International
IOR Rectifier

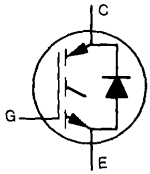
IRGPH50KD2

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast CoPack IGBT

Features

- Short circuit rated -10µs @125°C, V_{GE} = 10V (5µs @ 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} = 1200V

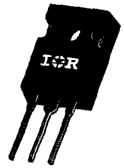
$V_{CE(sat)} \leq$ 3.5V

@V_{GE} = 15V, I_C = 20A

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	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	36	A
I_C @ T_C = 100°C	Continuous Collector Current	20	
I_{CM}	Pulsed Collector Current ①	72	
I_{LM}	Clamped Inductive Load Current ②	72	
I_F @ T_C = 100°C	Diode Continuous Foward Current	16	
I_{FM}	Diode Maximum Forward Current	72	
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	200	W
P_D @ T_C = 100°C	Maximum Power Dissipation	78	
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	—	—	0.64	°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)

Revision 3

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage③	1200	—	—	V	V_{GE} = 0V, I_C = 250µA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.8	—	V/°C	V_{GE} = 0V, I_C = 1.0mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.7	3.5	V	I_C = 20A V_{GE} = 15V
		—	3.4	—		I_C = 36A See Fig. 2, 5
		—	2.6	—		I_C = 20A, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-15	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
g_{fe}	Forward Transconductance ④	4.2	12	—	S	V_{CE} = 100V, I_C = 20A
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V
		—	—	6500		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.0	V	I_C = 16A See Fig. 13
		—	2.1	2.5		I_C = 16A, 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)	—	94	140	nC	I_C = 20A
Q_{ge}	Gate - Emitter Charge (turn-on)	—	23	35		V_{CC} = 400V
Q_{gc}	Gate - Collector Charge (turn-on)	—	24	36		See Fig. 8
$t_{d(on)}$	Turn-On Delay Time	—	70	—	ns	T_J = 25°C
t_r	Rise Time	—	68	—		I_C = 20A, V_{CC} = 800V
$t_{d(off)}$	Turn-Off Delay Time	—	200	470		V_{GE} = 15V, R_G = 5.0Ω
t_f	Fall Time	—	190	320		Energy losses include "tail" and
E_{on}	Turn-On Switching Loss	—	2.5	—	mJ	diode reverse recovery.
E_{off}	Turn-Off Switching Loss	—	2.4	—		See Fig. 9, 10, 11, 18
E_{ts}	Total Switching Loss	—	4.9	8.7		
t_{sc}	Short Circuit Withstand Time	10	—	—	µs	V_{GE} = 10V V_{CC} =720V, T_J = 125°C
		5.0	—	—		V_{GE} = 15V R_G = 5.0Ω, V_{CPK} < 1000V
$t_{d(on)}$	Turn-On Delay Time	—	68	—	ns	T_J = 150°C, See Fig. 9, 10, 11, 18
t_r	Rise Time	—	63	—		I_C = 20A, V_{CC} = 800V
$t_{d(off)}$	Turn-Off Delay Time	—	320	—		V_{GE} = 15V, R_G = 5.0Ω
t_f	Fall Time	—	310	—		Energy losses include "tail" and
E_{ts}	Total Switching Loss	—	7.5	—	mJ	diode reverse recovery.
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	2600	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	140	—		V_{CC} = 30V See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	26	—		f = 1.0MHz
t_{rr}	Diode Reverse Recovery Time	—	90	135	ns	T_J = 25°C See Fig.
		—	164	245		T_J = 125°C 14 I_F = 16A
I_{rr}	Diode Peak Reverse Recovery Current	—	5.8	10	A	T_J = 25°C See Fig.
		—	8.3	15		T_J = 125°C 15 V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	260	675	nC	T_J = 25°C See Fig.
		—	680	1838		T_J = 125°C 16 di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	120	—	A/µs	T_J = 25°C See Fig.
		—	76	—		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= 5.0Ω, (See fig. 19)

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

④ Pulse width 5.0µs, single shot.

