

IGBT SIP MODULE

UltraFast IGBT

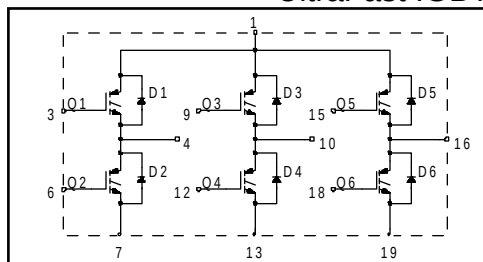
Features

- Fully isolated printed circuit board mount package
 - 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

Product Summary

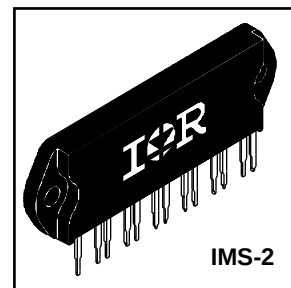
Output Current in a Typical 20 kHz Motor Drive

4.6 A_{RMS} per phase (1.3 kW total) with T_C = 90°C, T_J = 125°C, Supply Voltage 360Vdc, Power Factor 0.8, Modulation Depth 115% (See Figure 1)



Description

The IGBT technology is the key to International Rectifier's advanced line of IMS (Insulated Metal Substrate) Power Modules. These modules are more efficient than comparable bipolar transistor modules, while at the same time having the simpler gate-drive requirements of the familiar power MOSFET. This superior technology has now been coupled to a state of the art materials system that maximizes power throughput with low thermal resistance. This package is highly suited to motor drive applications and where space is at a premium.



Absolute Maximum Ratings

	Parameter	Max.	Units
V _{CES}	Collector-to-Emitter Voltage	600	V
I _C @ T _C = 25°C	Continuous Collector Current, each IGBT	7.2	A
I _C @ T _C = 100°C	Continuous Collector Current, each IGBT	3.9	
I _{CM}	Pulsed Collector Current ①	22	
I _{LM}	Clamped Inductive Load Current ②	22	
I _F @ T _C = 100°C	Diode Continuous Forward Current	3.4	
I _{FM}	Diode Maximum Forward Current	22	
V _{GE}	Gate-to-Emitter Voltage	±20	V
V _{ISOL}	Isolation Voltage, any terminal to case, 1 minute	2500	V _{RMS}
P _D @ T _C = 25°C	Maximum Power Dissipation, each IGBT	23	W
P _D @ T _C = 100°C	Maximum Power Dissipation, each IGBT	9.1	
T _J	Operating Junction and	-40 to +150	°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.	5-7 lbf•in (0.55-0.8 N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
R _{θJC} (IGBT)	Junction-to-Case, each IGBT, one IGBT in conduction	—	5.5	°C/W
R _{θJC} (DIODE)	Junction-to-Case, each diode, one diode in conduction	—	9.0	
R _{θCS} (MODULE)	Case-to-Sink, flat, greased surface	0.10	—	
Wt	Weight of module	20 (0.7)	—	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	600	—	—	V	$V_{GE} = 0V$, $I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.63	—	V/ $^\circ\text{C}$	$V_{GE} = 0V$, $I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.70	2.2	V	$I_C = 3.9A$ $V_{GE} = 15V$
		—	1.95	—		$I_C = 7.2A$ See Fig. 2, 5
		—	1.70	—		$I_C = 3.9A$, $T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}$, $I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}$, $I_C = 250\mu A$
g_{fe}	Forward Transconductance ^④	1.4	4.3	—	S	$V_{CE} = 100V$, $I_C = 6.5A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V$, $V_{CE} = 600V$
		—	—	2500		$V_{GE} = 0V$, $V_{CE} = 600V$, $T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.4	1.7	V	$I_C = 8.0A$ See Fig. 13
		—	1.3	1.6		$I_C = 8.0A$, $T_J = 150^\circ\text{C}$
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)	—	31	47	nC	$I_C = 3.9A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	5.0	7.5		$V_{CC} = 400V$
Q_{gc}	Gate - Collector Charge (turn-on)	—	13	20		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	45	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	22	—		$I_C = 3.9A$, $V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	100	160		$V_{GE} = 15V$, $R_G = 50\Omega$
t_f	Fall Time	—	120	180	mJ	Energy losses include "tail" and diode reverse recovery.
E_{on}	Turn-On Switching Loss	—	0.13	—		See Fig. 9, 10, 11, 18
E_{off}	Turn-Off Switching Loss	—	0.07	—		
E_{ts}	Total Switching Loss	—	0.20	0.3		
$t_{d(on)}$	Turn-On Delay Time	—	42	—	ns	$T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18
t_r	Rise Time	—	22	—		$I_C = 3.9A$, $V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	120	—		$V_{GE} = 15V$, $R_G = 50\Omega$
t_f	Fall Time	—	250	—		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	—	0.35	—	mJ	
C_{ies}	Input Capacitance	—	530	—		$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	39	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	7.4	—	pF	$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	—	37	55		$T_J = 25^\circ\text{C}$ See Fig. 14
		—	55	90		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Charge	—	3.5	5.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		—	4.5	8.0		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	—	65	138	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		—	124	360		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	240	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		—	210	—		$T_J = 125^\circ\text{C}$

