

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

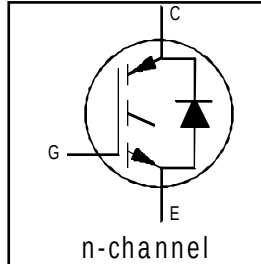
Short Circuit Rated UltraFast IGBT

Features

- High short circuit rating optimized for motor control, $t_{sc} = 10\mu s$, @360V V_{CE} (start), $T_J = 125^\circ C$, $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes

Benefits

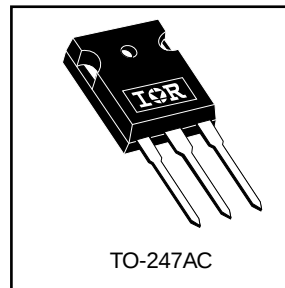
- Latest generation 4 IGBT's offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- This part replaces the IRGPC50KD2 and IRGPC50MD2 products
- For hints see design tip 97003



$$V_{CES} = 600V$$

$$V_{CE(on)} \text{ typ.} = 1.84V$$

$$@V_{GE} = 15V, I_C = 30A$$



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	52	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	30	
I_{CM}	Pulsed Collector Current ①	104	
I_{LM}	Clamped Inductive Load Current ②	104	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	25	
I_{FM}	Diode Maximum Forward Current	280	
t_{sc}	Short Circuit Withstand Time	10	μs
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	104	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
T_J	Operating Junction and	-55 to +150	$^\circ C$
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	—	—	0.64	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.83	
$R_{\theta CS}$	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 @ $T_J = 25^\circ\text{C}$ (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	—	0.47	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.84	2.2	V	$I_C = 30A$ $V_{GE} = 15V$
		—	2.19	—		$I_C = 52A$ See Fig. 2, 5
		—	1.79	—		$I_C = 25A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	—	-12	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ④	17	24	—	S	$V_{CE} = 100V, I_C = 30A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	6500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.3	1.7	V	$I_C = 25A$ See Fig. 13
		—	1.2	1.5		$I_C = 25A, T_J = 150^\circ\text{C}$
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)	—	200	300	nC	$I_C = 30A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	25	38		$V_{CC} = 400V$ See Fig.8
Q_{gc}	Gate - Collector Charge (turn-on)	—	85	127		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	63	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 30A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 5.0\Omega$
t_r	Rise Time	—	49	—		
$t_{d(off)}$	Turn-Off Delay Time	—	150	220		
t_f	Fall Time	—	95	140		
E_{on}	Turn-On Switching Loss	—	1.61	—	mJ	Energy losses include "tail" and diode reverse recovery See Fig. 9,10,18
E_{off}	Turn-Off Switching Loss	—	0.84	—		
E_{ts}	Total Switching Loss	—	2.45	3.0		
t_{sc}	Short Circuit Withstand Time	10	—	—	μs	$V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 10\Omega, V_{CPK} < 500V$
$t_{d(on)}$	Turn-On Delay Time	—	61	—	ns	$T_J = 150^\circ\text{C},$ See Fig. 11,18 $I_C = 30A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 5.0\Omega$
t_r	Rise Time	—	46	—		
$t_{d(off)}$	Turn-Off Delay Time	—	310	—		
t_f	Fall Time	—	170	—		
E_{ts}	Total Switching Loss	—	3.53	—	mJ	Energy losses include "tail" and diode reverse recovery
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	3200	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	370	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	95	—		$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	—	50	75	ns	$T_J = 25^\circ\text{C}$ See Fig. 14
		—	105	160		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Current	—	4.5	10	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		—	8.0	15		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	—	112	375	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		—	420	1200		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	250	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		—	160	—		$T_J = 125^\circ\text{C}$

