

**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-220AB package

Benefits

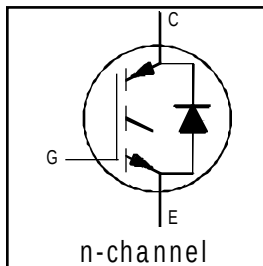
- Generation -4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard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

Absolute Maximum Ratings

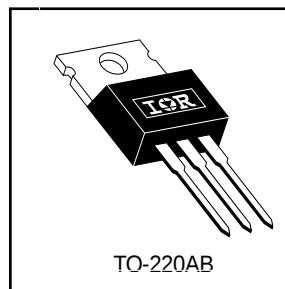
	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^{\circ}\text{C}$	Continuous Collector Current	16	A
$I_C @ T_C = 100^{\circ}\text{C}$	Continuous Collector Current	9.0	
I_{CM}	Pulsed Collector Current ①	64	
I_{LM}	Clamped Inductive Load Current ②	64	
$I_F @ T_C = 100^{\circ}\text{C}$	Diode Continuous Forward Current	7.0	
I_{FM}	Diode Maximum Forward Current	32	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^{\circ}\text{C}$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^{\circ}\text{C}$	Maximum Power Dissipation	24	
T_J	Operating Junction and	-55 to +150	$^{\circ}\text{C}$
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	$^{\circ}\text{C/W}$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	3.5	
$R_{\theta CS}$	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)



$V_{CES} = 600\text{V}$
 $V_{CE(on)} \text{ typ.} = 1.66\text{V}$
@ $V_{GE} = 15\text{V}$, $I_C = 9.0\text{A}$



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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.72	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.66	2.0	V	$I_C = 9.0A$ $V_{GE} = 15V$
		—	2.06	—		$I_C = 16A$ See Fig. 2, 5
		—	1.76	—		$I_C = 9.0A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	—	-11	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ④	2.9	5.1	—	S	$V_{CE} = 100V, I_C = 9.0A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	1700		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
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)	—	27	40	nC	$I_C = 9.0A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	4.2	6.2		$V_{CC} = 400V$ See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	9.9	15		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	43	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	20	—		$I_C = 9.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	240	360		$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	—	150	220	mJ	Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 18
E_{on}	Turn-On Switching Loss	—	0.25	—		
E_{off}	Turn-Off Switching Loss	—	0.64	—		
E_{ts}	Total Switching Loss	—	0.89	1.3	mJ	
$t_{d(on)}$	Turn-On Delay Time	—	41	—		$T_J = 150^\circ\text{C}$, See Fig. 11, 18
t_r	Rise Time	—	22	—		$I_C = 9.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	320	—	ns	$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	—	290	—		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	—	1.35	—		
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	540	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	37	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	7.0	—		$f = 1.0MHz$
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	—		$T_J = 125^\circ\text{C}$

