International
IOR Rectifier

PD - 9.1109

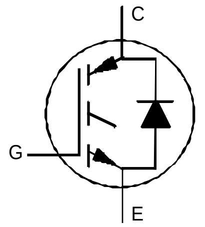
IRGPC20KD2

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast CoPack IGBT

Features

- Short circuit rated -10µs @125°C, V_{GE} = 15V
- 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



n-channel

V_{CES} = 600V

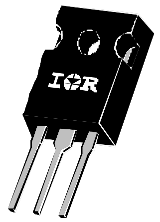
$V_{CE(sat)} \leq$ 3.5V

@V_{GE} = 15V, I_C = 6.0A

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, applications.

These new short circuit rated devices are especially suited for motor control and other applications requiring short circuit withstand capability.



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	10	A
I_C @ T_C = 100°C	Continuous Collector Current	6.0	
I_{CM}	Pulsed Collector Current ①	20	
I_{LM}	Clamped Inductive Load Current ②	20	
I_F @ T_C = 100°C	Diode Continuous Foward Current	7.0	
I_{FM}	Diode Maximum Forward Current	20	
t_{sc}	Short Circuit Withstand Time	10	µs
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	60	W
P_D @ T_C = 100°C	Maximum Power Dissipation	24	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	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	------	------	3.5	
$R_{\theta CS}$	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 @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	600	----	----	V	$V_{GE} = 0V$, $I_C = 250µA$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.37	----	V/°C	$V_{GE} = 0V$, $I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	2.4	3.5	V	$I_C = 6.0A$ $V_{GE} = 15V$
		----	3.6	----		$I_C = 10A$ See Fig. 2, 5
		----	2.9	----		$I_C = 6.0A$, $T_J = 150°C$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	----	5.5		$V_{CE} = V_{GE}$, $I_C = 250µA$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-11	----	mV/°C	$V_{CE} = V_{GE}$, $I_C = 250µA$
g_{fe}	Forward Transconductance ④	1.9	3.3	----	S	$V_{CE} = 100V$, $I_C = 6.0A$
I_{CES}	Zero Gate Voltage Collector Current	----	----	250	µA	$V_{GE} = 0V$, $V_{CE} = 600V$
		----	----	1700		$V_{GE} = 0V$, $V_{CE} = 600V$, $T_J = 150°C$
V_{FM}	Diode Forward Voltage Drop	----	1.4	1.7	V	$I_C = 8.0A$ See Fig. 13
		----	1.3	1.6		$I_C = 8.0A$, $T_J = 150°C$
I_{GES}	Gate-to-Emitter Leakage Current	----	----	±100	nA	$V_{GE} = ±20V$

Switching Characteristics @ $T_J = 25°C$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	
Q_g	Total Gate Charge (turn-on)	----	17	26	nC	$I_C = 6.0A$	
Q_{ge}	Gate - Emitter Charge (turn-on)	----	4.3	6.8		$V_{CC} = 400V$	
Q_{gc}	Gate - Collector Charge (turn-on)	----	6.4	11		See Fig. 8	
$t_{d(on)}$	Turn-On Delay Time	----	59	----	ns	$T_J = 25°C$	
t_r	Rise Time	----	38	----		$I_C = 6.0A$, $V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	110	210		$V_{GE} = 15V$, $R_G = 50\Omega$	
t_f	Fall Time	----	80	120		Energy losses include "tail" and	
E_{on}	Turn-On Switching Loss	----	0.28	----	mJ	diode reverse recovery.	
E_{off}	Turn-Off Switching Loss	----	0.15	----		See Fig. 9, 10, 11, 18	
E_{ts}	Total Switching Loss	----	0.43	0.90			
t_{sc}	Short Circuit Withstand Time	10	----	----	µs	$V_{CC} = 360V$, $T_J = 125°C$ $V_{GE} = 15V$, $R_G = 50\Omega$, $V_{CPK} < 500V$	
$t_{d(on)}$	Turn-On Delay Time	----	52	----	ns	$T_J = 150°C$, See Fig. 9, 10, 11, 18	
t_r	Rise Time	----	35	----		$I_C = 6.0A$, $V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	170	----		$V_{GE} = 15V$, $R_G = 50\Omega$	
t_f	Fall Time	----	170	----		Energy losses include "tail" and	
E_{ts}	Total Switching Loss	----	0.65	----	mJ	diode reverse recovery.	
L_E	Internal Emitter Inductance	----	13	----	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	----	350	----	pF	$V_{GE} = 0V$	
C_{oes}	Output Capacitance	----	45	----		$V_{CC} = 30V$ See Fig. 7	
C_{res}	Reverse Transfer Capacitance	----	4.7	----		$f = 1.0MHz$	
t_{rr}	Diode Reverse Recovery Time	----	37	55	ns	$T_J = 25°C$ See Fig.	
		----	55	90		$T_J = 125°C$ 14	$I_F = 8.0A$
I_{rr}	Diode Peak Reverse Recovery Current	----	3.5	5.0	A	$T_J = 25°C$ See Fig.	
		----	4.5	8.0		$T_J = 125°C$ 15	$V_R = 200V$
Q_{rr}	Diode Reverse Recovery Charge	----	65	138	nC	$T_J = 25°C$ See Fig.	
		----	124	360		$T_J = 125°C$ 16	di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	----	240	----	A/µs	$T_J = 25°C$ See Fig.	
		----	210	----		$T_J = 125°C$ 17	

