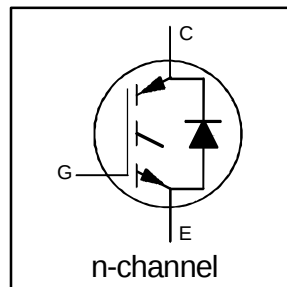


**INSULATED GATE BIPOLAR TRANSISTOR
WITH ULTRAFAST SOFT RECOVERY DIODE**

UltraFast CoPack IGBT

Features

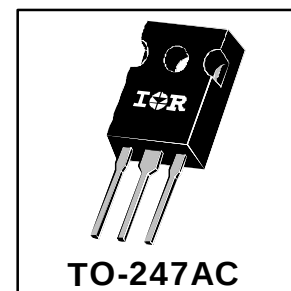
- Switching-loss rating includes all "tail" losses
- HEXFRED™ soft ultrafast diodes
- Optimized for high operating frequency (over 5kHz)
See Fig. 1 for Current vs. Frequency curve



$V_{CES} = 500V$
$V_{CE(sat)} \leq 3.0V$
@ $V_{GE} = 15V, I_C = 22A$

Description

Co-packaged IGBTs are a natural extension of International Rectifier's well known IGBT line. They provide the convenience of an IGBT and an ultrafast recovery diode in one package, resulting in substantial benefits to a host of high-voltage, high-current, motor control, UPS and power supply applications.



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	500	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	40	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	22	
I_{CM}	Pulsed Collector Current ①	80	
I_{LM}	Clamped Inductive Load Current ②	80	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
I_{FM}	Diode Maximum Forward Current	80	
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	-55 to +150	$^\circ C$
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 sec.		
	Mounting Torque, 6-32 or M3 Screw.	300 (0.063 in. (1.6mm) from case) 10 lbf•in (1.1 N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.77	$^\circ C/W$
$R_{\theta JC}$	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)

IRGP440UD2



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	500	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temp. Coeff. of Breakdown Voltage	—	0.35	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.4	3.0	V	$I_C = 22A$ $V_{GE} = 15V$
		—	2.8	—		$I_C = 40A$ See Fig. 2, 5
		—	2.4	—		$I_C = 22A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-11	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ④	6.6	13	—	S	$V_{CE} = 100V, I_C = 22A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 500V$
		—	—	3500		$V_{GE} = 0V, V_{CE} = 500V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.3	1.7	V	$I_C = 15A$ See Fig. 13
		—	1.2	1.6		$I_C = 15A, T_J = 150^\circ\text{C}$
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)	—	55	83	nC	$I_C = 22A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	11	17		$V_{CC} = 400V$
Q_{gc}	Gate - Collector Charge (turn-on)	—	19	29		See Fig. 8
$t_{d(on)}$	Turn-On Delay Time	—	80	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	68	—		$I_C = 22A, V_{CC} = 400V$
$t_{d(off)}$	Turn-Off Delay Time	—	160	240		$V_{GE} = 15V, R_G = 10\Omega$
t_f	Fall Time	—	130	220	mJ	Energy losses include "tail" and diode reverse recovery.
E_{on}	Turn-On Switching Loss	—	0.81	—		See Fig. 9, 10, 11, 18
E_{off}	Turn-Off Switching Loss	—	0.82	—		
E_{ts}	Total Switching Loss	—	1.6	2.4	ns	$T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18
$t_{d(on)}$	Turn-On Delay Time	—	78	—		$I_C = 22A, V_{CC} = 400V$
t_r	Rise Time	—	64	—		$V_{GE} = 15V, R_G = 10\Omega$
$t_{d(off)}$	Turn-Off Delay Time	—	290	—	mJ	Energy losses include "tail" and diode reverse recovery.
t_f	Fall Time	—	250	—		
E_{ts}	Total Switching Loss	—	2.6	—		
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	1400	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	250	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	42	—		$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	—	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig. 14
		—	74	120		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Current	—	4.0	6.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		—	6.5	10		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		—	220	600		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	188	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		—	160	—		$T_J = 125^\circ\text{C}$

Notes:

- ① Repetitive rating; $V_{GE}=20V$, pulse width limited by max. junction temperature. (See fig. 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=10\Omega$, (See fig. 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width 5.0 μs , single shot.

