

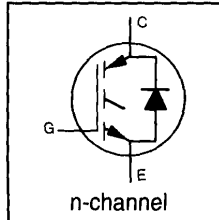
IRGPH50KD2

INSULATED GATE BIPOLAR TRANSISTOR
WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast CoPack IGBT

Features

- Short circuit rated -10 μ s @ 125°C, $V_{GE} = 10V$ (5 μ s @ $V_{GE} = 15V$)
- 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



$$V_{CES} = 1200V$$

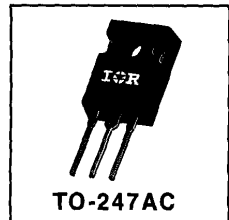
$$V_{CE(sat)} \leq 3.5V$$

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

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.



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	36	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	20	
I_{CM}	Pulsed Collector Current Φ	72	
I_{LM}	Clamped Inductive Load Current Φ	72	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	16	
I_{FM}	Diode Maximum Forward Current	72	
t_{sc}	Short Circuit Withstand Time	10	μ s
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
T_J	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$
	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	$^\circ C/W$
$R_{\theta JC}$	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 Voltage ^③	1200	—	—	V	$V_{GE} = 0\text{V}$, $I_C = 250\mu\text{A}$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.8	—	$^\circ\text{V}/^\circ\text{C}$	$V_{GE} = 0\text{V}$, $I_C = 1.0\text{mA}$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.7	3.5	V	$I_C = 20\text{A}$ $I_C = 36\text{A}$ $I_C = 20\text{A}$, $T_J = 150^\circ\text{C}$
		—	3.4	—		
		—	2.6	—		
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}$, $I_C = 250\mu\text{A}$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-15	—	$\text{mV}/^\circ\text{C}$	$V_{CE} = V_{GE}$, $I_C = 250\mu\text{A}$
g_{fe}	Forward Transconductance ^④	4.2	12	—	S	$V_{CE} = 100\text{V}$, $I_C = 20\text{A}$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0\text{V}$, $V_{CE} = 1200\text{V}$
		—	—	6500		$V_{GE} = 0\text{V}$, $V_{CE} = 1200\text{V}$, $T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.0	V	$I_C = 16\text{A}$ $I_C = 16\text{A}$, $T_J = 150^\circ\text{C}$
		—	2.1	2.5		
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20\text{V}$

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	94	140	nC	$I_C = 20\text{A}$ $V_{CC} = 400\text{V}$ See Fig. 8
Q_{ge}	Gate - Emitter Charge (turn-on)	—	23	35		
Q_{gc}	Gate - Collector Charge (turn-on)	—	24	36		
$t_{d(on)}$	Turn-On Delay Time	—	70	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 20\text{A}$, $V_{CC} = 800\text{V}$
t_r	Rise Time	—	68	—		
$t_{d(off)}$	Turn-Off Delay Time	—	200	470	ns	$V_{GE} = 15\text{V}$, $R_G = 5.0\Omega$ Energy losses include "tail" and diode reverse recovery.
t_f	Fall Time	—	190	320		
E_{on}	Turn-On Switching Loss	—	2.5	—	mJ	See Fig. 9, 10, 11, 18
E_{off}	Turn-Off Switching Loss	—	2.4	—		
E_{ts}	Total Switching Loss	—	4.9	8.7	μs	$V_{GE} = 10\text{V}$, $V_{CC} = 720\text{V}$, $T_J = 125^\circ\text{C}$ $V_{GE} = 15\text{V}$, $R_G = 5.0\Omega$, $V_{CPK} < 1000\text{V}$
t_{sc}	Short Circuit Withstand Time	10	—	—		
$t_{d(on)}$	Turn-On Delay Time	—	68	—	ns	$T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18 $I_C = 20\text{A}$, $V_{CC} = 800\text{V}$
		—	63	—		
t_r	Rise Time	—	63	—	ns	$V_{GE} = 15\text{V}$, $R_G = 5.0\Omega$ Energy losses include "tail" and diode reverse recovery.
$t_{d(off)}$	Turn-Off Delay Time	—	320	—		
t_f	Fall Time	—	310	—	mJ	See Fig. 9, 10, 11, 18
E_{ts}	Total Switching Loss	—	7.5	—		
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	2600	—	pF	$V_{GE} = 0\text{V}$ $V_{CC} = 30\text{V}$ $f = 1.0\text{MHz}$
C_{oes}	Output Capacitance	—	140	—		
C_{res}	Reverse Transfer Capacitance	—	26	—		
t_{rr}	Diode Reverse Recovery Time	—	90	135	ns	$T_J = 25^\circ\text{C}$ See Fig. 14 $T_J = 125^\circ\text{C}$ 14
		—	164	245		
I_{rr}	Diode Peak Reverse Recovery Current	—	5.8	10	A	$T_J = 25^\circ\text{C}$ See Fig. 15 $T_J = 125^\circ\text{C}$ 15
		—	8.3	15		
Q_{rr}	Diode Reverse Recovery Charge	—	260	675	nC	$T_J = 25^\circ\text{C}$ See Fig. 16 $T_J = 125^\circ\text{C}$ 16
		—	680	1838		
$di_{(rec)}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	120	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17 $T_J = 125^\circ\text{C}$ 17
		—	76	—		