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=10µH, R_G= 50Ω, (See fig. 19)

③ Pulse width ≤ 80µs; duty factor ≤ 0.1%.

④ Pulse width 5.0µs, single shot.

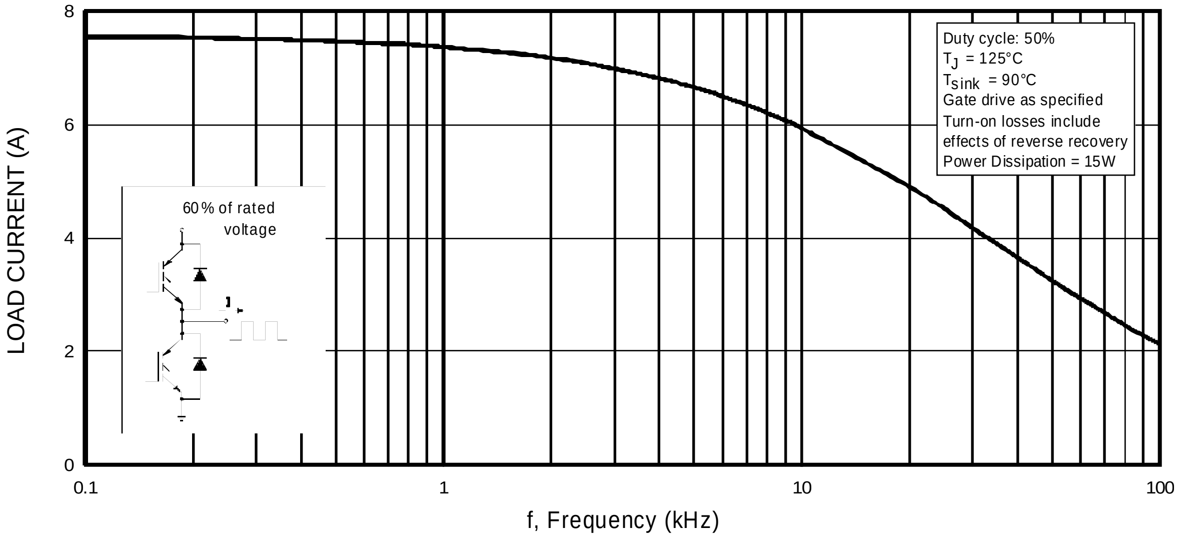


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

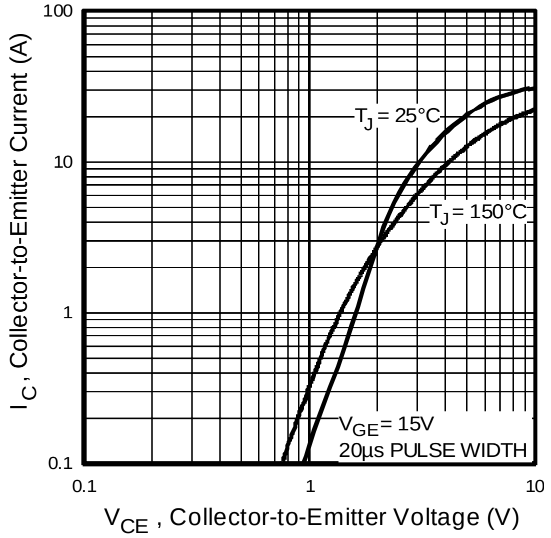


Fig. 2 - Typical Output Characteristics