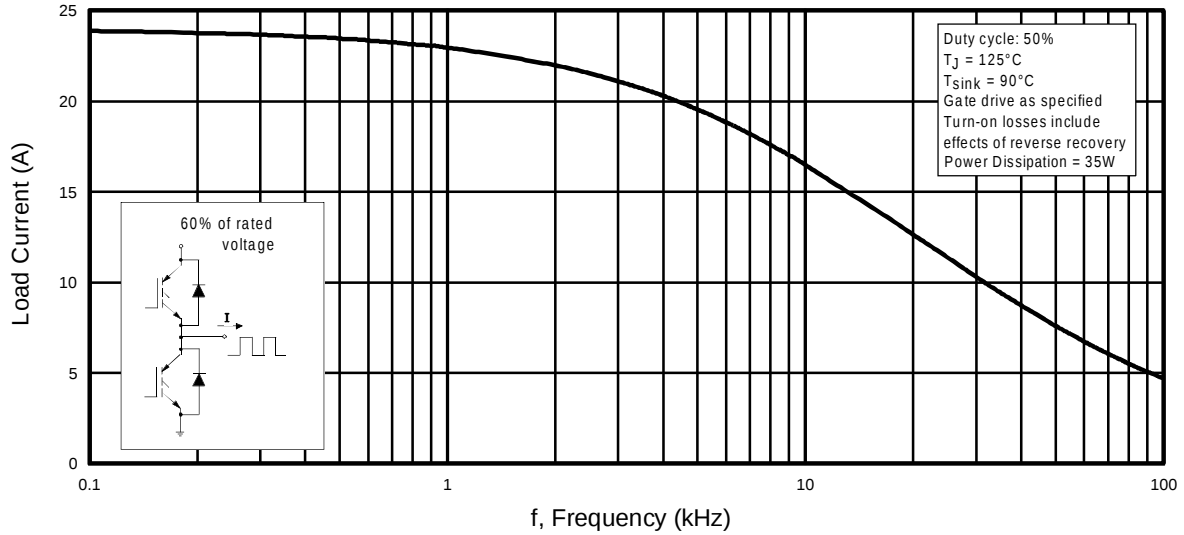


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

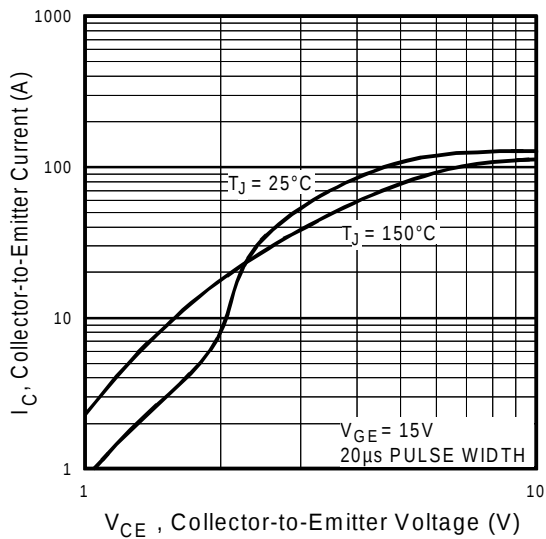


Fig. 2 - Typical Output Characteristics

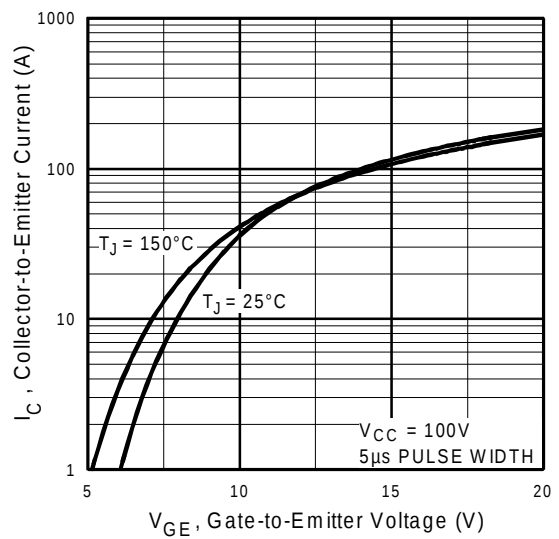


Fig. 3 - Typical Transfer Characteristics

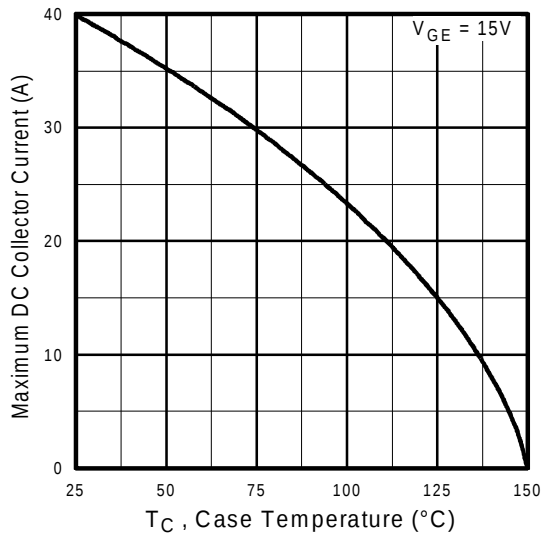


Fig. 4 - Maximum Collector Current vs. Case Temperature