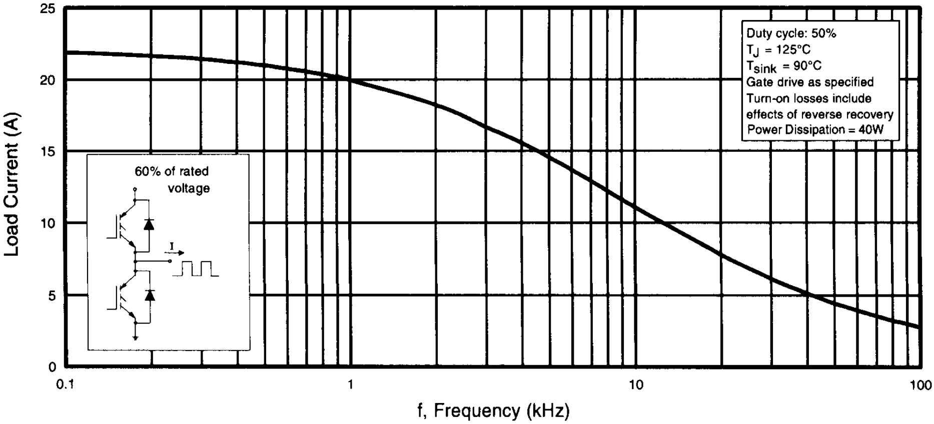
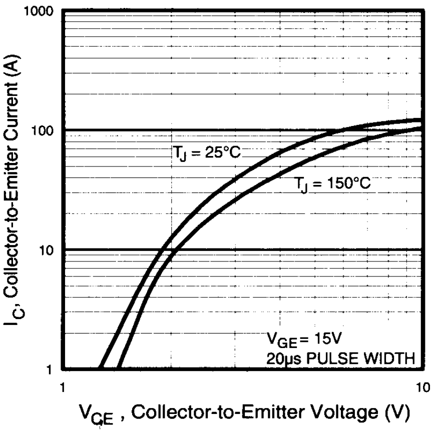


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)