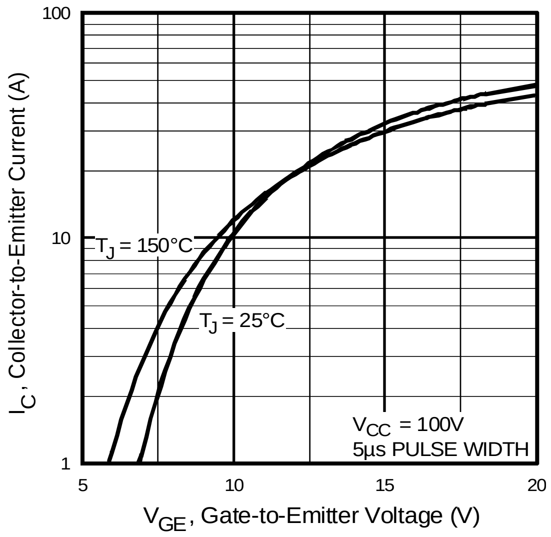


Fig. 3 - Typical Transfer Characteristics

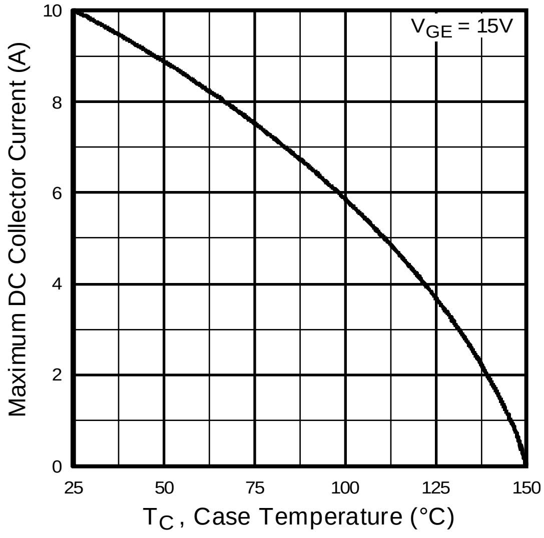


Fig. 4 - Maximum Collector Current vs. Case Temperature

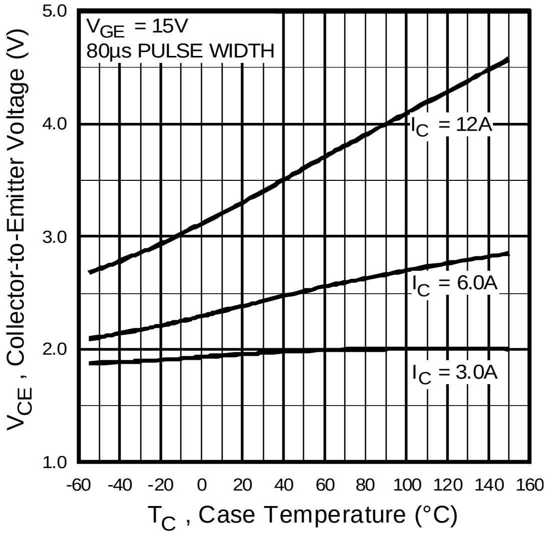


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

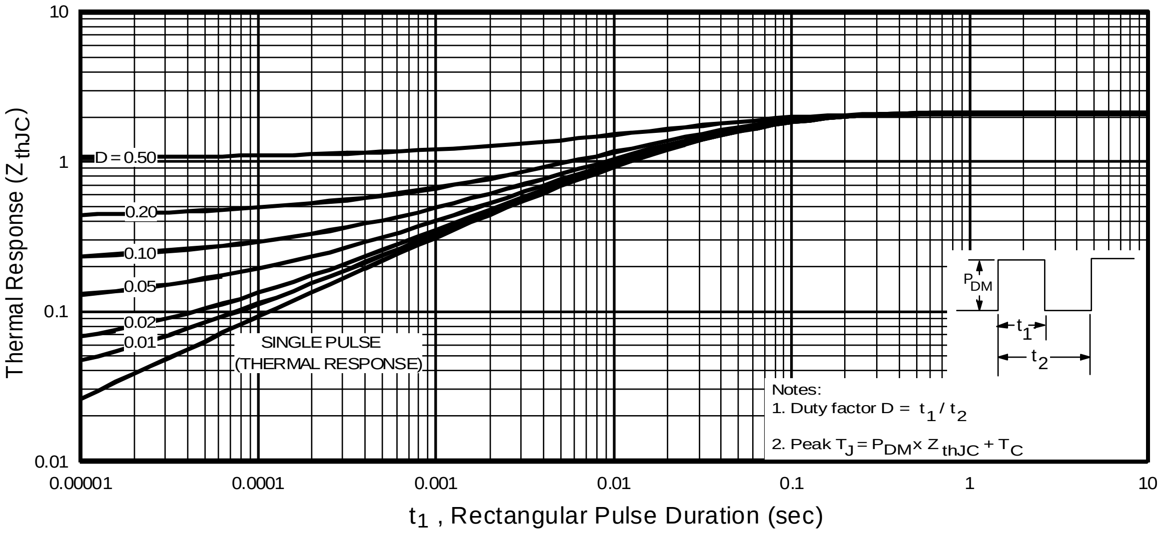


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