$I_F = 25A$

$V_R = 200V$

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

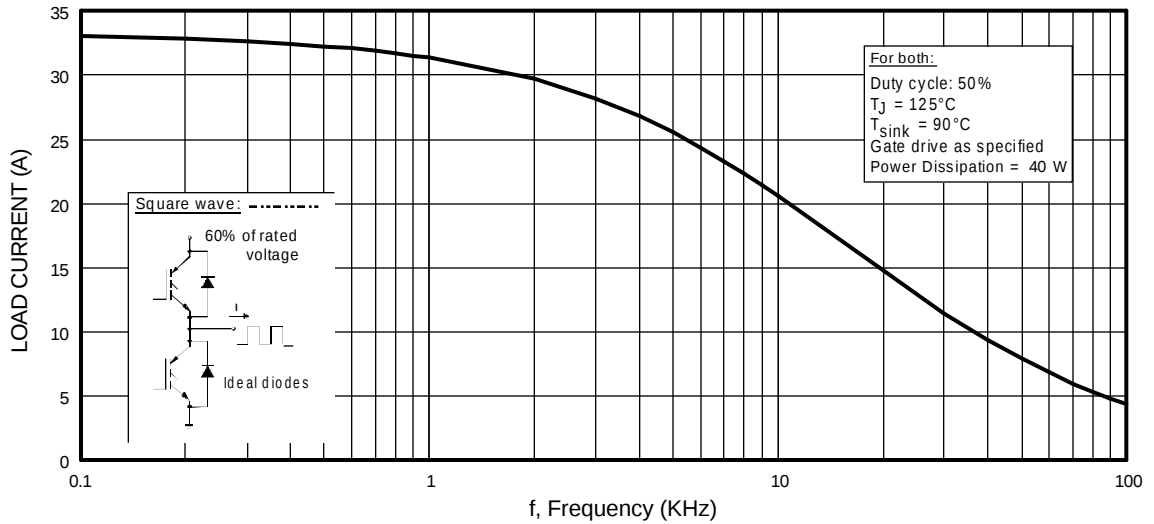


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

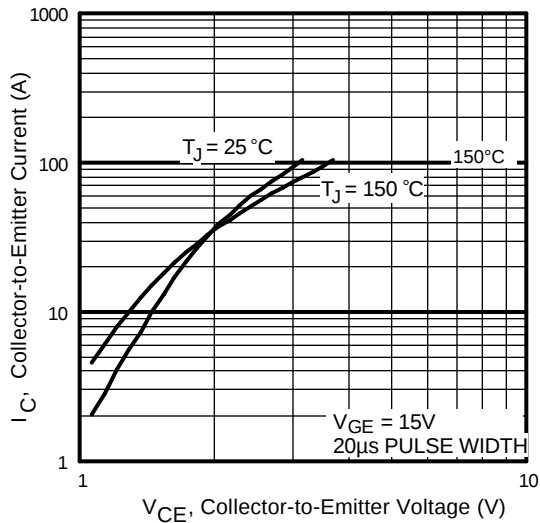


Fig. 2 - Typical Output Characteristics

