

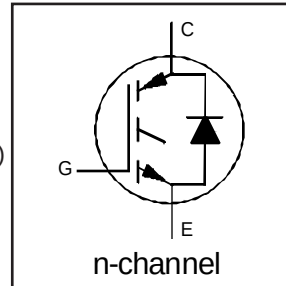
IRGPC40KD2

INSULATED GATE BIPOLAR TRANSISTOR
WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast CoPack IGBT

Features

- Short circuit rated -10 μ s @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

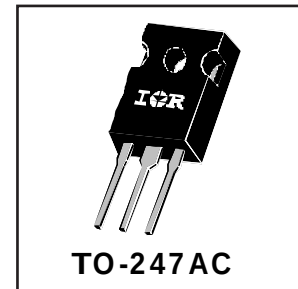


$V_{CES} = 600V$
$V_{CE(sat)} \leq 3.2V$
@ $V_{GE} = 15V$, $I_C = 25A$

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.



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	42	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	25	
I_{CM}	Pulsed Collector Current ①	84	
I_{LM}	Clamped Inductive Load Current ②	84	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
I_{FM}	Diode Maximum Forward Current	84	
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	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.	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	-----	-----	0.77	$^\circ C/W$
$R_{\theta JC}$	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)

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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	----	0.46	----	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	2.1	3.2	V	$I_C = 25A, V_{GE} = 15V$
		----	2.8	----		$I_C = 42A, \text{See Fig. 2, 5}$
		----	2.5	----		$I_C = 25A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	----	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-13	----	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ^④	7.0	14	----	S	$V_{CE} = 100V, I_C = 25A$
I_{CES}	Zero Gate Voltage Collector Current	----	----	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		----	----	3500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	----	1.3	1.7	V	$I_C = 15A, \text{See Fig. 13}$
		----	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)	----	61	92	nC	$I_C = 25A$
Q_{ge}	Gate - Emitter Charge (turn-on)	----	13	19		$V_{CC} = 400V$
Q_{gc}	Gate - Collector Charge (turn-on)	----	22	33		See Fig. 8
$t_{d(on)}$	Turn-On Delay Time	----	72	----	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	----	90	----		$I_C = 25A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	----	170	250		$V_{GE} = 15V, R_G = 10\Omega$
t_f	Fall Time	----	140	220		Energy losses include "tail" and diode reverse recovery.
E_{on}	Turn-On Switching Loss	----	1.5	----	mJ	See Fig. 9, 10, 11, 18
E_{off}	Turn-Off Switching Loss	----	1.5	----		
E_{ts}	Total Switching Loss	----	3.0	4.2		
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	----	70	----	ns	$T_J = 150^\circ\text{C}, \text{See Fig. 9, 10, 11, 18}$
t_r	Rise Time	----	86	----		$I_C = 25A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	----	280	----		$V_{GE} = 15V, R_G = 10\Omega$
t_f	Fall Time	----	270	----		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	----	4.2	----	mJ	
L_E	Internal Emitter Inductance	----	13	----	nH	Measured 5mm from package
C_{ies}	Input Capacitance	----	1500	----	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	----	190	----		$V_{CC} = 30V$
C_{res}	Reverse Transfer Capacitance	----	17	----		$f = 1.0MHz$
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		$T_J = 125^\circ\text{C}$
μs	$d_{(rec)M}/dt$ Diode Peak Rate of Fall of Recovery	----	----	----		188
----	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17	----	----		During t_b ---- 160

Notes:

① Repetitive rating; $V_{GE}=20V$, pulse width limited by max. junction temperature. (See fig. 20)

$T_J = 125^\circ\text{C}$
② $V_{CC} = 80\%(V_{CES}), V_{GE}=20V, L=10\mu H, R_G = 10\Omega, (\text{ See fig. 19 })$

③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.

④ Pulse width 5.0 μs , single shot.