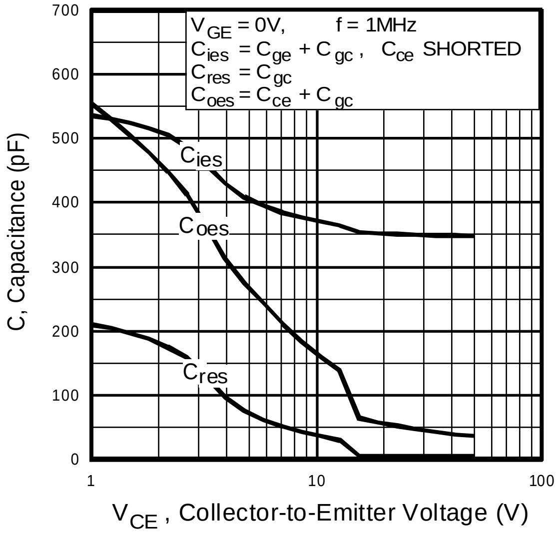


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

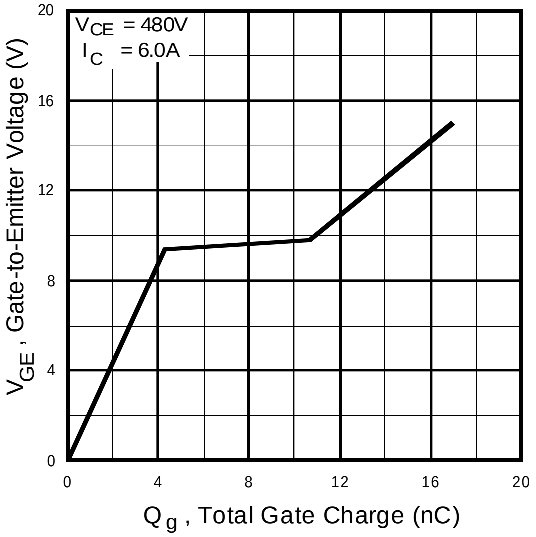


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

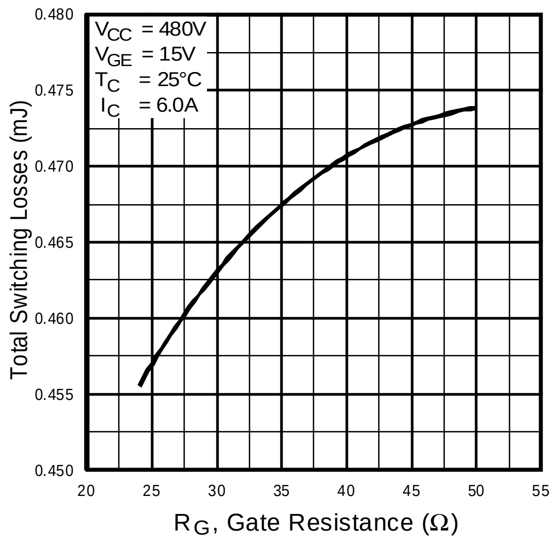


Fig. 9 - Typical Switching Losses vs. Gate Resistance

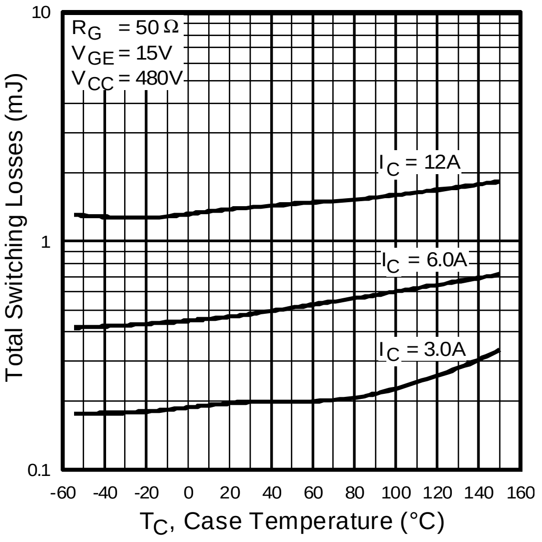