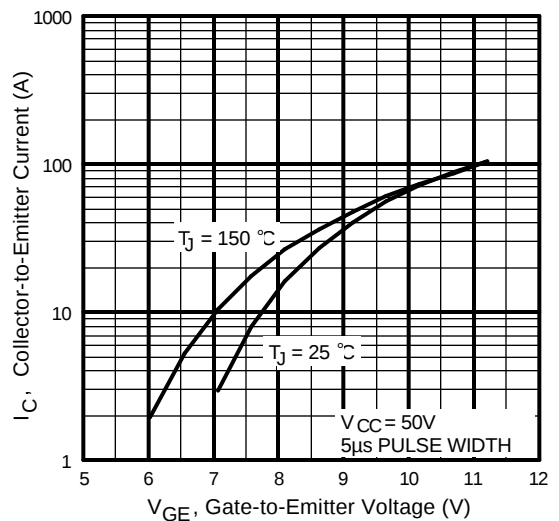


Fig. 3 - Typical Transfer Characteristics

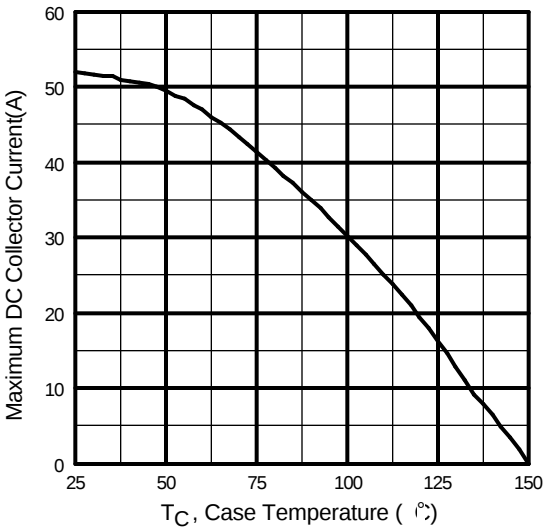


Fig. 4 - Maximum Collector Current vs. Case Temperature

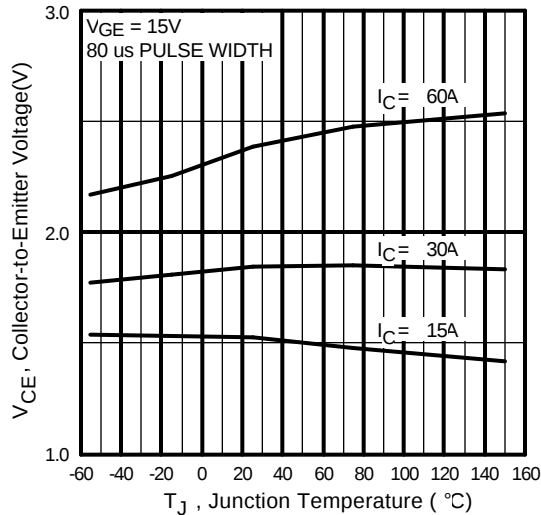


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