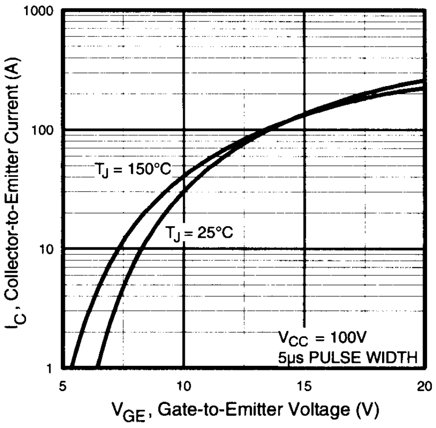


Fig. 2 - Typical Output Characteristics

Fig. 3 - Typical Transfer Characteristics

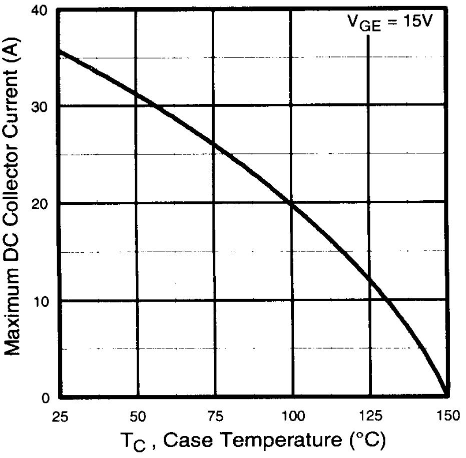


Fig. 4 - Maximum Collector Current vs. Case Temperature

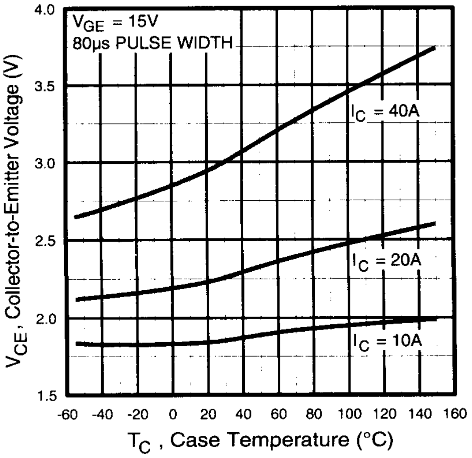


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

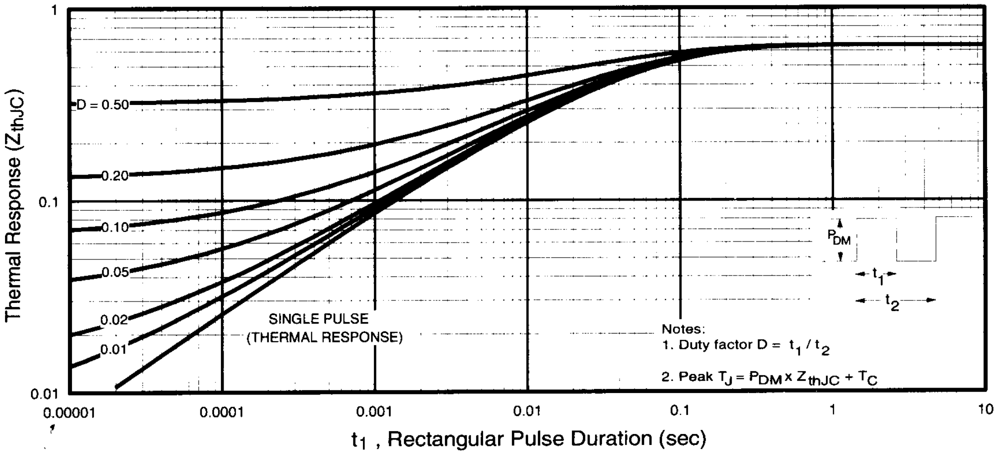


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

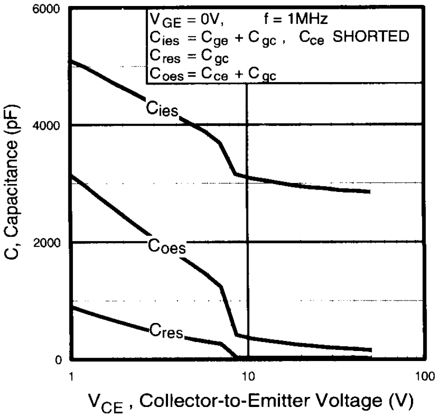


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

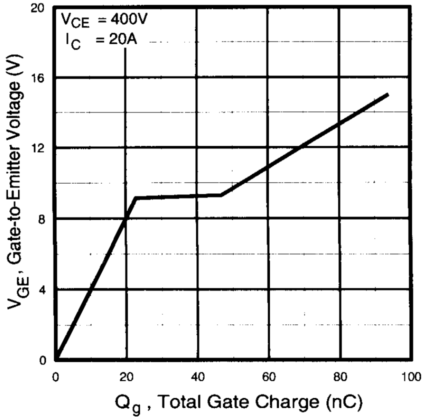


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

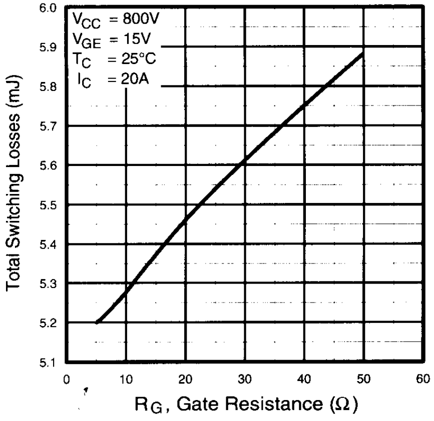


Fig. 9 - Typical Switching Losses vs. Gate Resistance