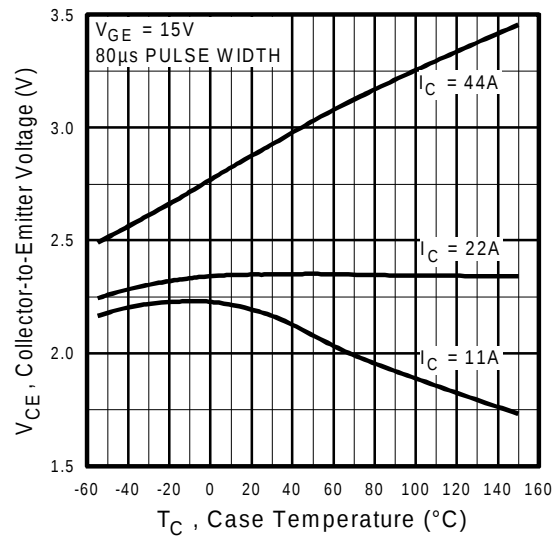


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

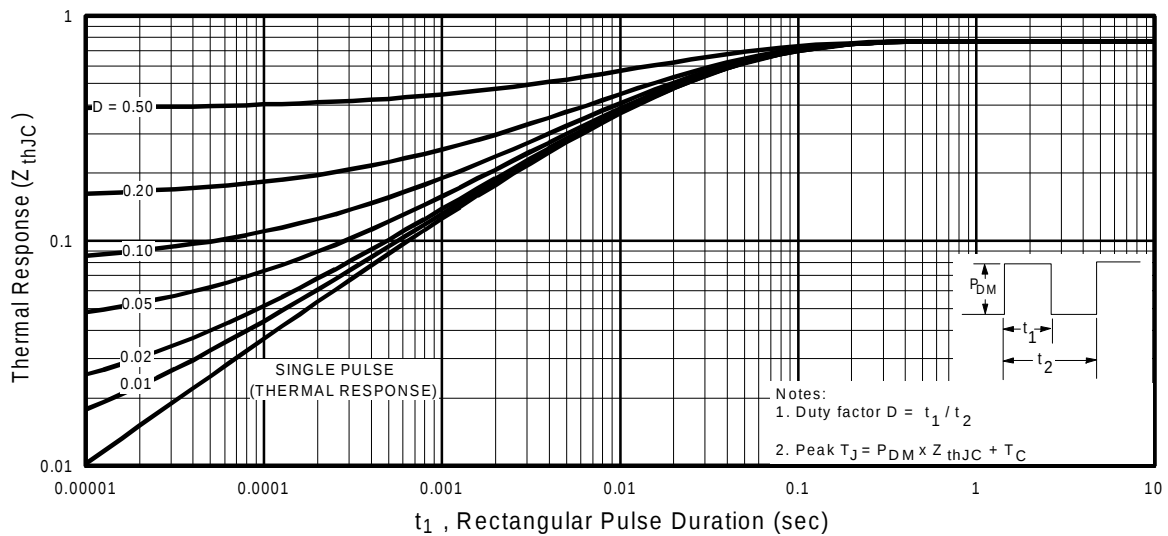


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

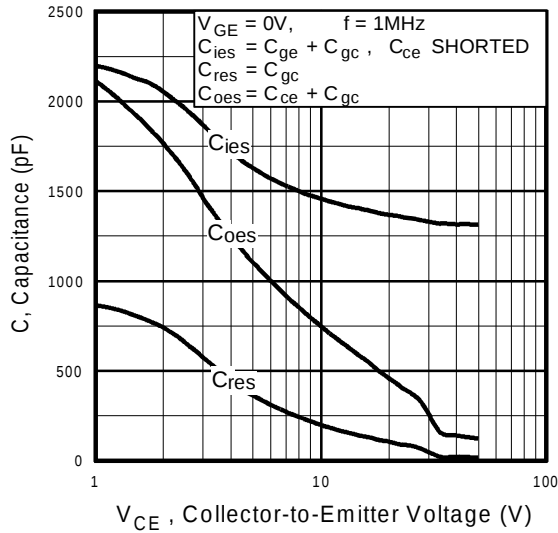


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

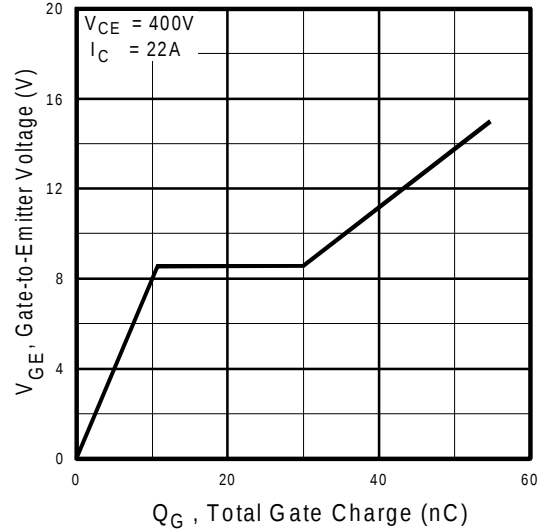