Fig. 10 - Typical Switching Losses vs. Case Temperature

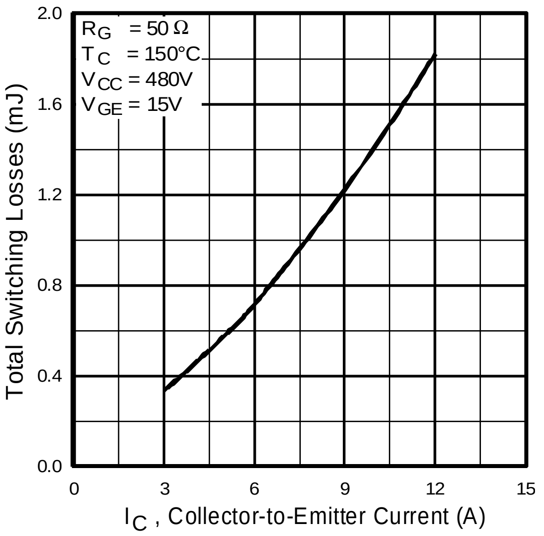


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

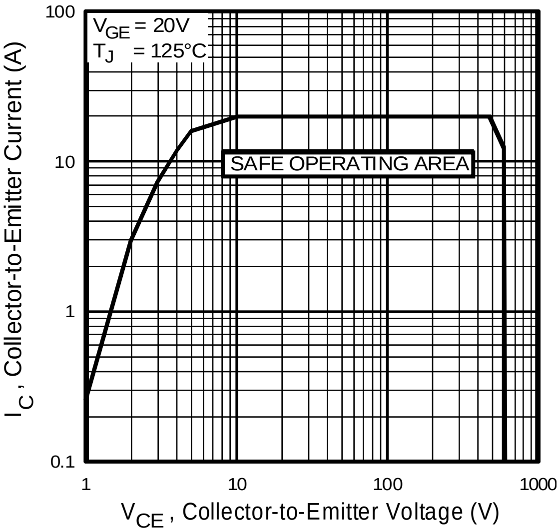


Fig. 12 - Turn-Off SOA

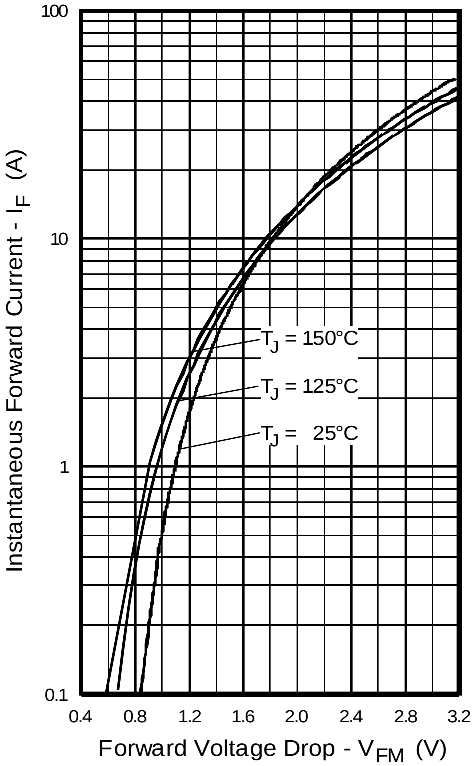


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

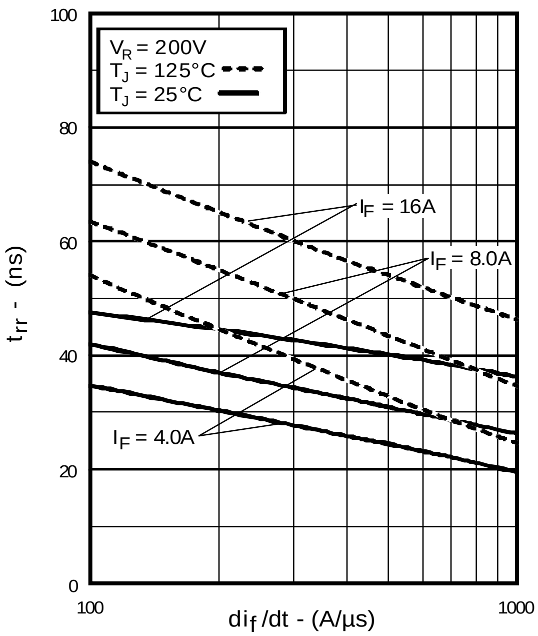