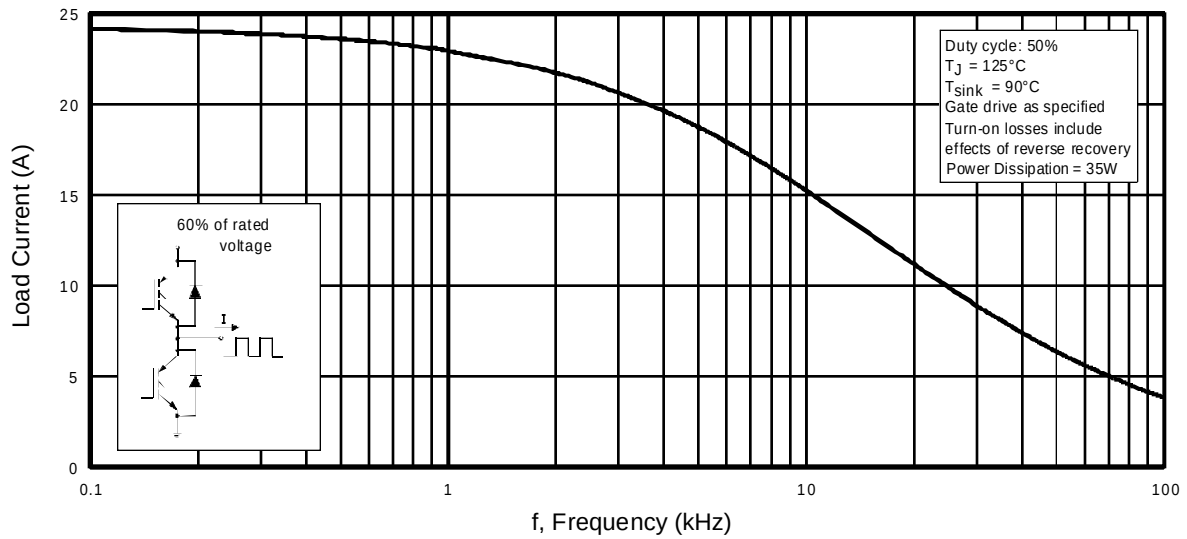


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

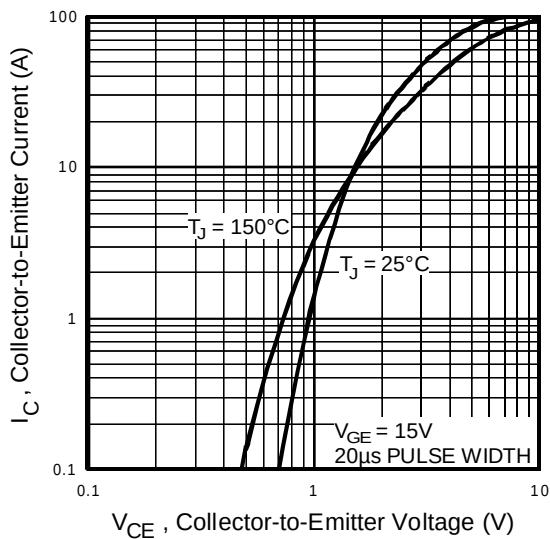


Fig. 2 - Typical Output Characteristics

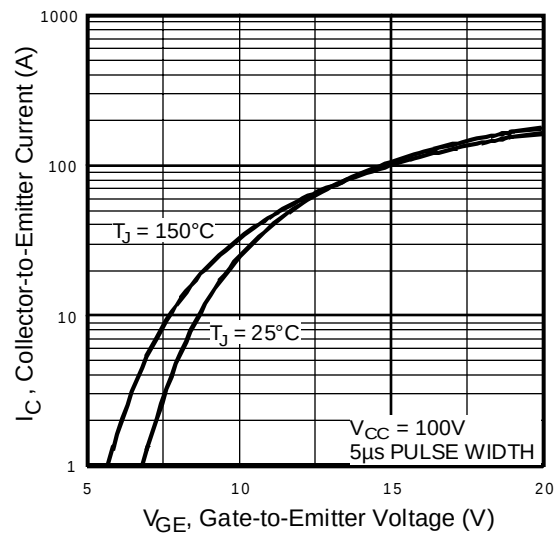


Fig. 3 - Typical Transfer Characteristics

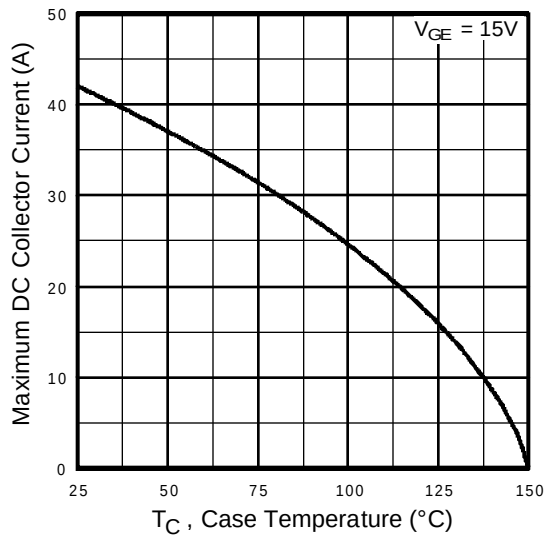


Fig. 4 - Maximum Collector Current vs. Case Temperature