Notes:

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

② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20\text{V}$, $L=10\mu\text{H}$, $R_G = 5.0\Omega$, (See fig. 19)

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

④ Pulse width $5.0\mu\text{s}$, single shot.

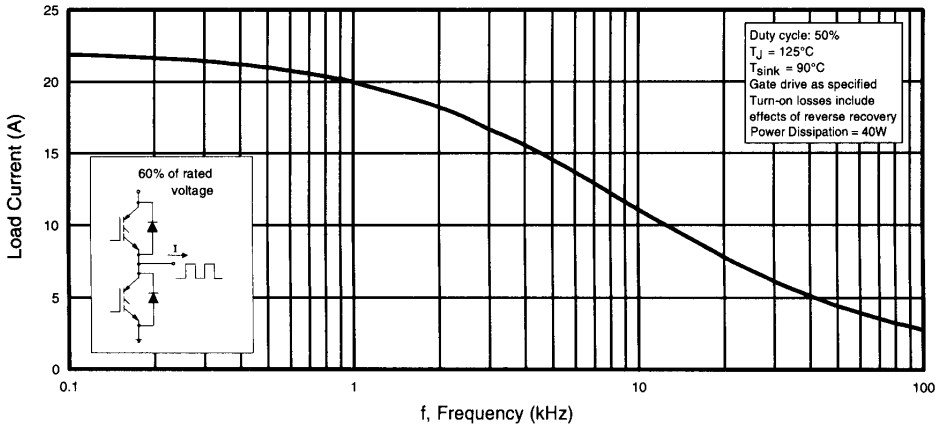


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

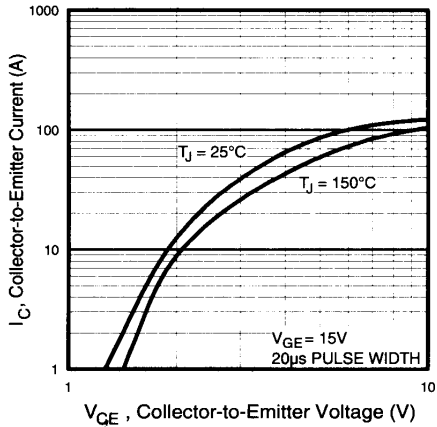


Fig. 2 - Typical Output Characteristics

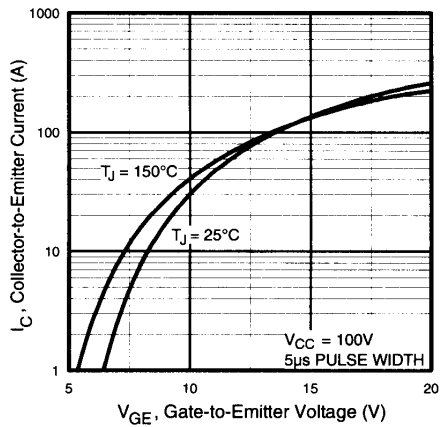


Fig. 3 - Typical Transfer Characteristics

Motor
Control
Power
Electronics

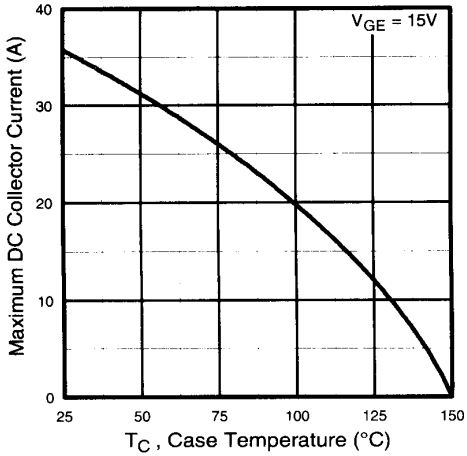


