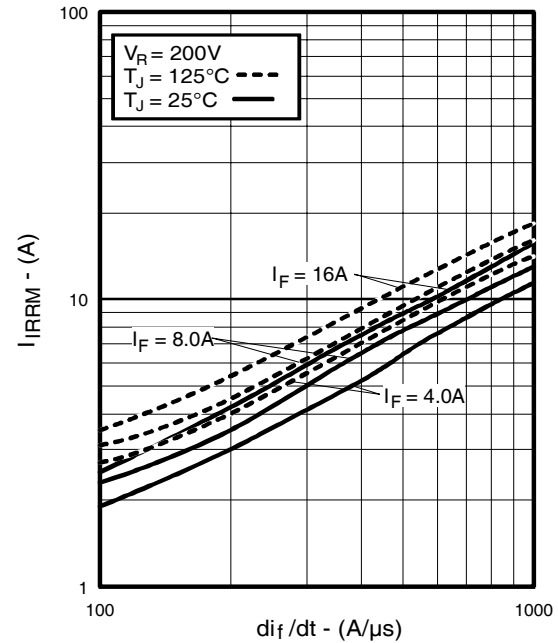


Fig. 15 - Typical Recovery Current vs. di_f/dt

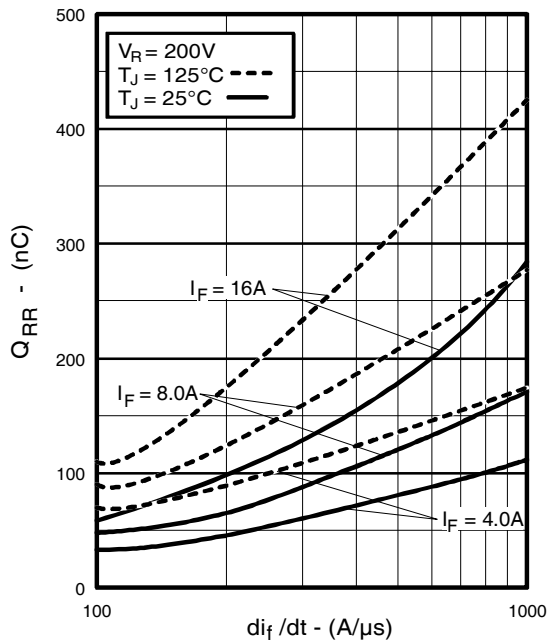


Fig. 16 - Typical Stored Charge vs. di_f/dt

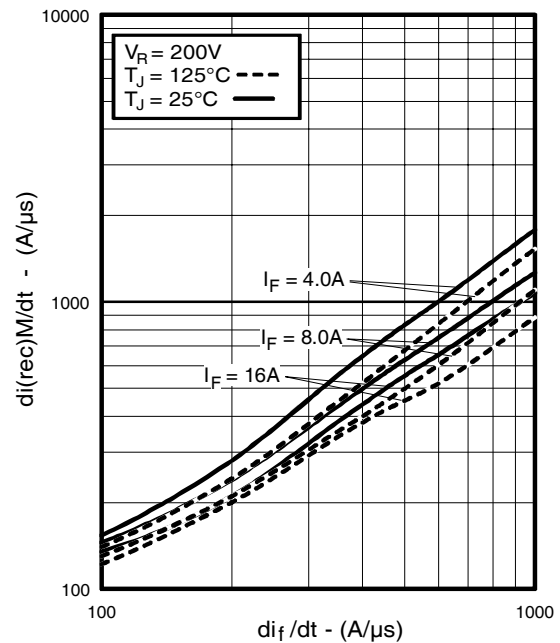


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

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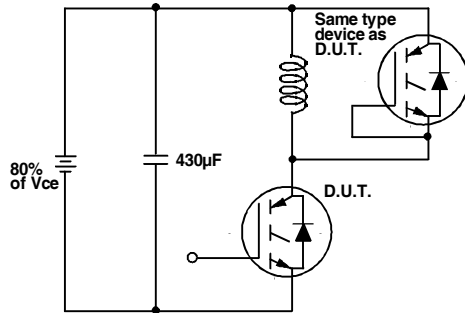


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, E_{off}(diode), t_{rr}, Q_{rr}, I_{rr}, t_d(on), t_r, t_d(off), t_f