$I_F = 8.0A$
 $V_R = 200V$
 $di/dt = 200A/\mu s$

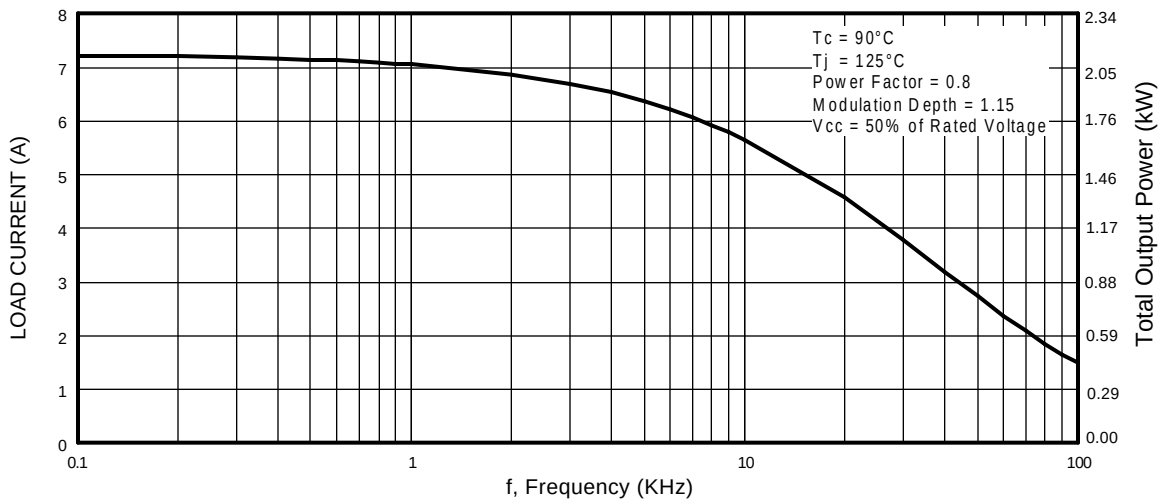


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

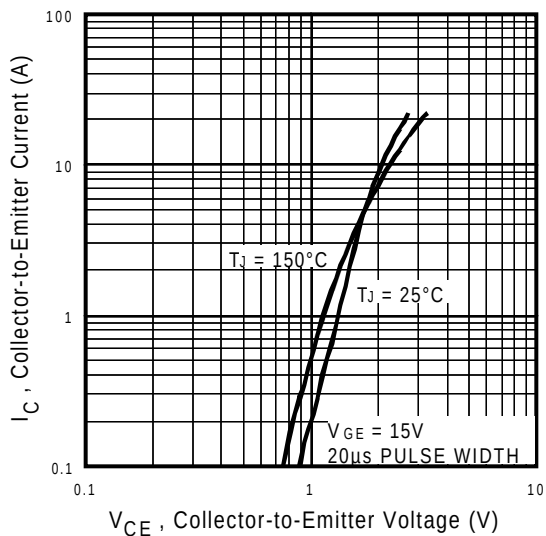


Fig. 2 - Typical Output Characteristics