$I_F = 8.0A$

$V_R = 200V$

$di/dt = 200A/\mu s$

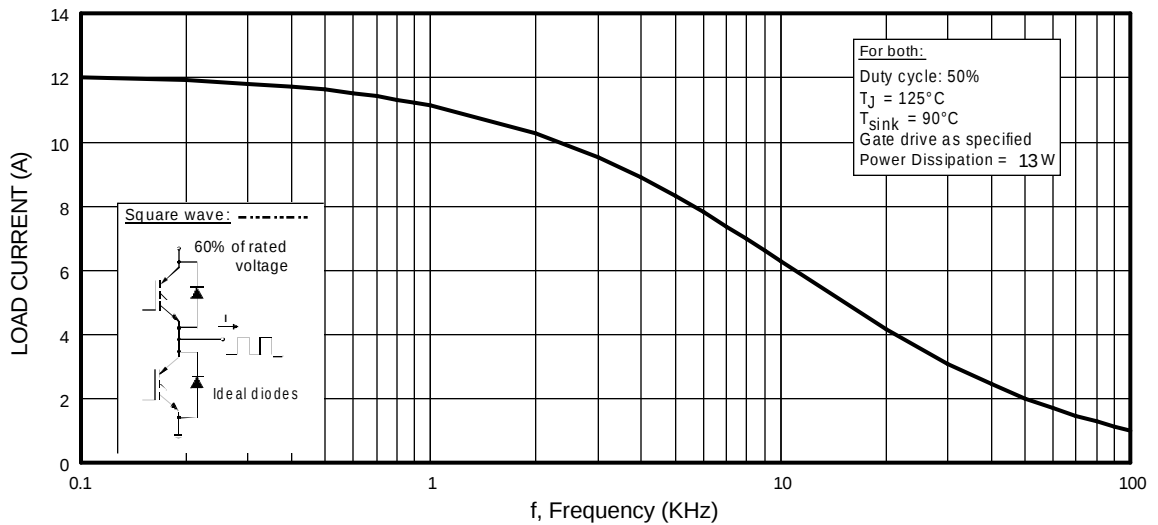


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

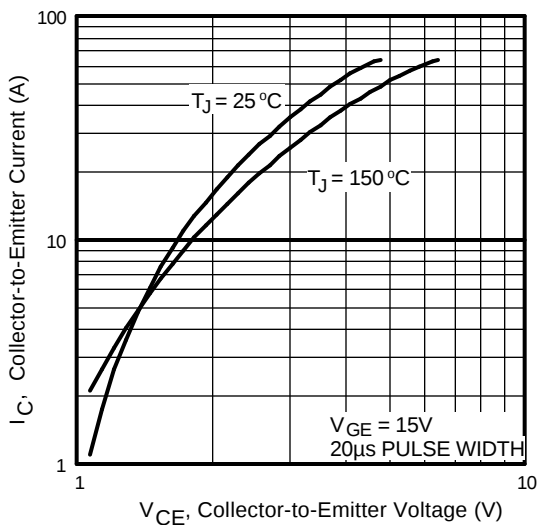


Fig. 2 - Typical Output Characteristics

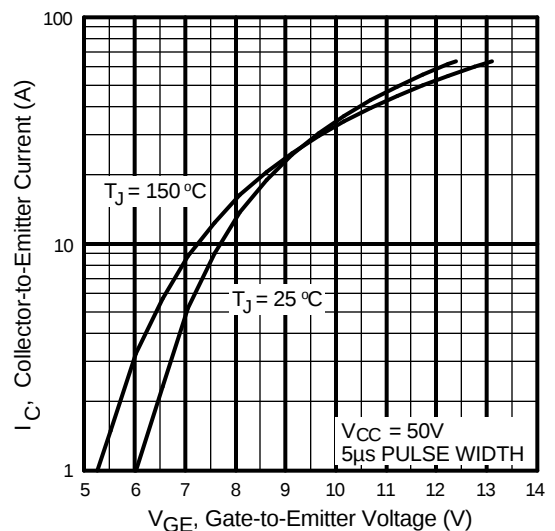


Fig. 3 - Typical Transfer Characteristics

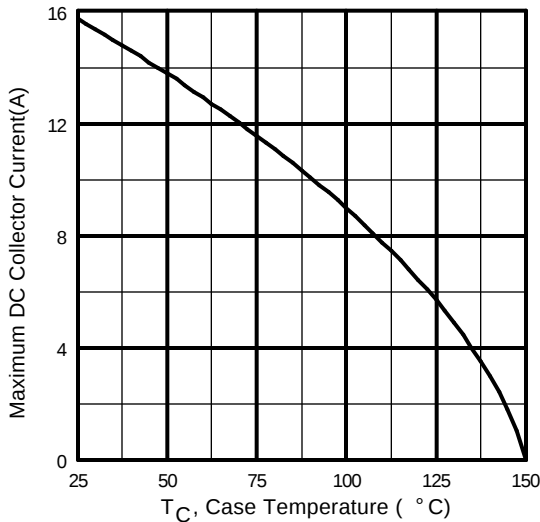