Fig. 4 - Maximum Collector Current vs. Case Temperature

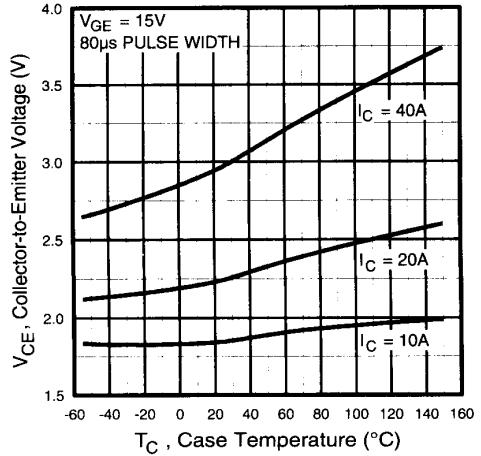


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

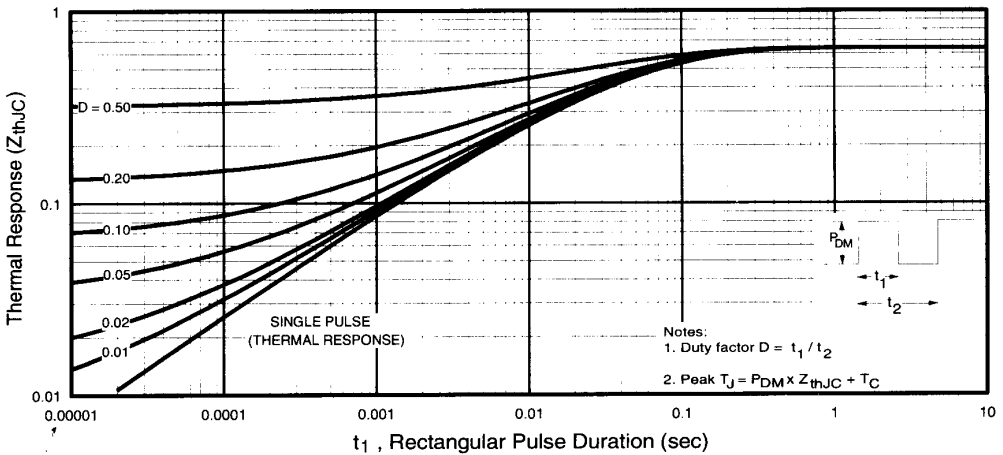


Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

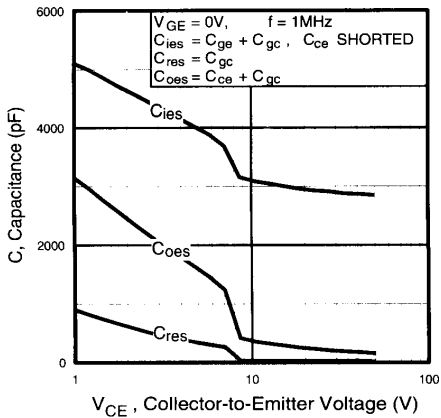


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

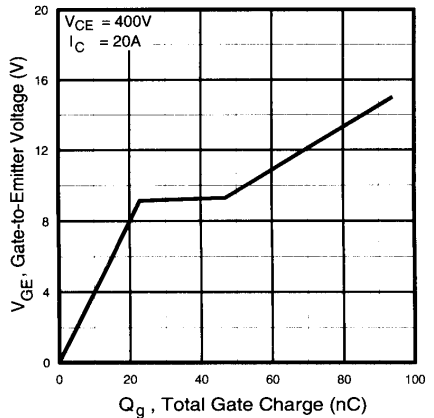


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

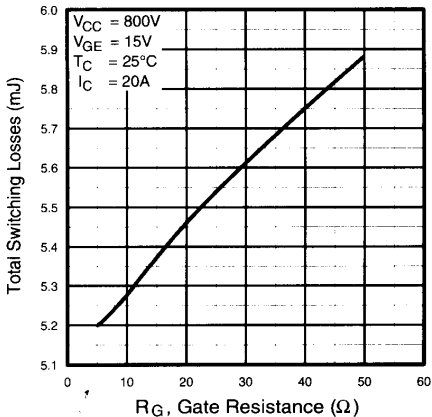


Fig. 9 - Typical Switching Losses vs. Gate Resistance

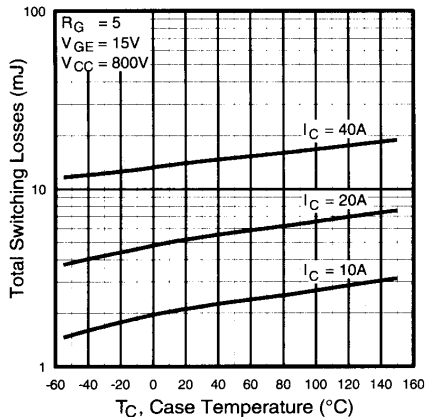