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

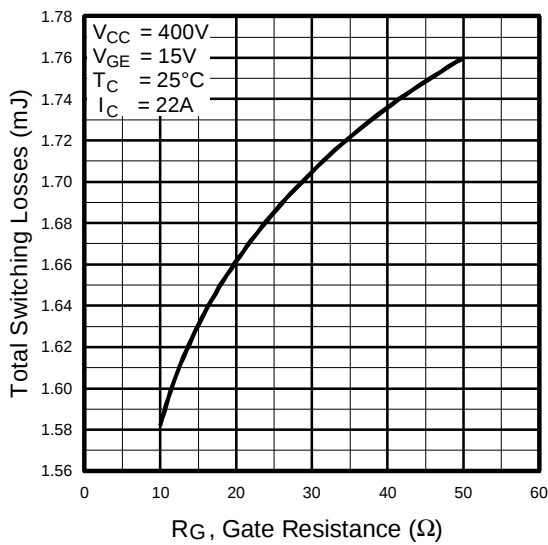


Fig. 9 - Typical Switching Losses vs. Gate Resistance

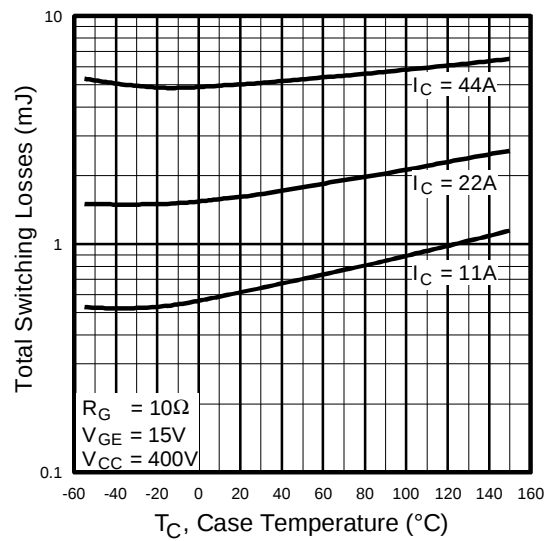


Fig. 10 - Typical Switching Losses vs. Case Temperature

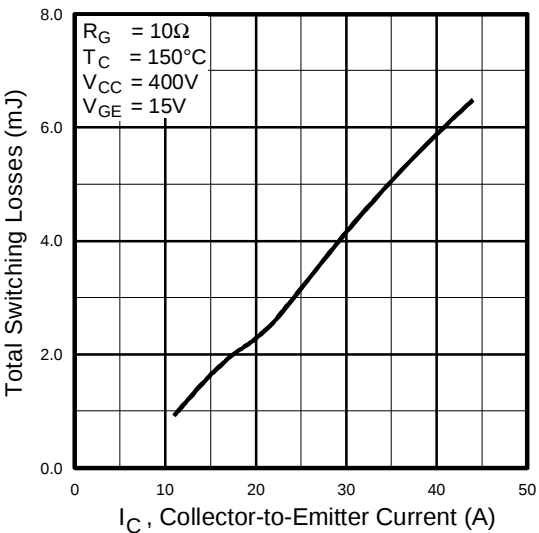


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

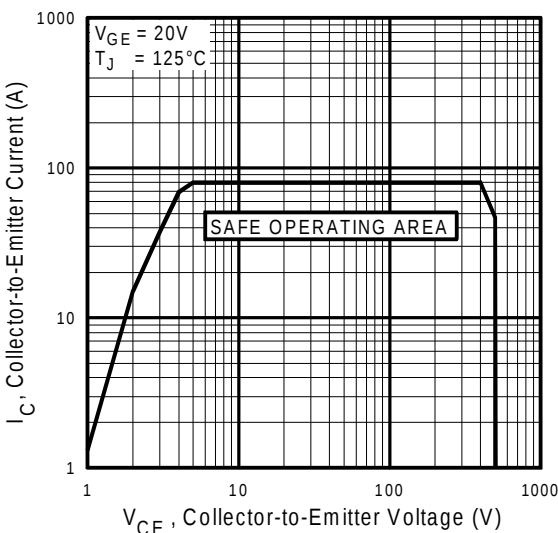