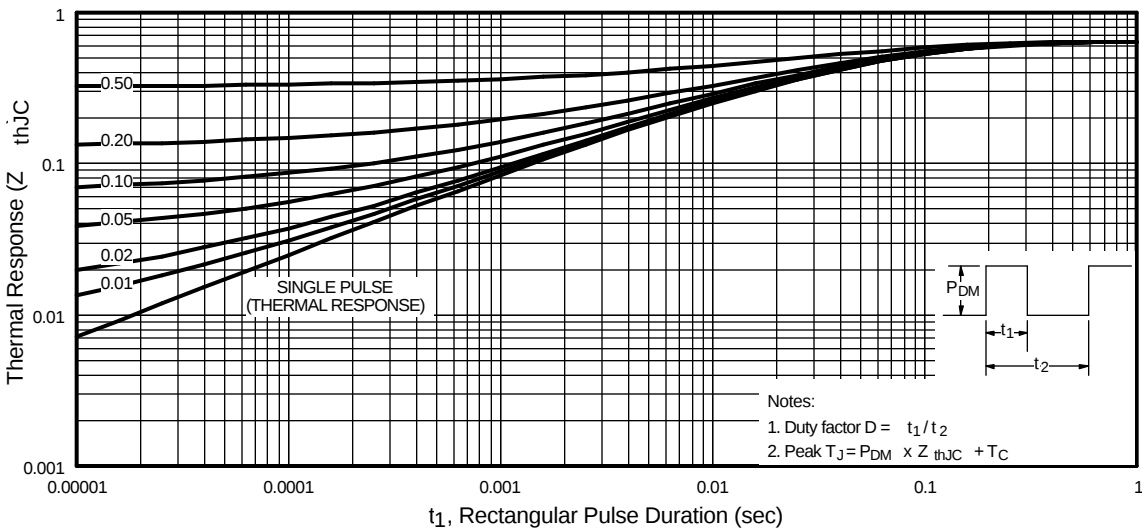


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

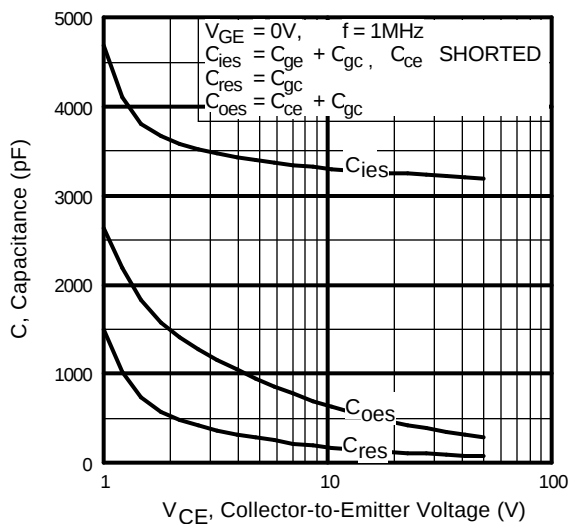


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

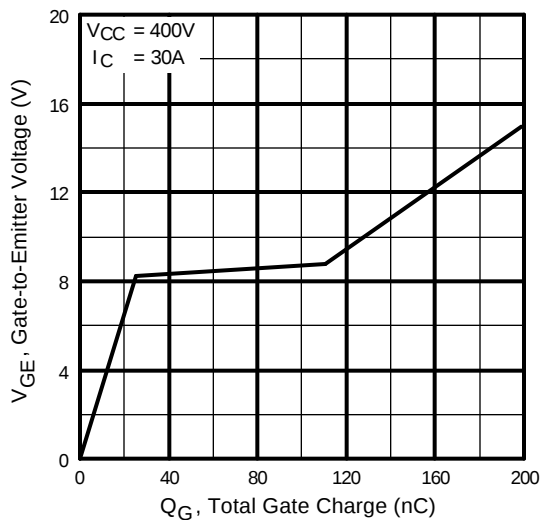


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