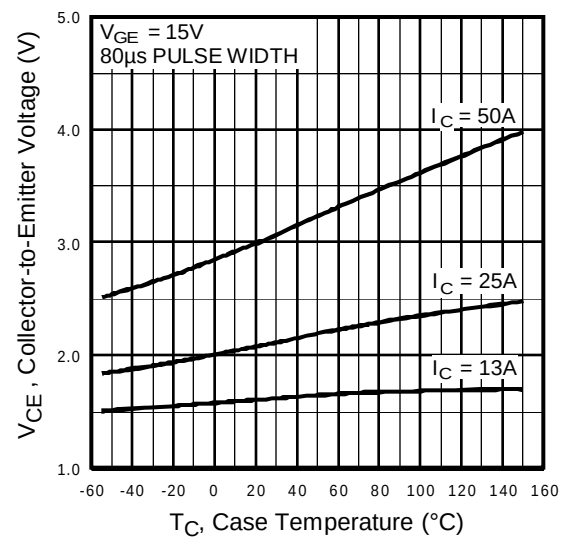


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

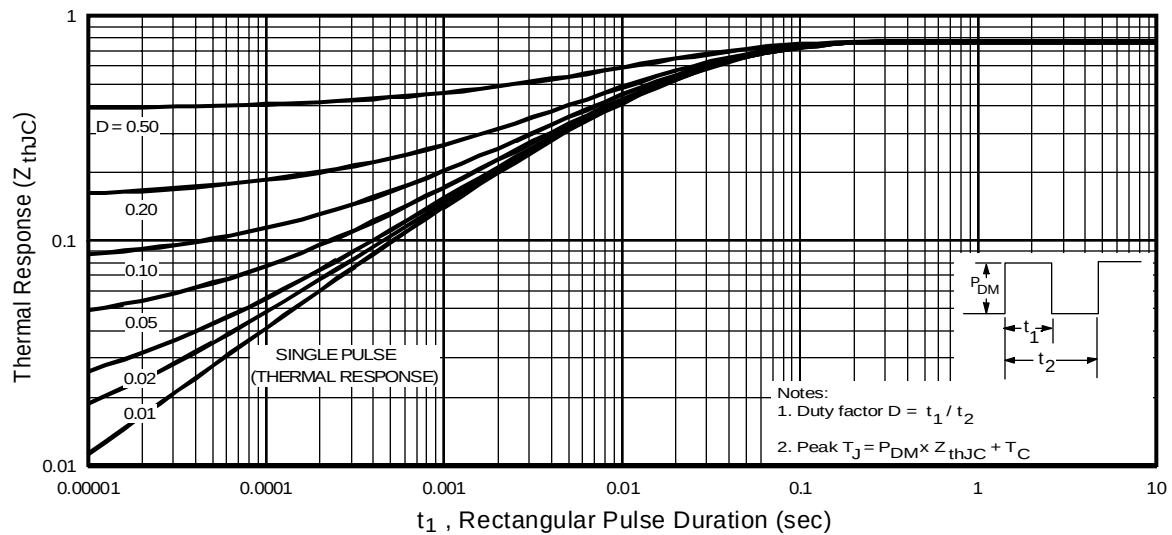


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

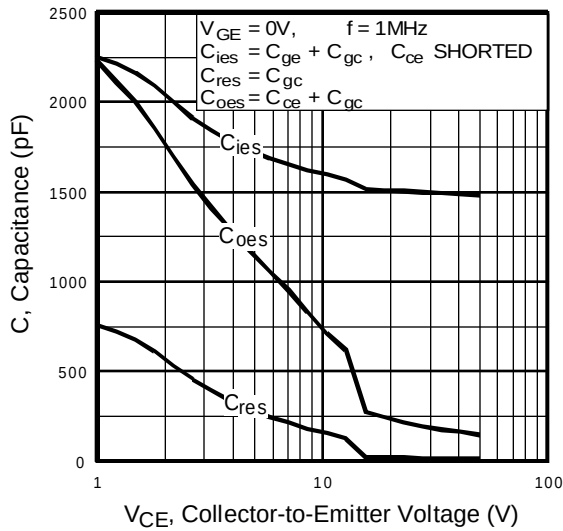


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

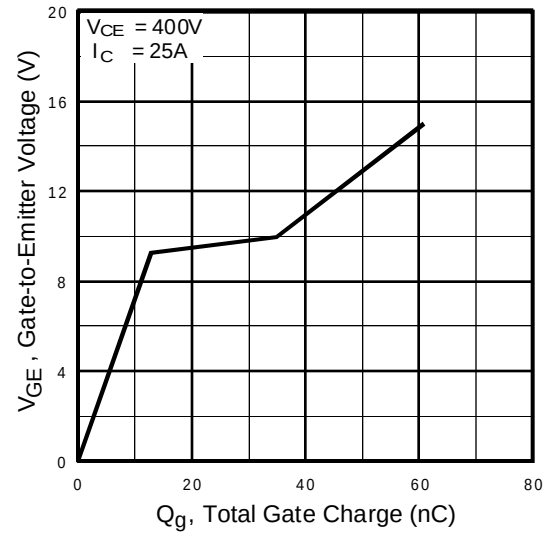