Fig. 4 - Maximum Collector Current vs. Case Temperature

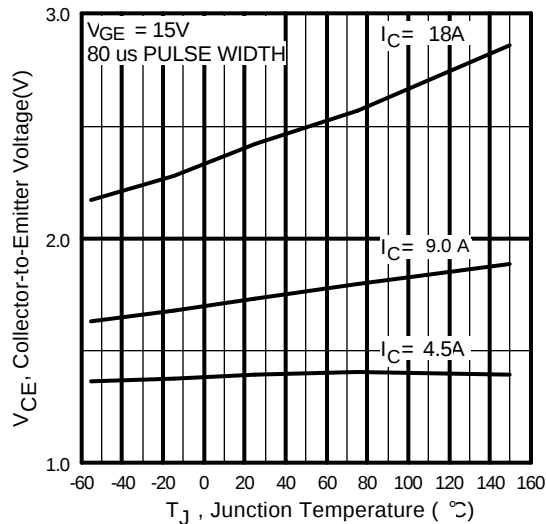


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

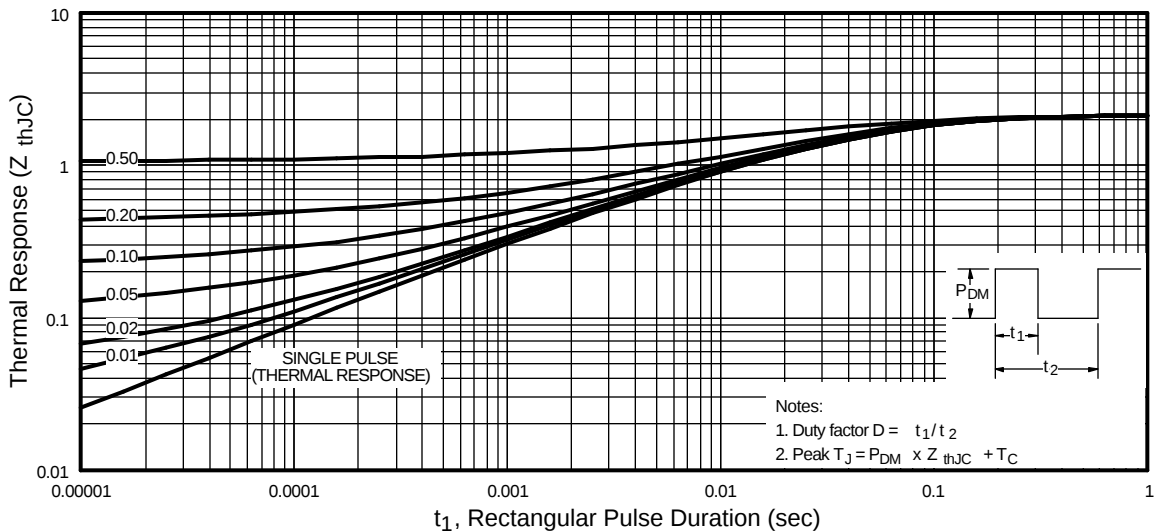


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

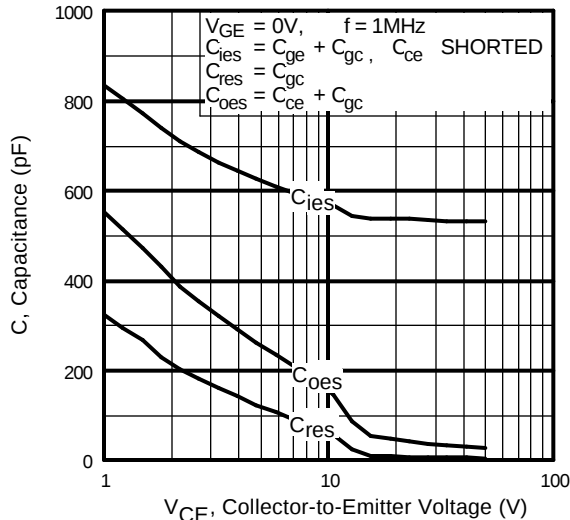