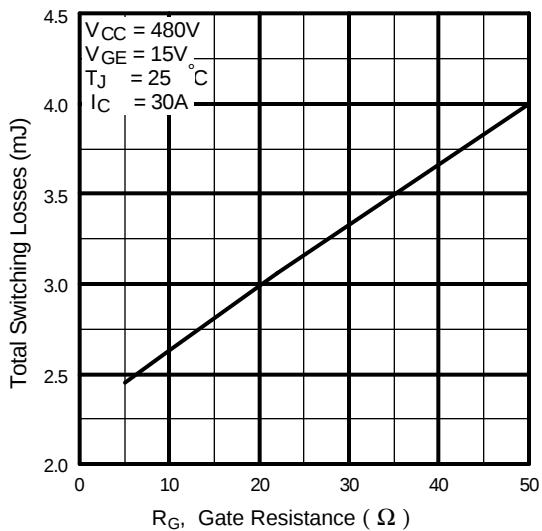


Fig. 9 - Typical Switching Losses vs. Gate Resistance

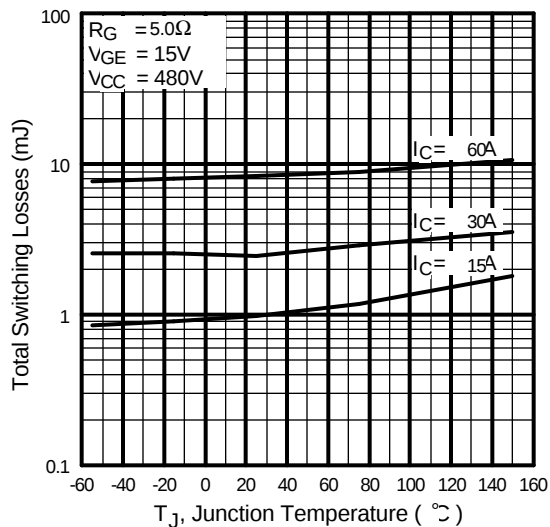


Fig. 10 - Typical Switching Losses vs. Junction Temperature

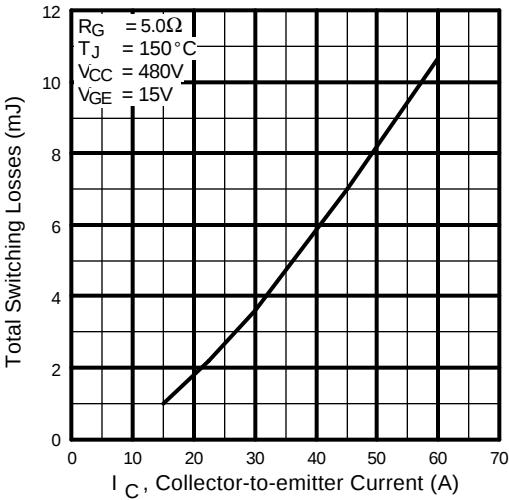


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