Fig. 10 - Typical Switching Losses vs. Case Temperature

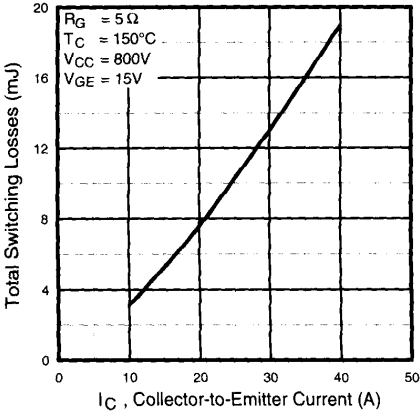


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

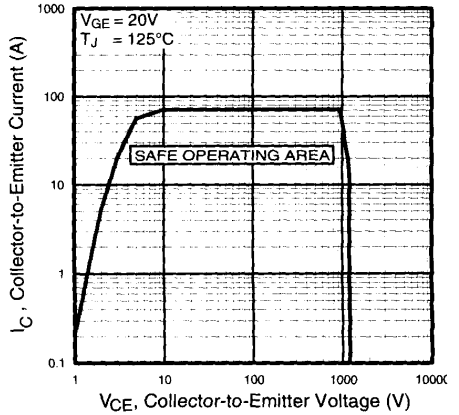


Fig. 12 - Turn-Off SOA

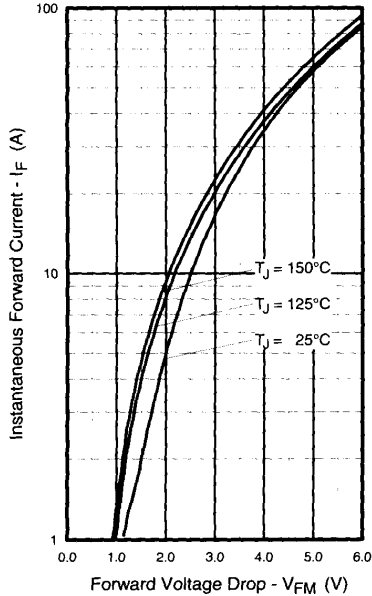


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

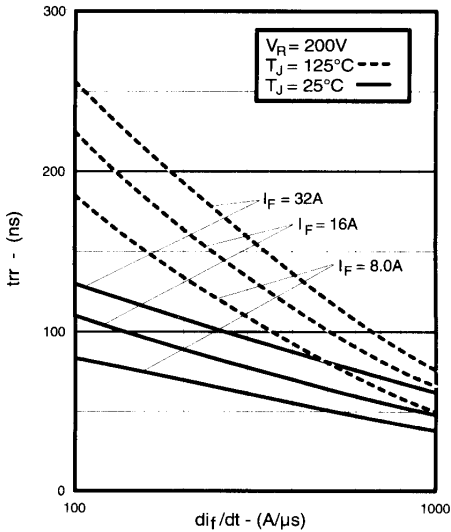


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

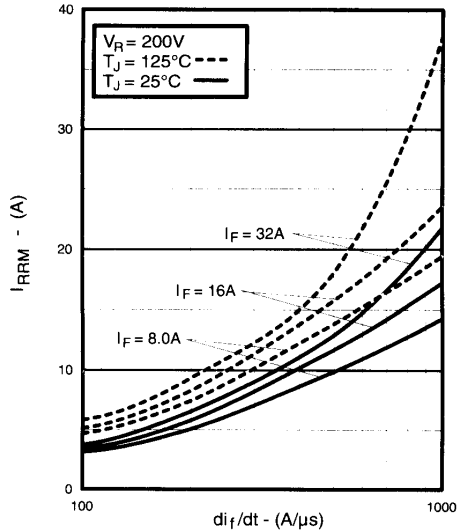


Fig. 15 - Typical Recovery Current vs. di_f/dt

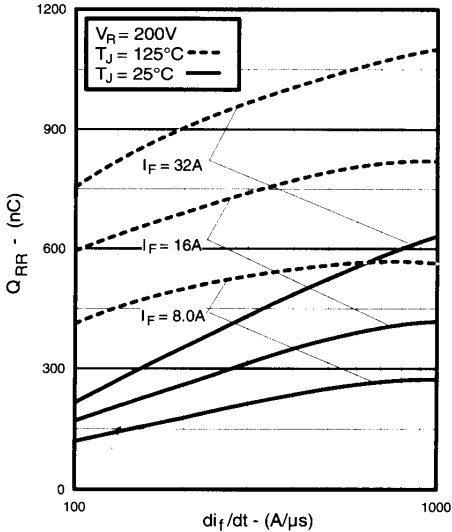


Fig. 16 - Typical Stored Charge vs. di_f/dt

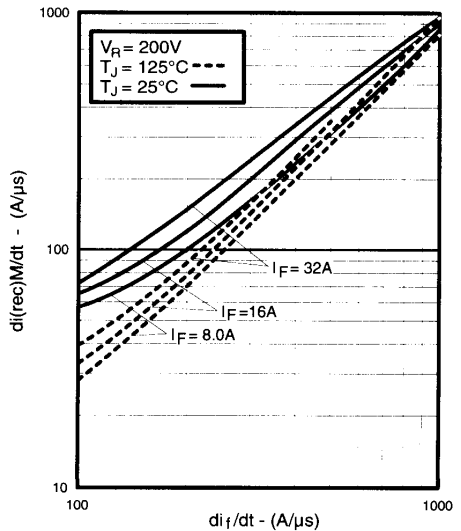