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

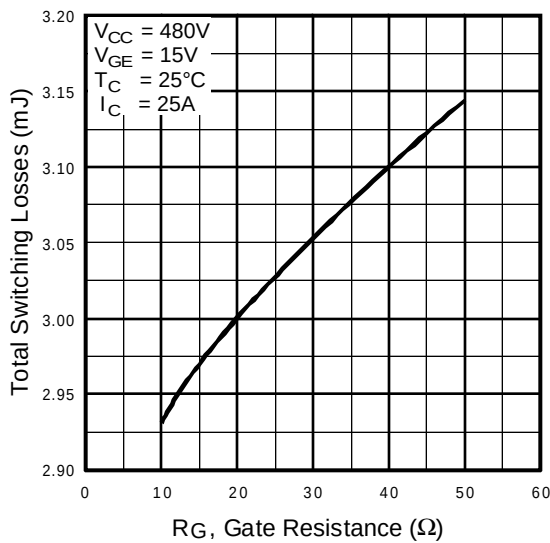


Fig. 9 - Typical Switching Losses vs. Gate Resistance

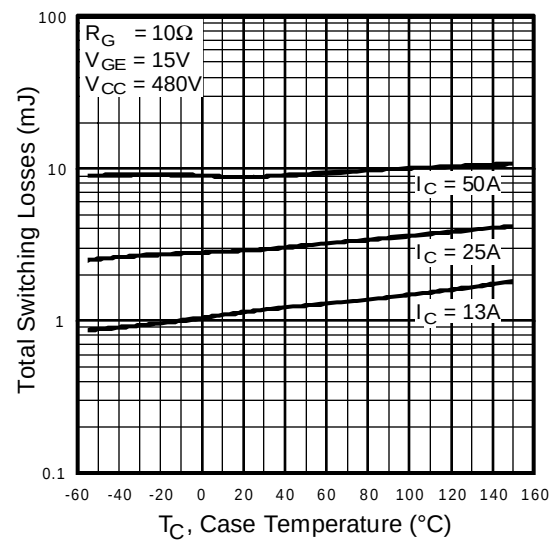


Fig. 10 - Typical Switching Losses vs. Case Temperature

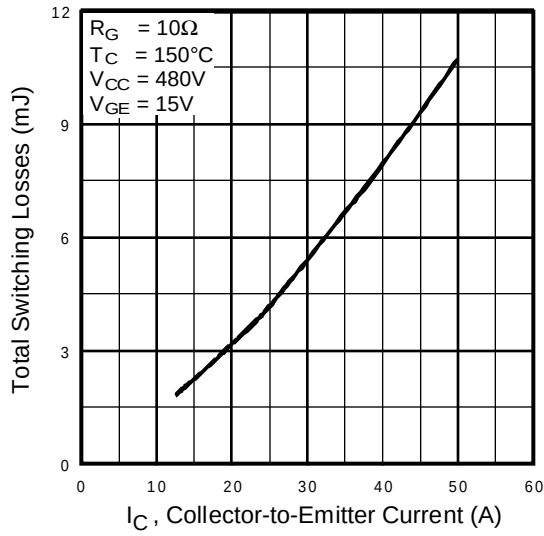


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