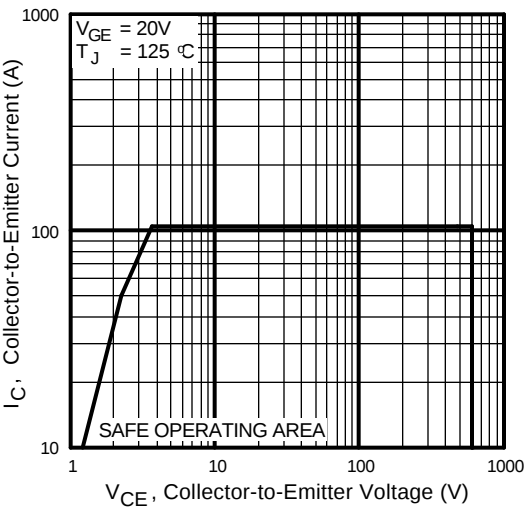


Fig. 12 - Turn-Off SOA

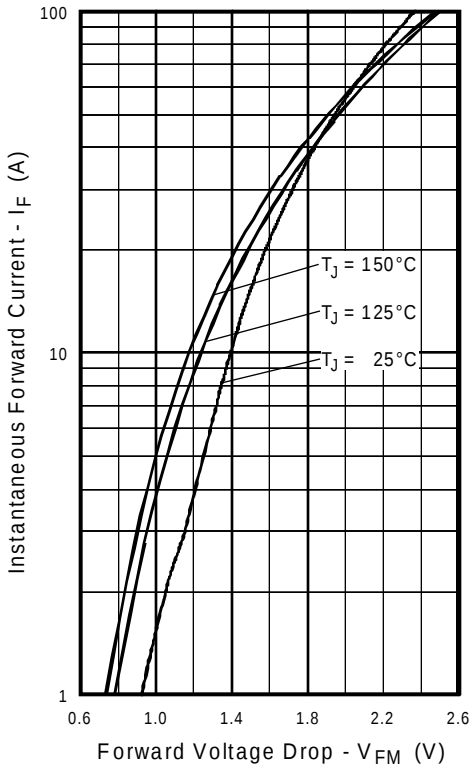
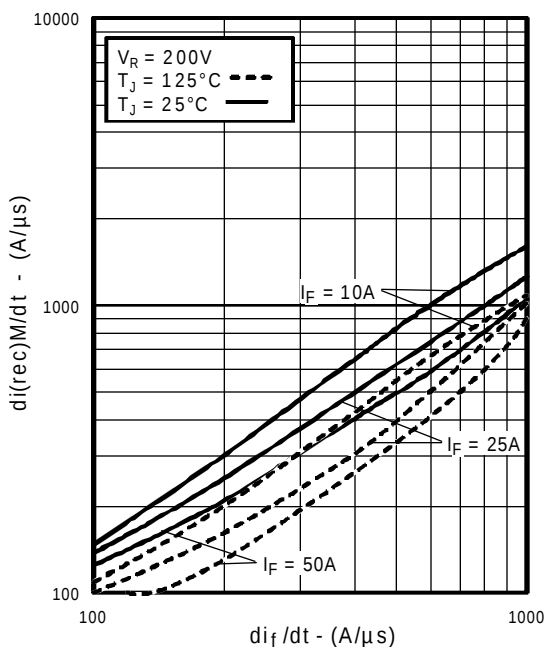
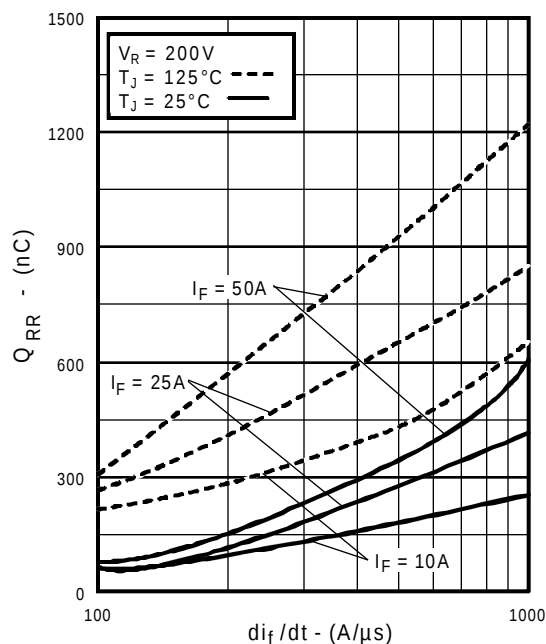
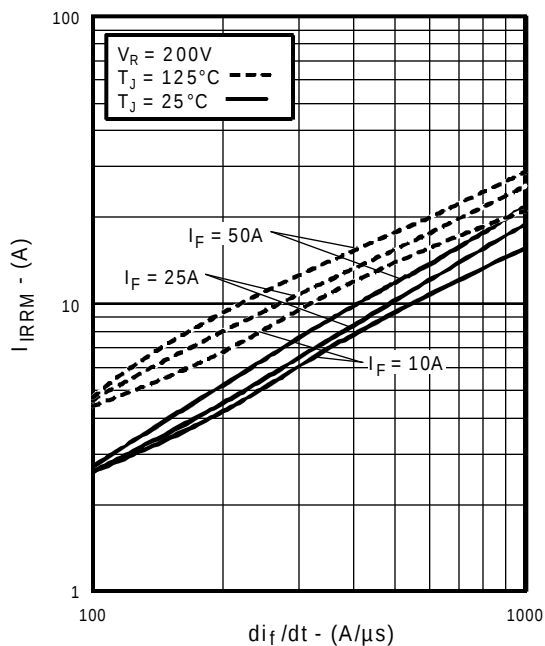
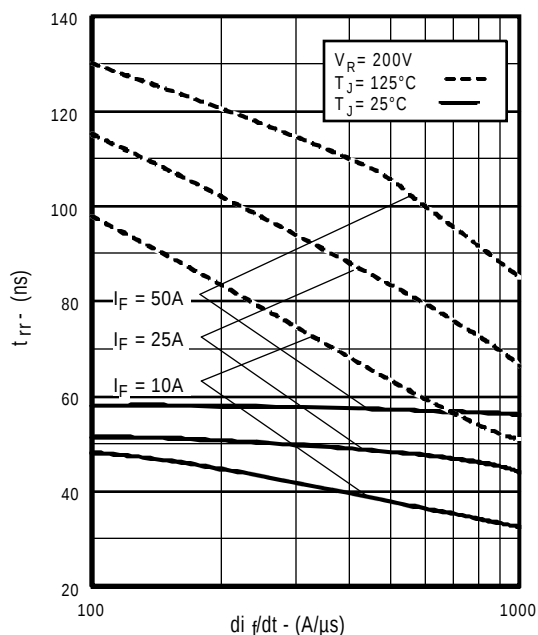