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

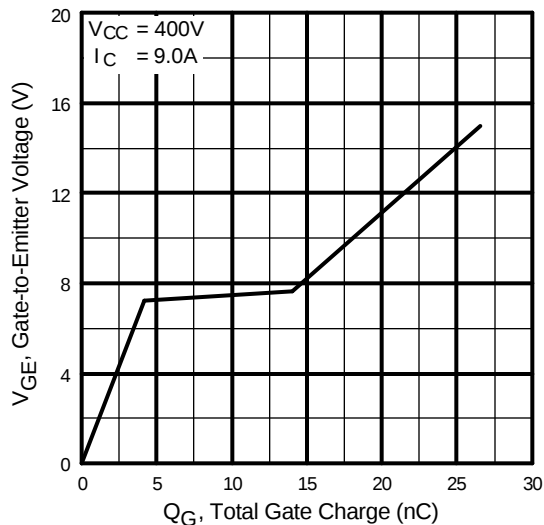


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

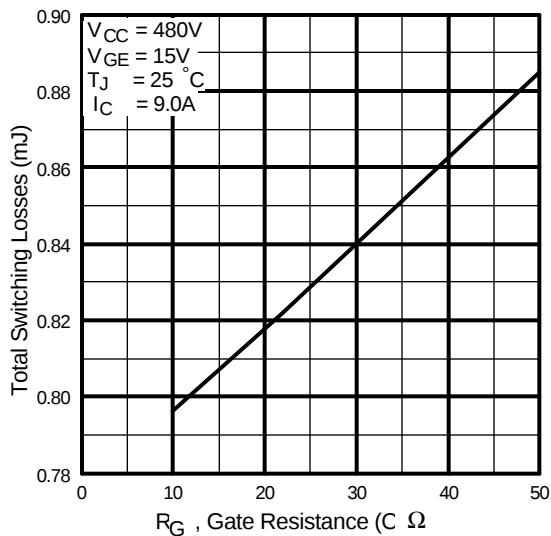


Fig. 9 - Typical Switching Losses vs. Gate Resistance

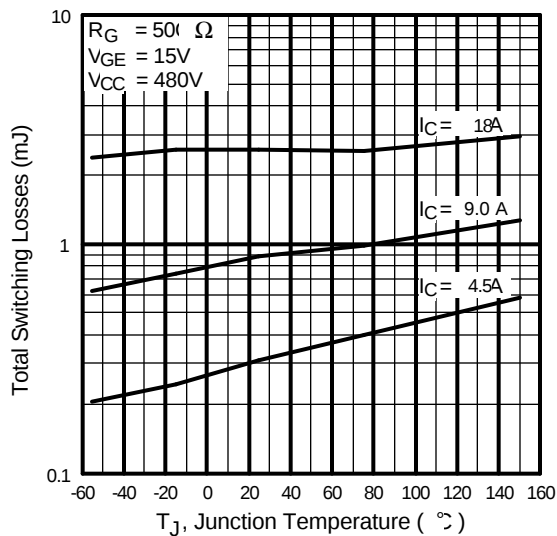


Fig. 10 - Typical Switching Losses vs. Junction Temperature