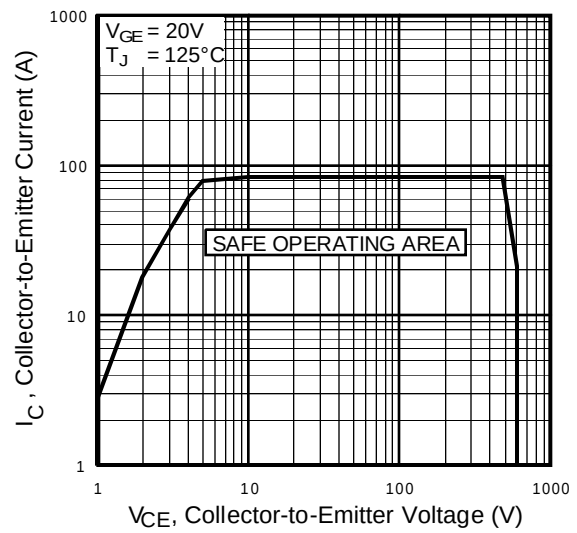


Fig. 12 - Turn-Off SOA

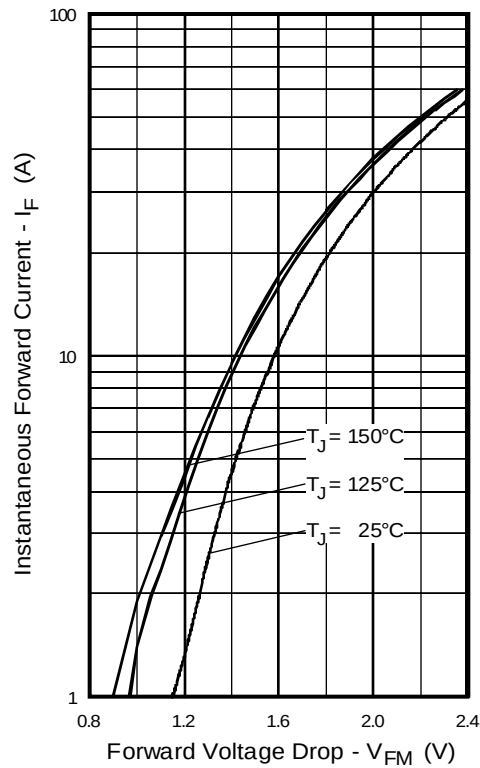


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

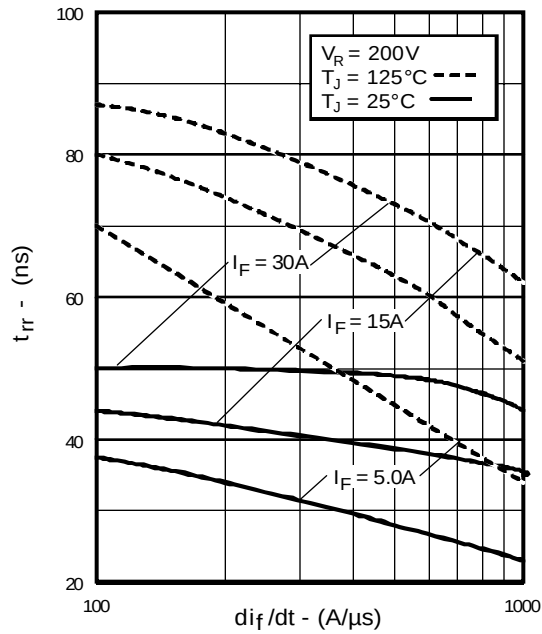


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

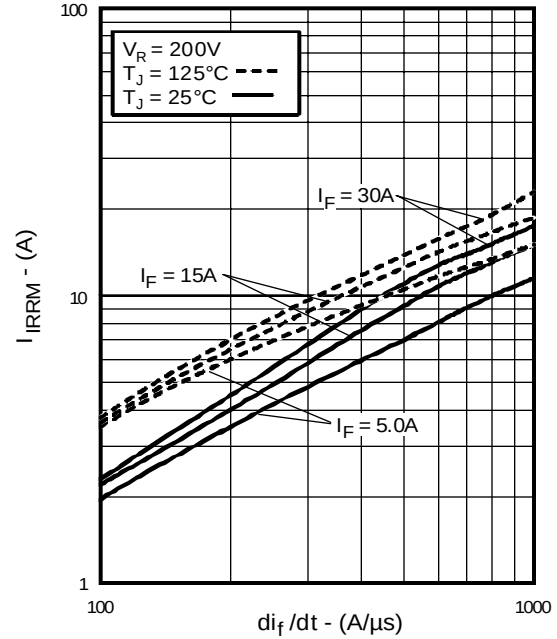


Fig. 15 - Typical Recovery Current vs. di_f/dt