Fig. 14 - Typical Reverse Recovery vs. di$_f$/dt

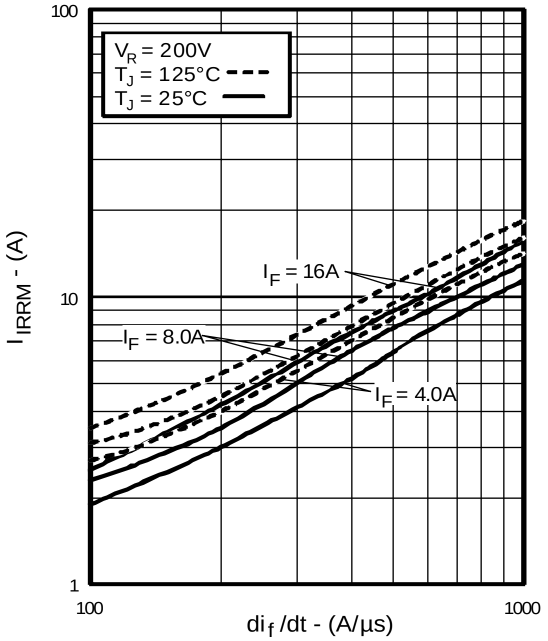


Fig. 15 - Typical Recovery Current vs. di$_f$/dt

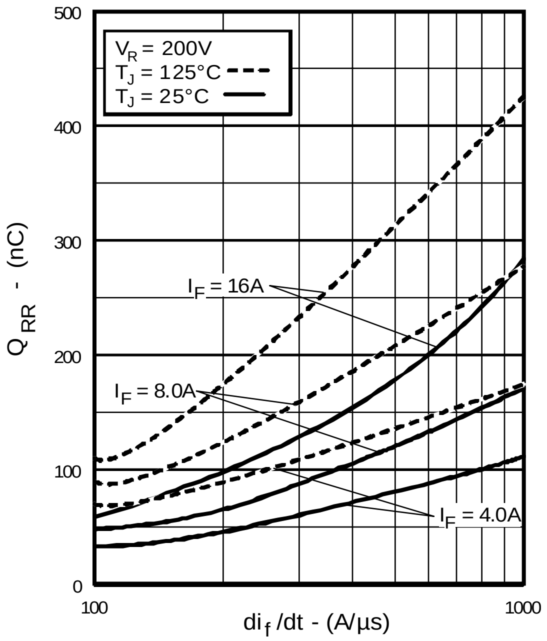


Fig. 16 - Typical Stored Charge vs. di$_f$/dt

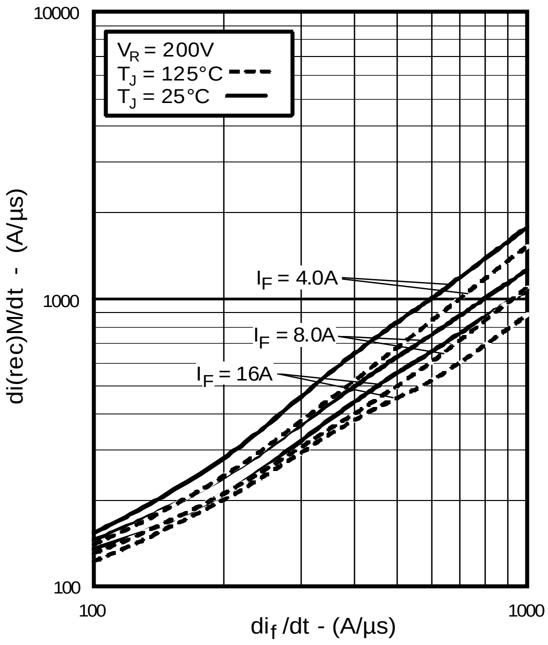


Fig. 17 - Typical di$_{(rec)M}$/dt vs. di$_f$/dt

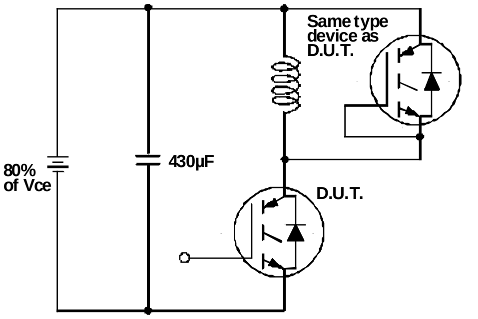