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



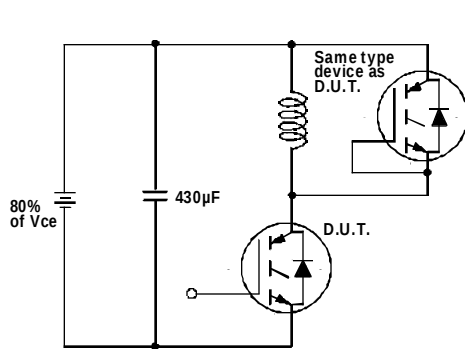


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

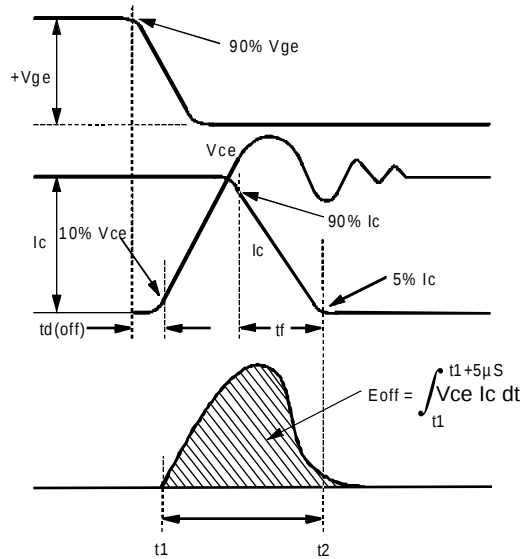


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

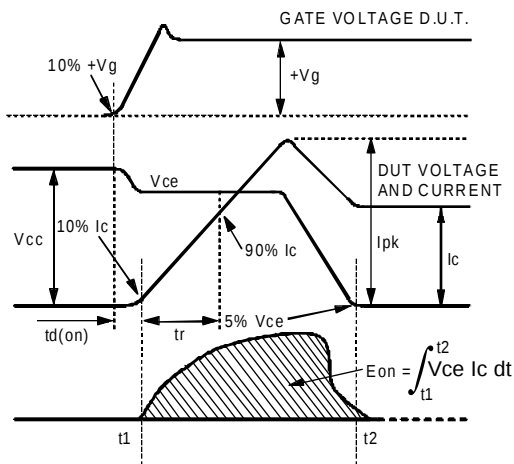


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

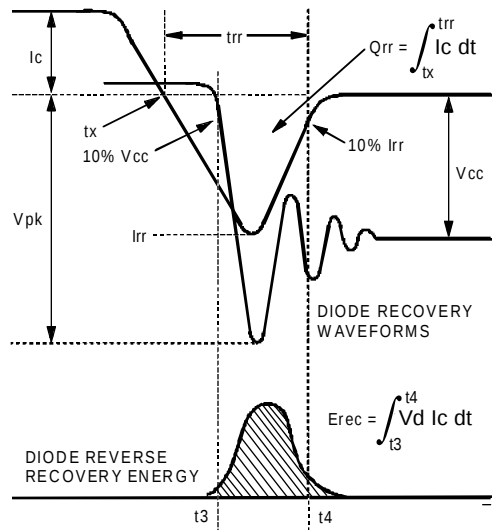


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

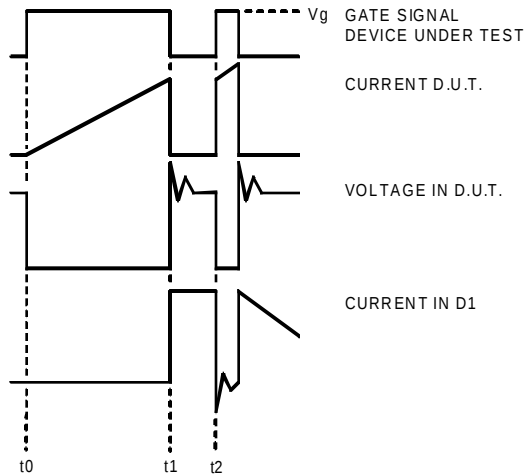


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

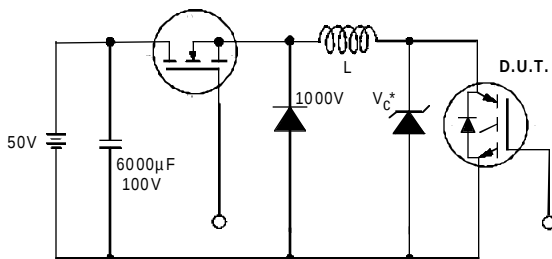


Figure 19. Clamped Inductive Load Test Circuit

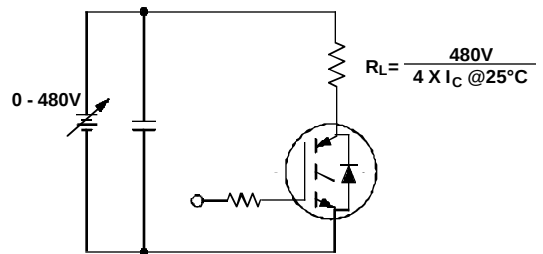


Figure 20. Pulsed Collector Current Test Circuit

Notes:

- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=5.0\Omega$ (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 — TO-247AC