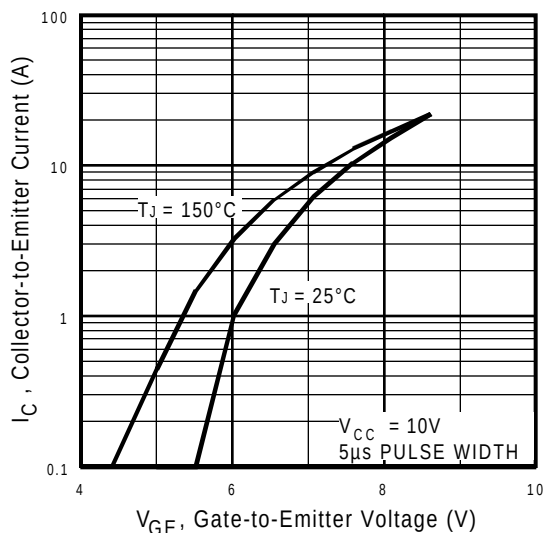


Fig. 3 - Typical Transfer Characteristics

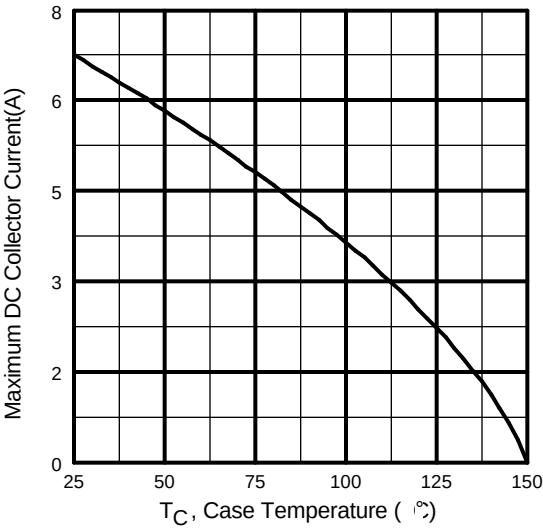


Fig. 4 - Maximum Collector Current vs. Case Temperature

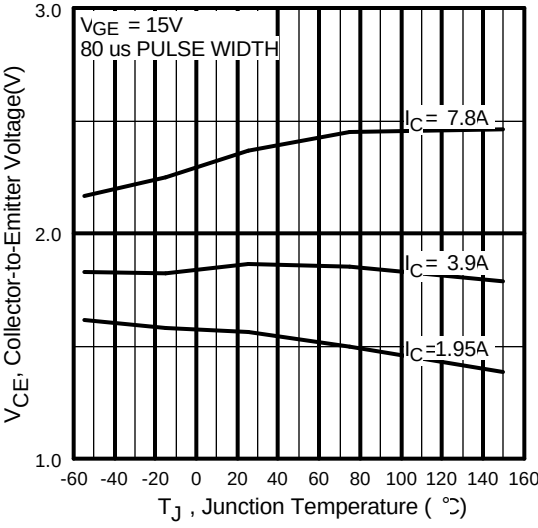