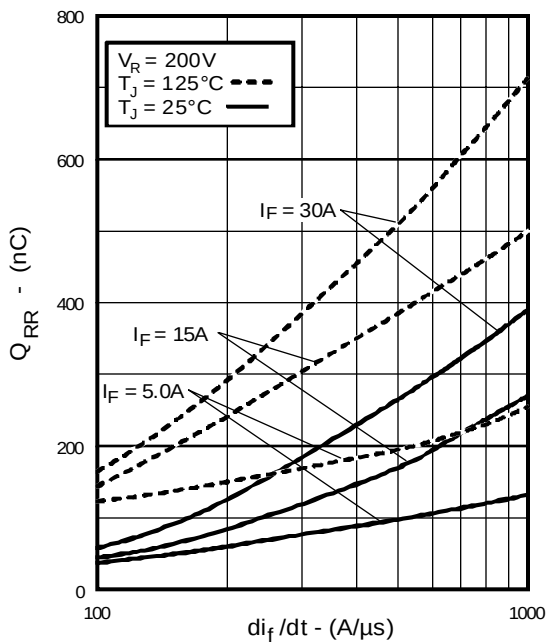


Fig. 16 - Typical Stored Charge vs. di_f/dt

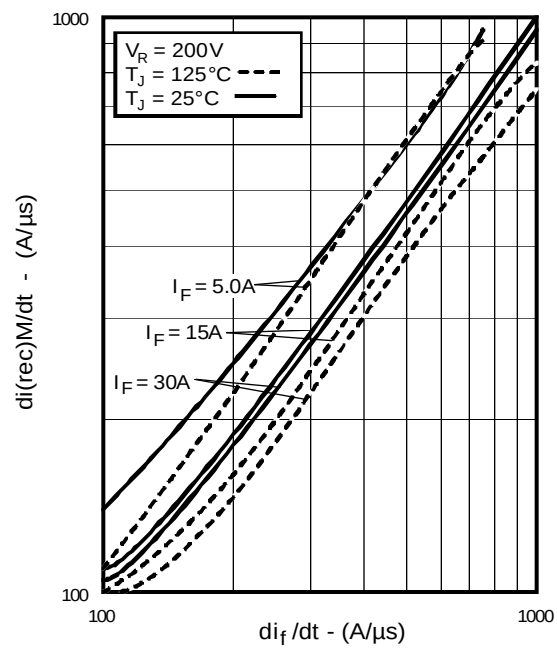


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

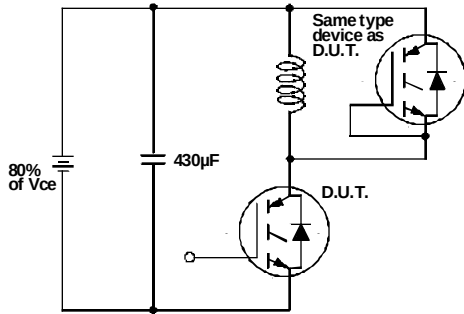


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

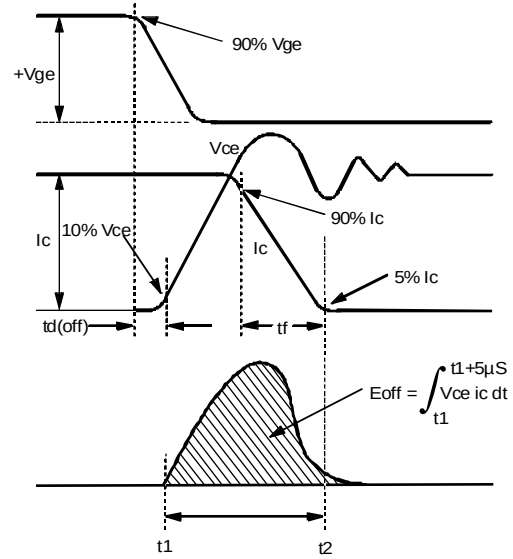