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

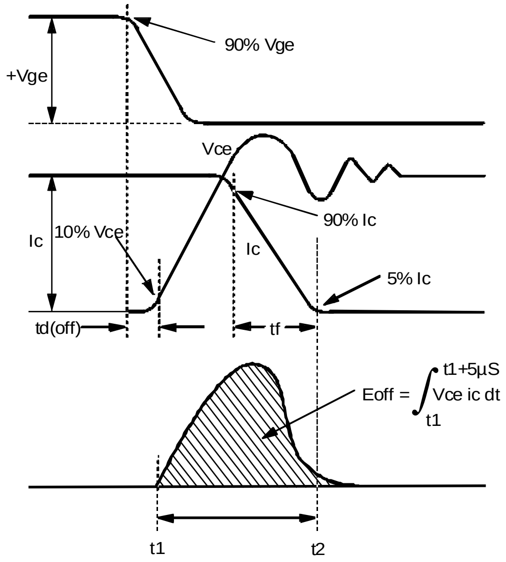


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

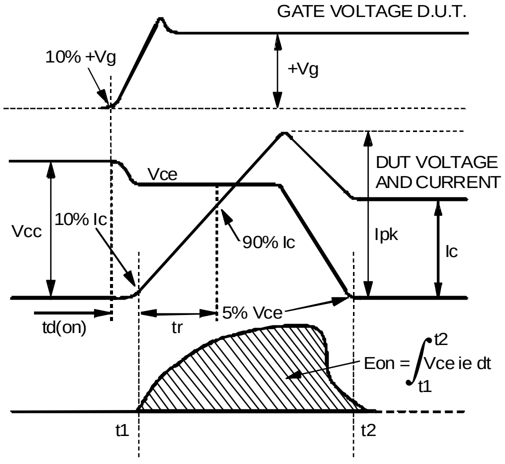


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

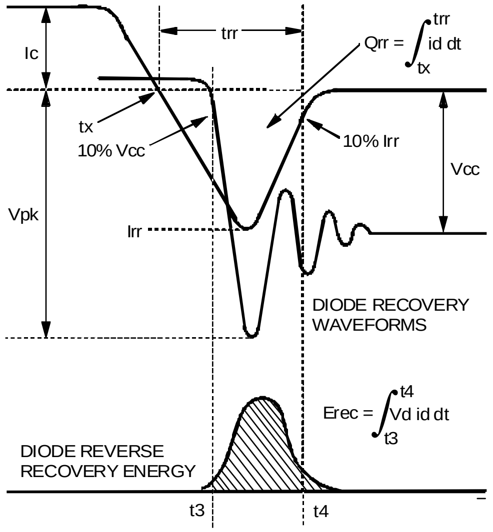


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