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

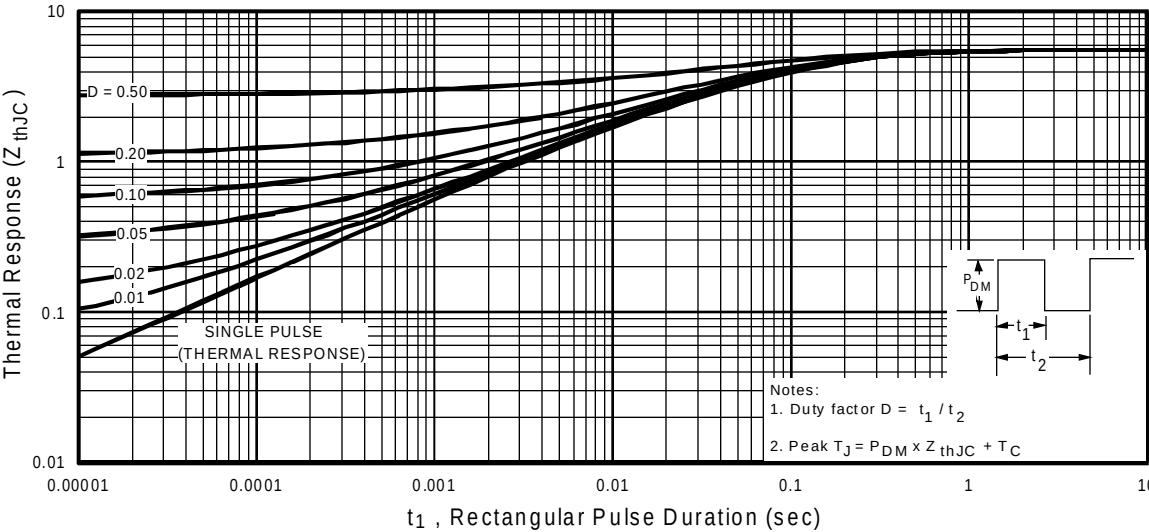
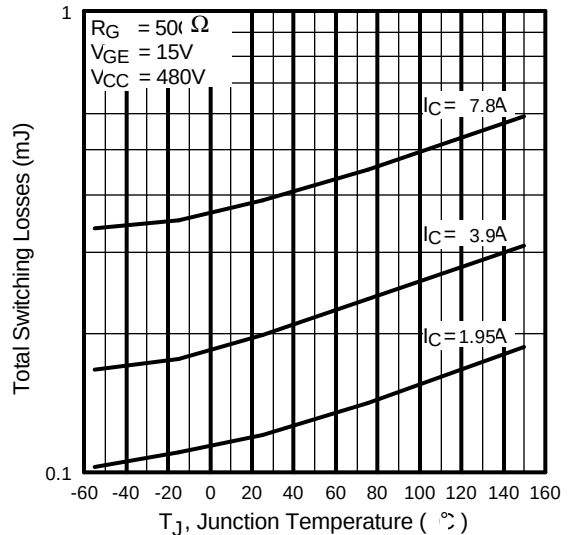
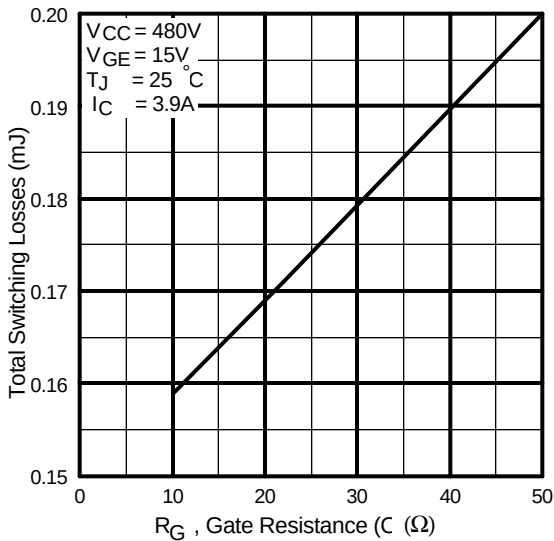
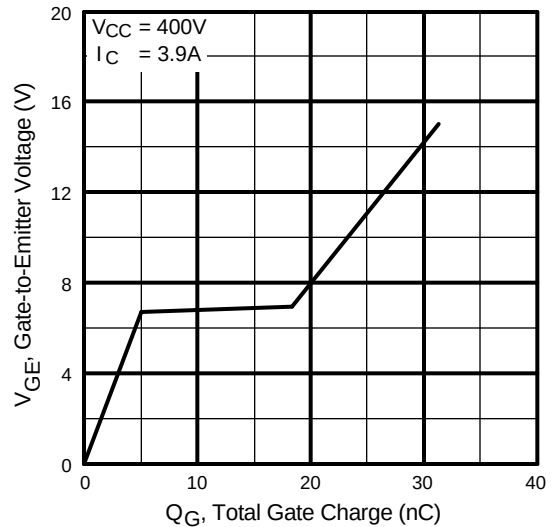
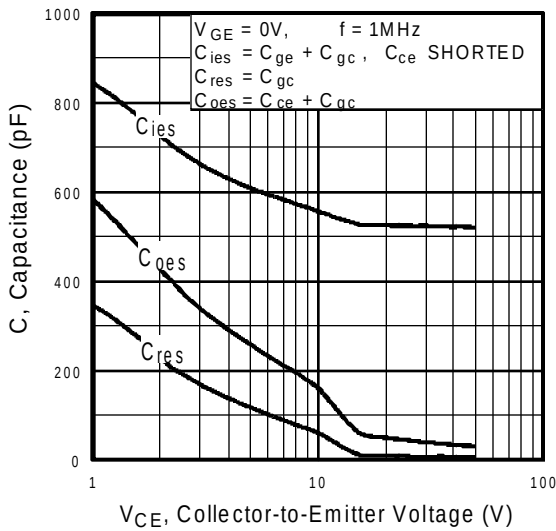