Fig. 12 - Turn-Off SOA

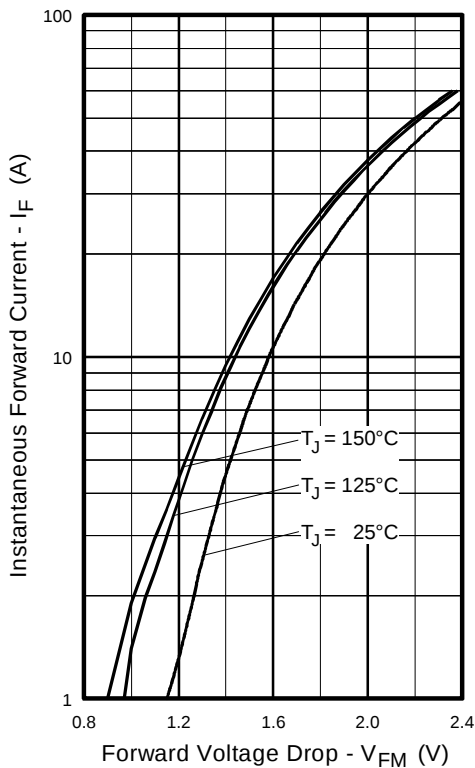


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

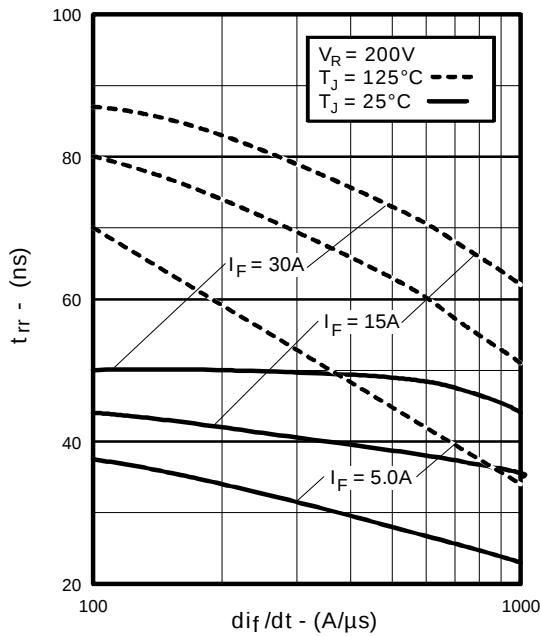


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

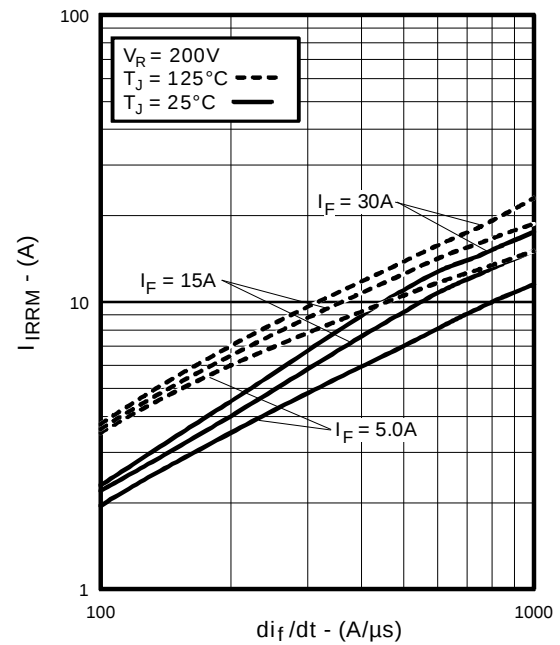


Fig. 15 - Typical Recovery Current vs. di_f/dt

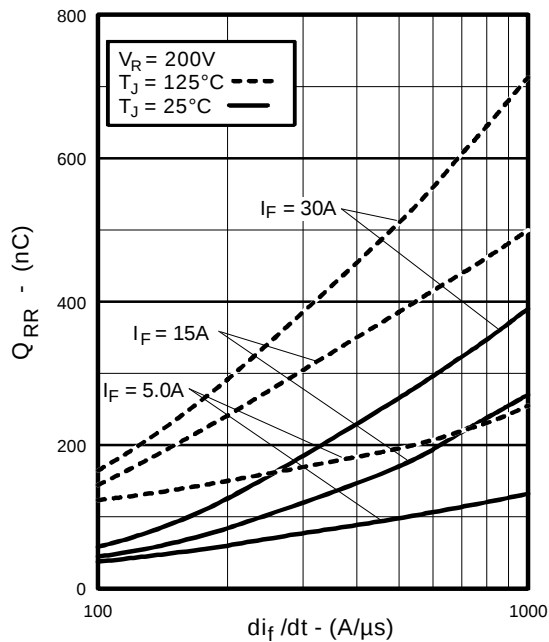