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

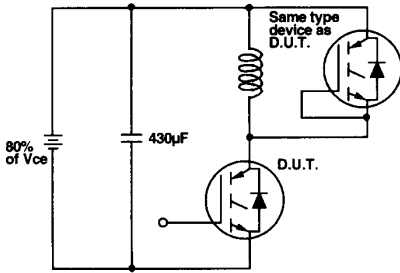


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

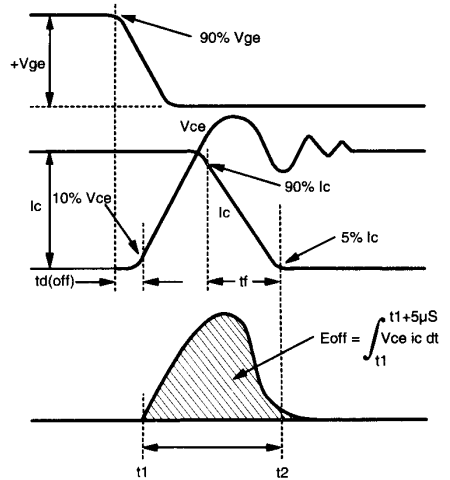


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

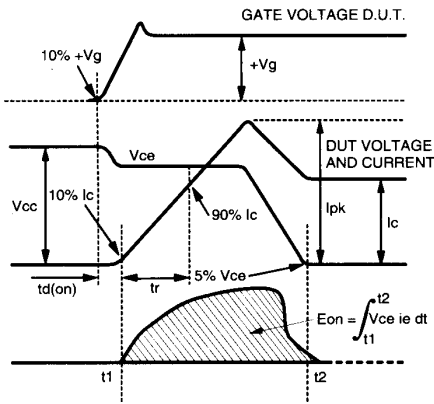


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

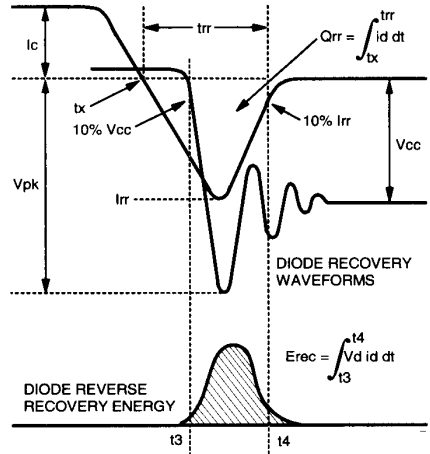


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

Refer to Section D for the following:
Appendix 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



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