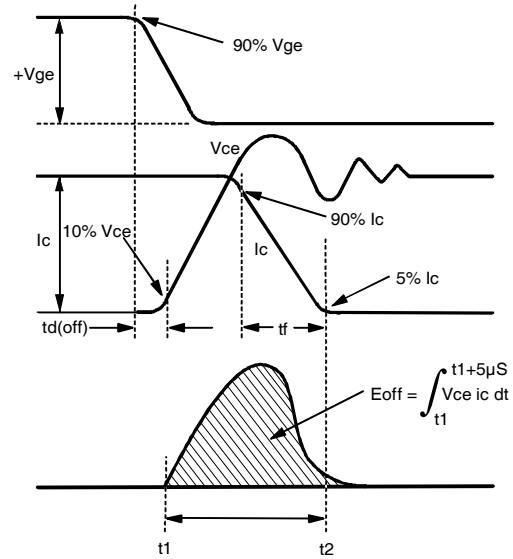


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, t_d(off), t_f

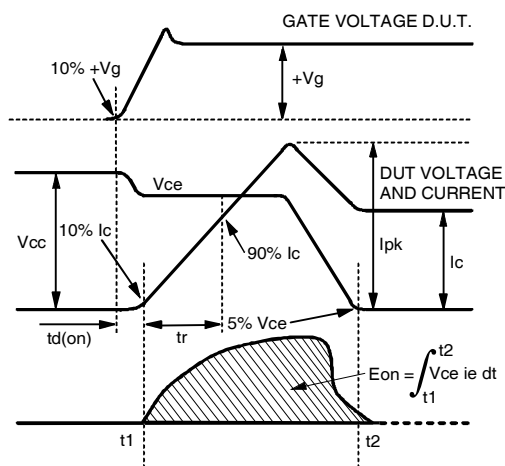


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, t_d(on), t_r

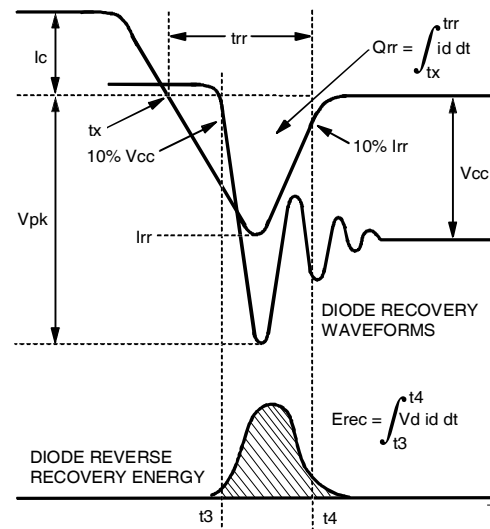


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

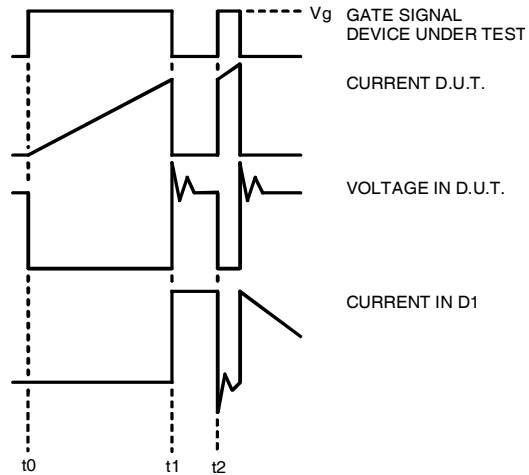


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

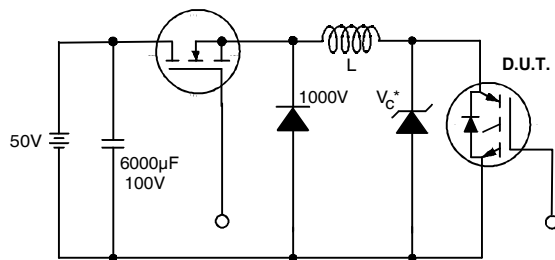
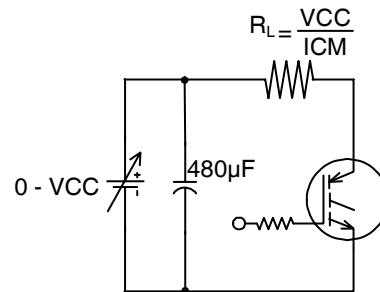


Figure 19. Clamped Inductive Load Test Circuit



Pulsed Collector Current
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 $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G = 50\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

TO-220AB Package Outline (Dimensions are shown in millimeters (inches))