Fig. 16 - Typical Stored Charge vs. di_f/dt

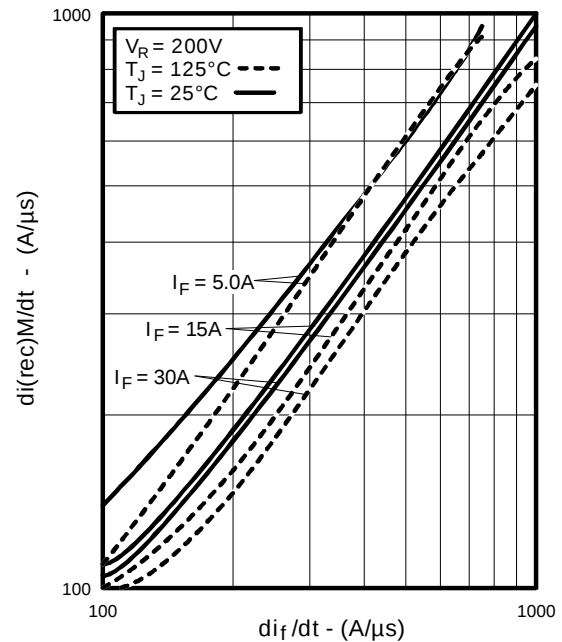


Fig. 17 - Typical $di(rec)M/dt$ vs. di_f/dt

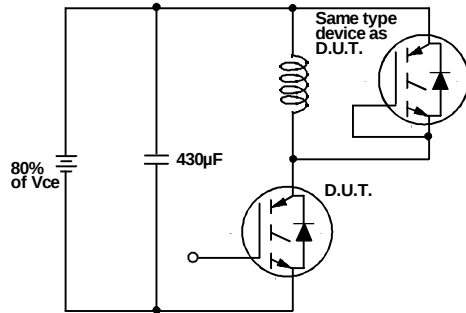


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

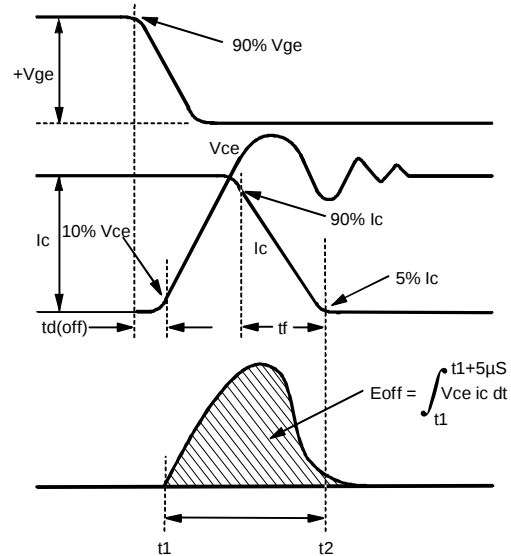


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

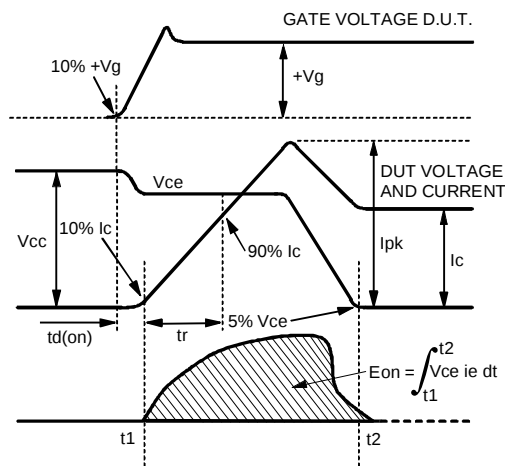


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

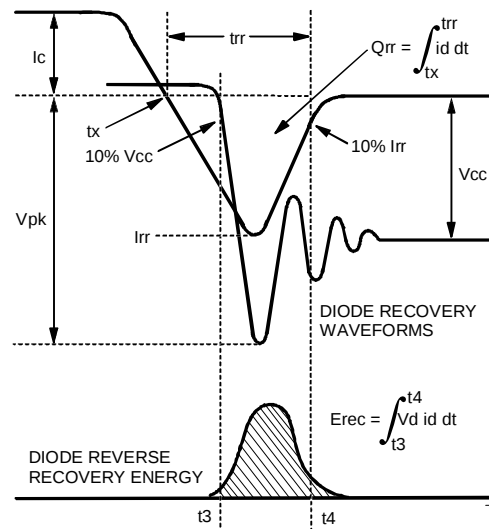


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

Refer to Section D for the following:
Appendix B: Section D - page D-4

Fig. 18e - Clamped Inductive Load Test Circuit
Fig. 19 - Pulsed Collector Current Test Circuit
Fig. 20 - Switching Loss Test Circuit