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

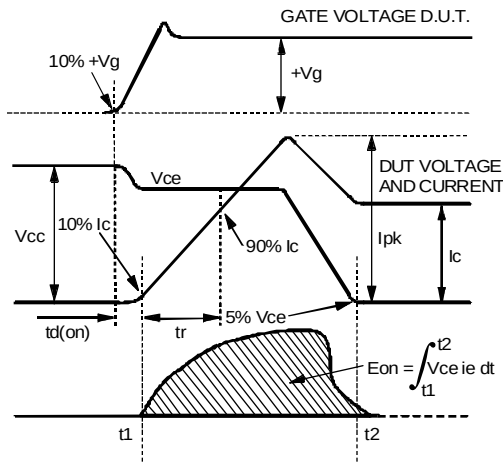


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

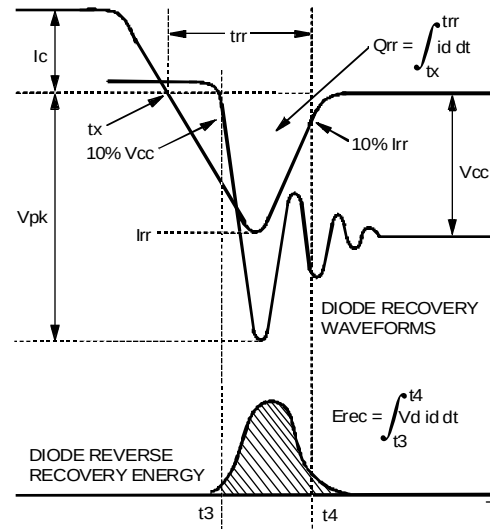


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{tr} , Q_{rr} , I_{rr}



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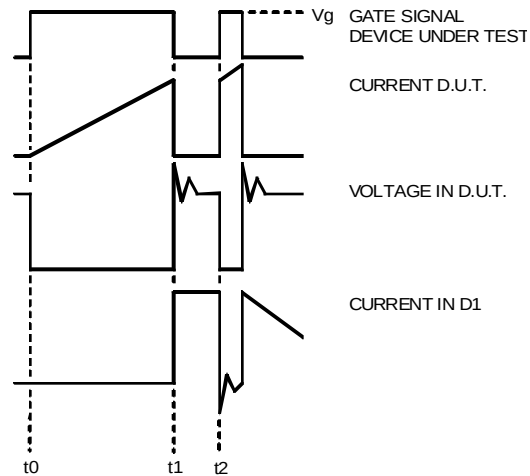