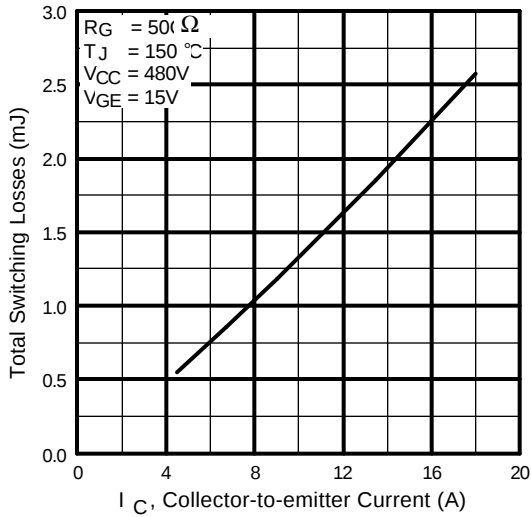


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

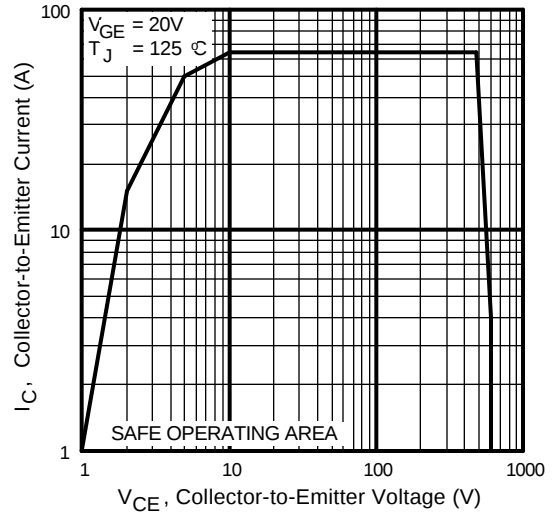


Fig. 12 - Turn-Off SOA

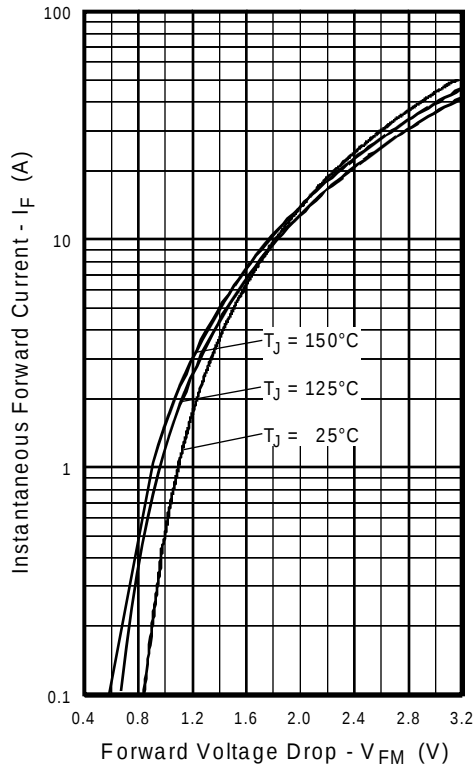


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

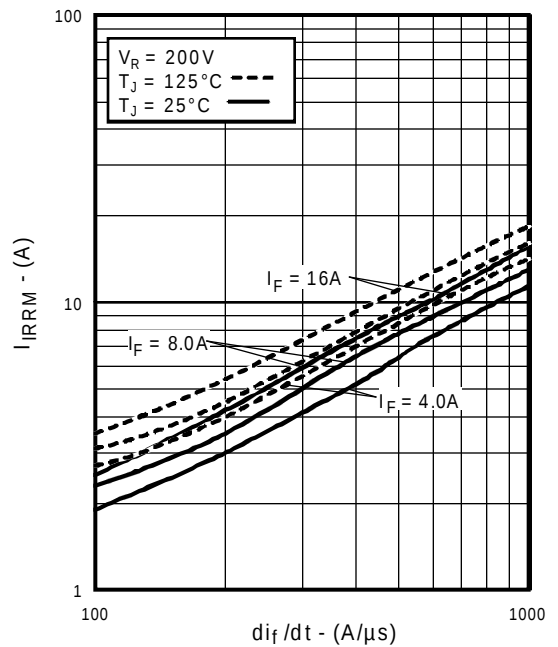
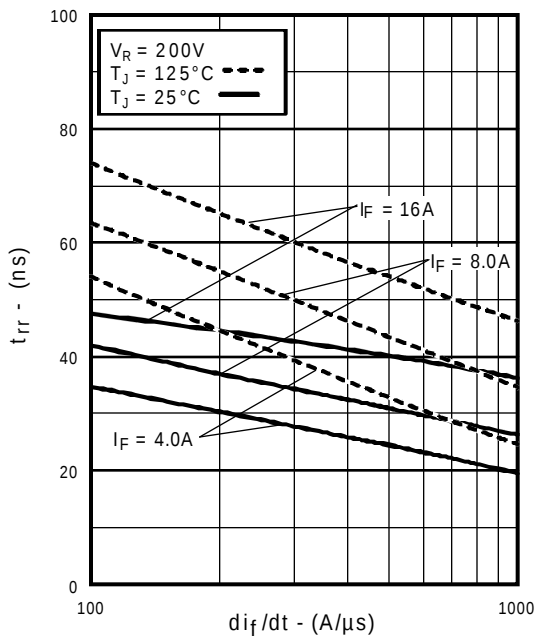