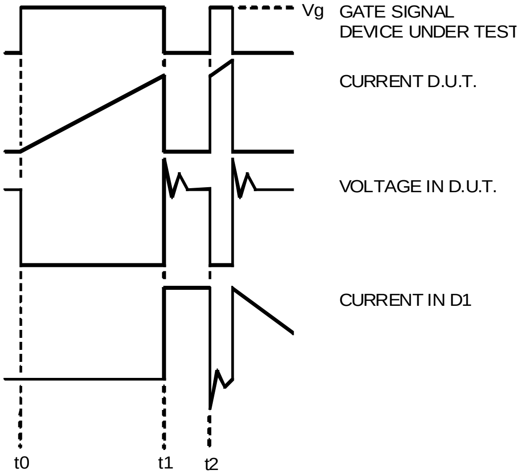
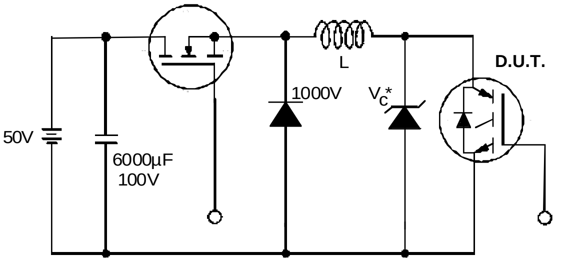


Fig. 18e - Macro Waveforms for Test Circuit of Fig. 18a



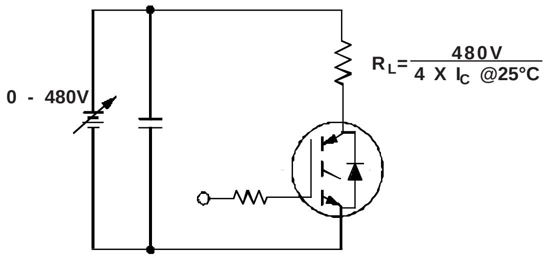
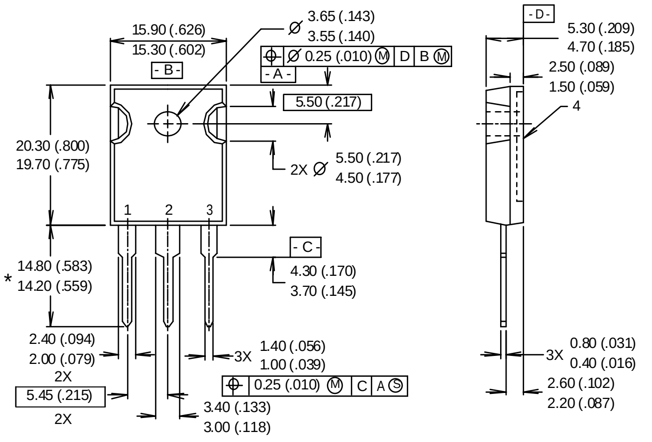


Fig. 19 - Clamped Inductive Load Test Circuit

Fig. 20 - Pulsed Collector Current Test Circuit



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)