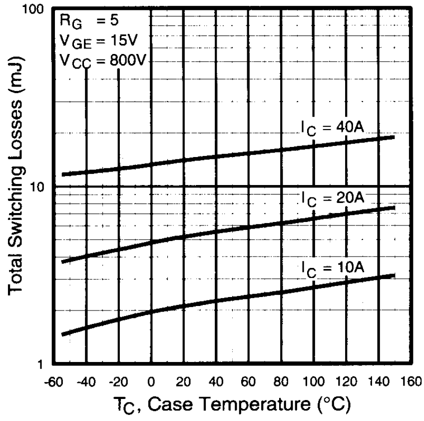


Fig. 10 - Typical Switching Losses vs. Case Temperature

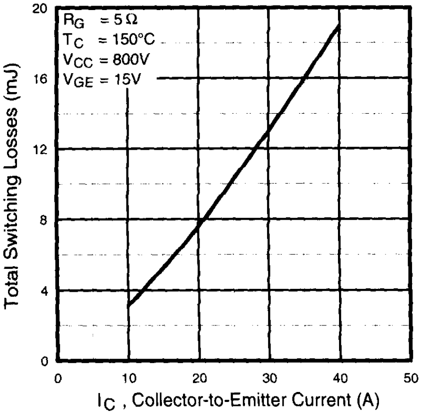


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

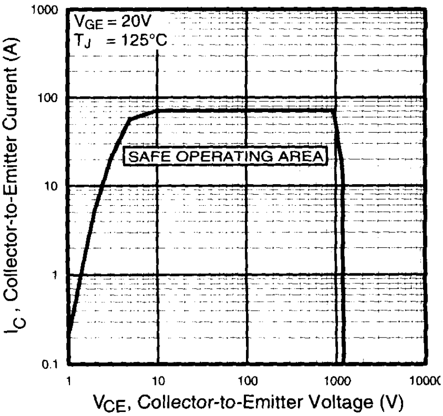


Fig. 12 - Turn-Off SOA

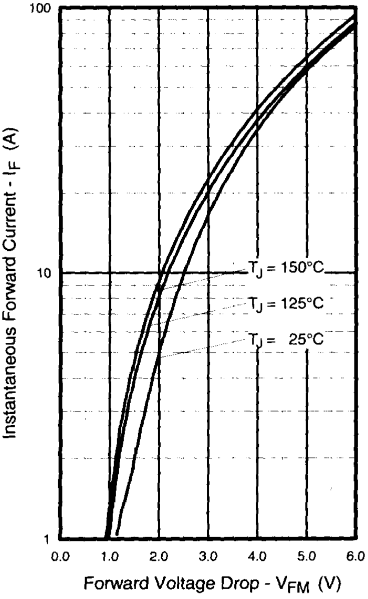


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

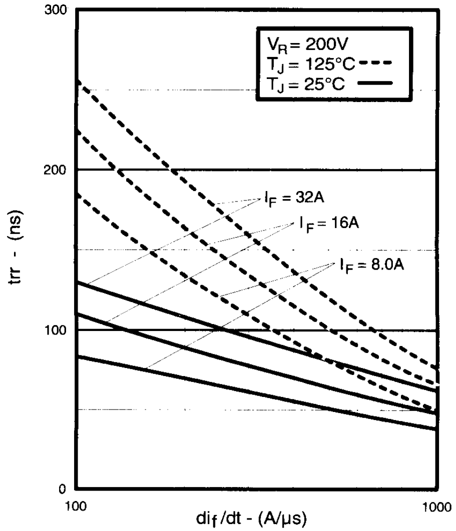


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

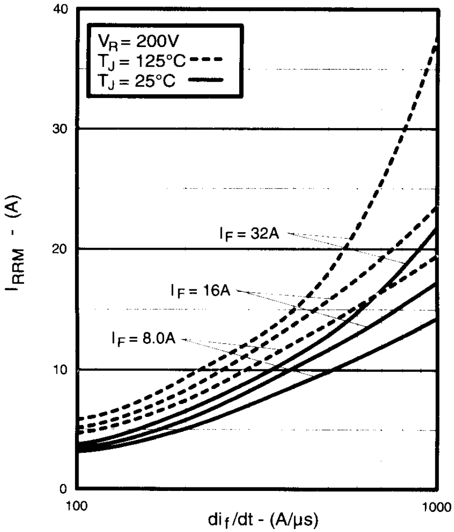


Fig. 15 - Typical Recovery Current vs. di_f/dt

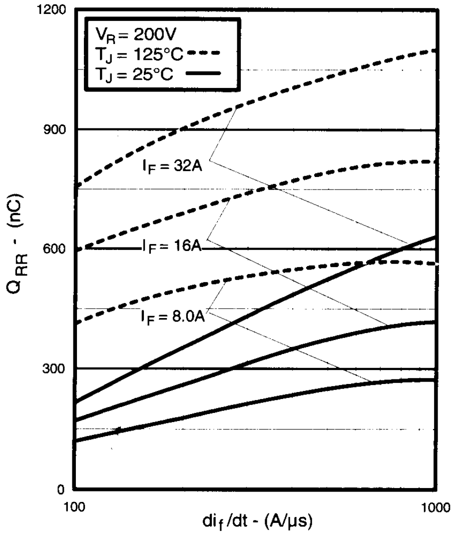


Fig. 16 - Typical Stored Charge vs. di_f/dt

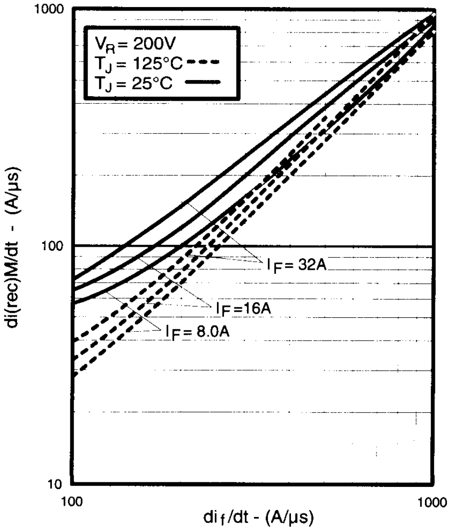