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

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

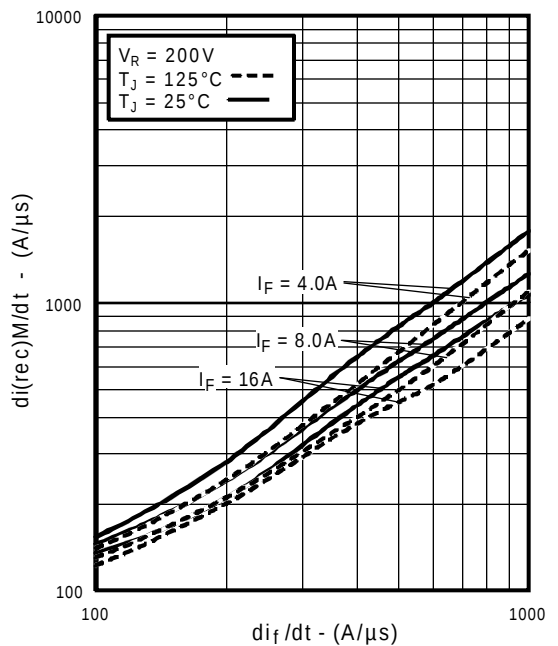
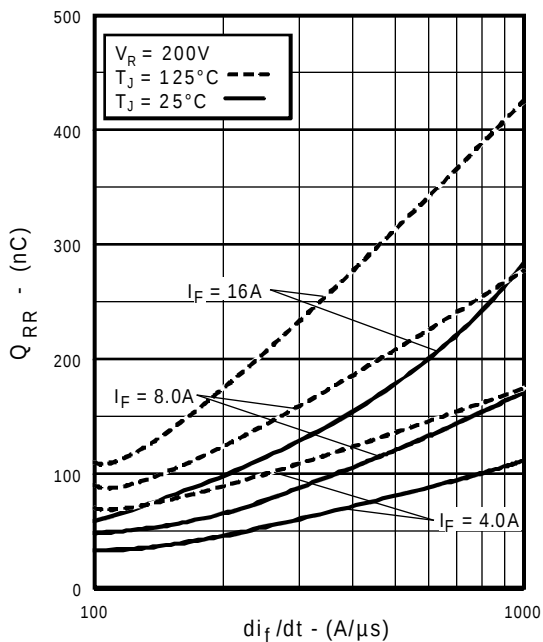