Fig. 18e - Macro Waveforms for Test Circuit of Fig. 18a

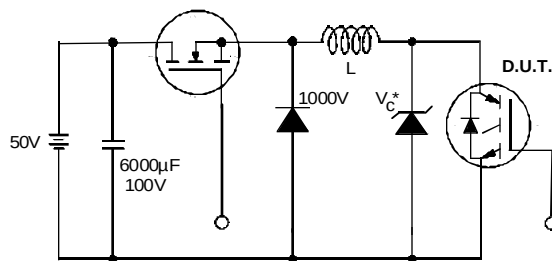


Fig. 19 - Clamped Inductive Load Test Circuit

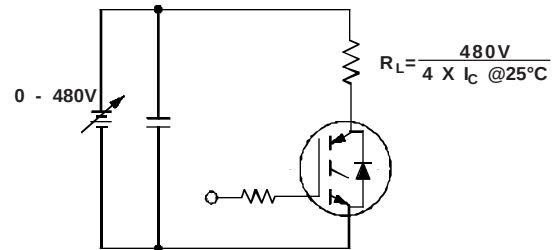
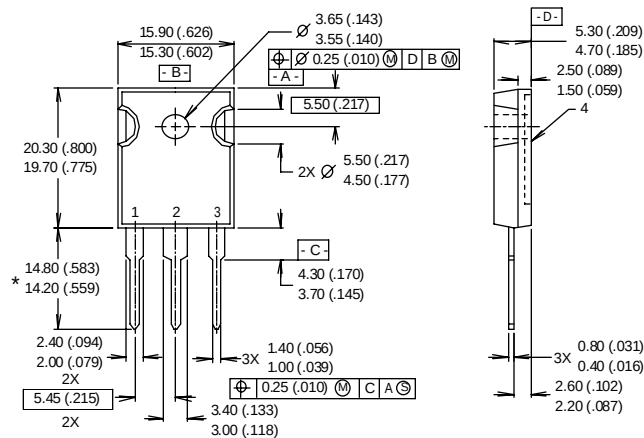


Fig. 20 - Pulsed Collector Current Test Circuit



- 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)