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

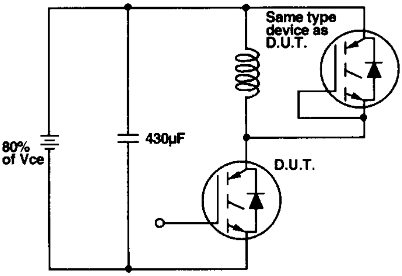


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

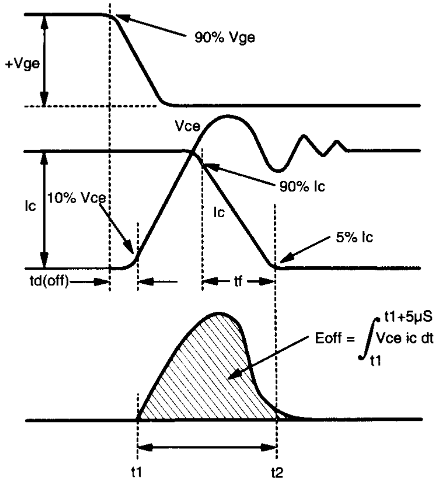


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

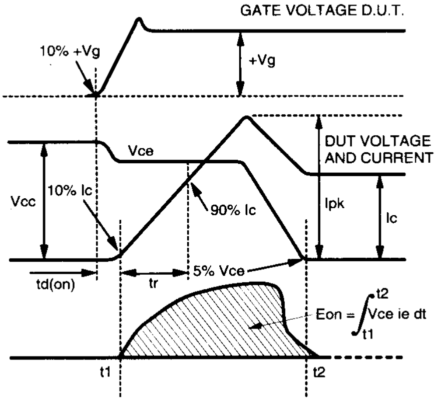


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

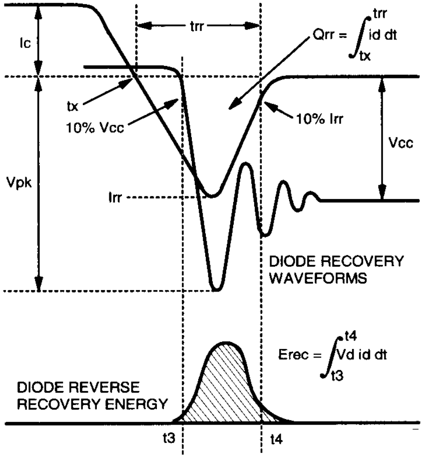


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

Refer to Section D for the following:

Appendix H: Section D - page D-9

Fig. 18e - Macro Waveforms for Test Circuit of Fig. 18a
Fig. 19 - Clamped Inductive Load Test Circuit
Fig. 20 - Pulsed Collector Current Test Circuit

Package Outline 3 - JEDEC Outline TO-247AC **Section D - page D-13**