Fig. 16 - Typical Stored Charge vs. di_f/dt

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

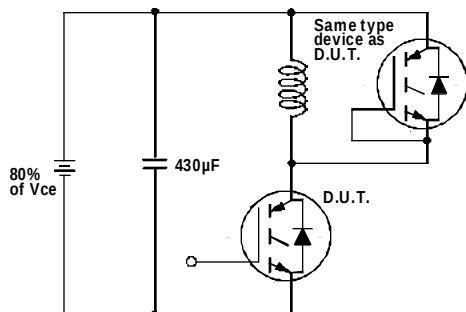


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

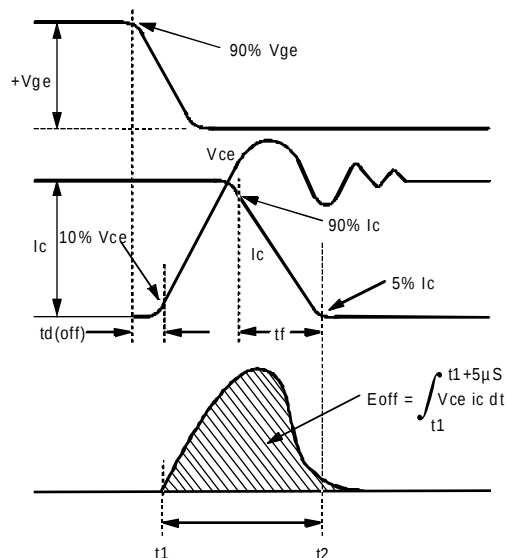


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

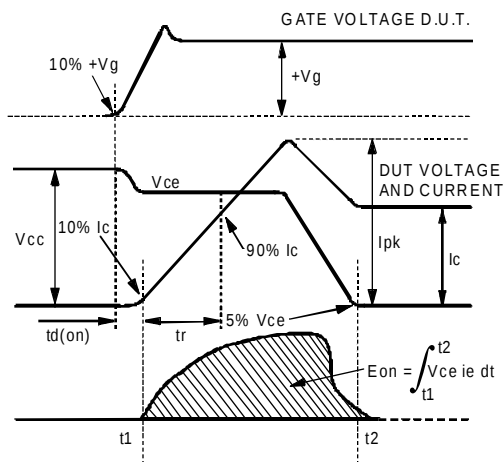


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

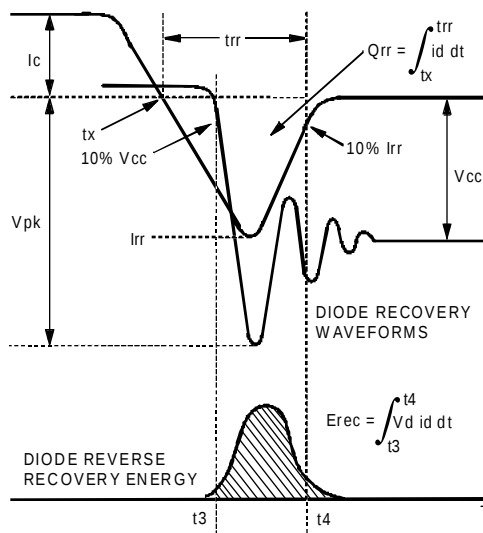


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

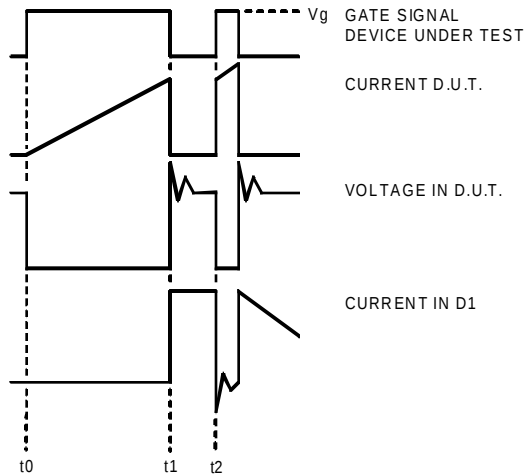


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

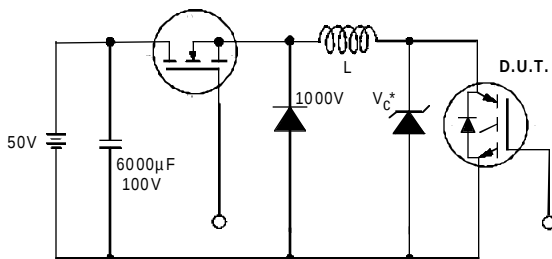


Figure 19. Clamped Inductive Load Test Circuit

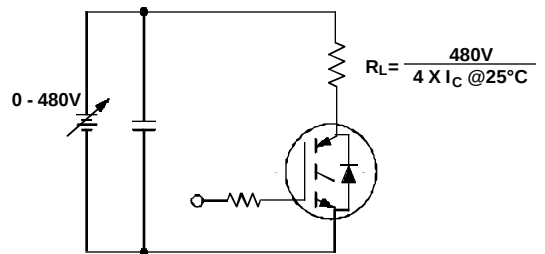


Figure 20. Pulsed Collector Current Test Circuit

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.

Case Outline — TO-220AB