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



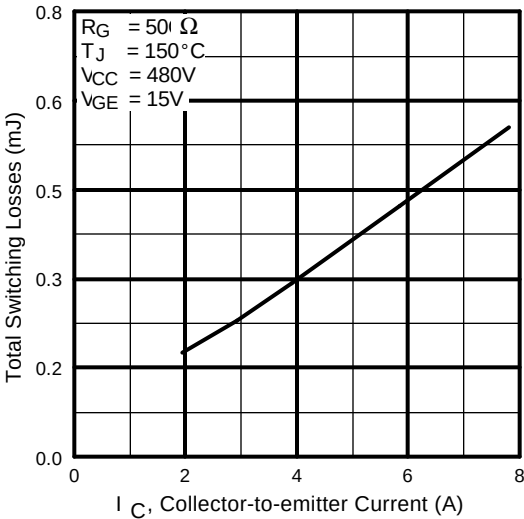


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

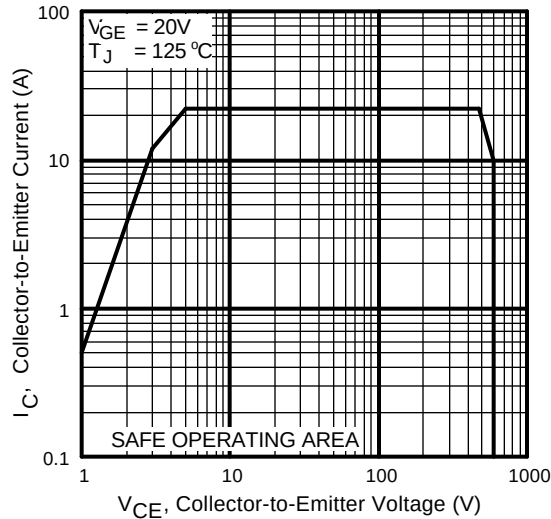


Fig. 12 - Turn-Off SOA

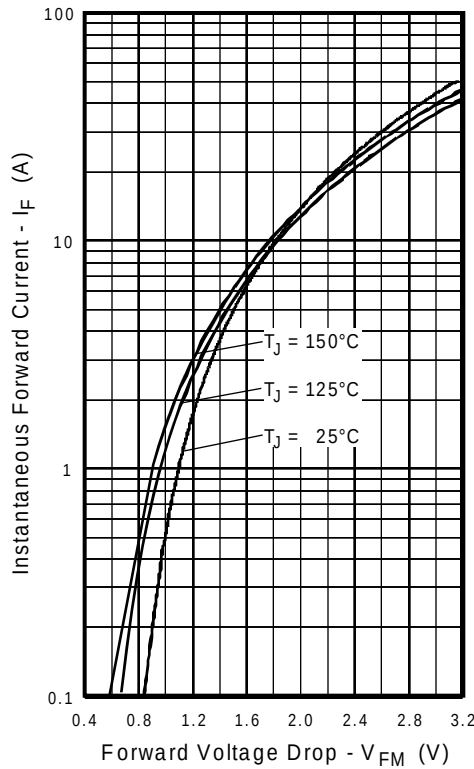


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

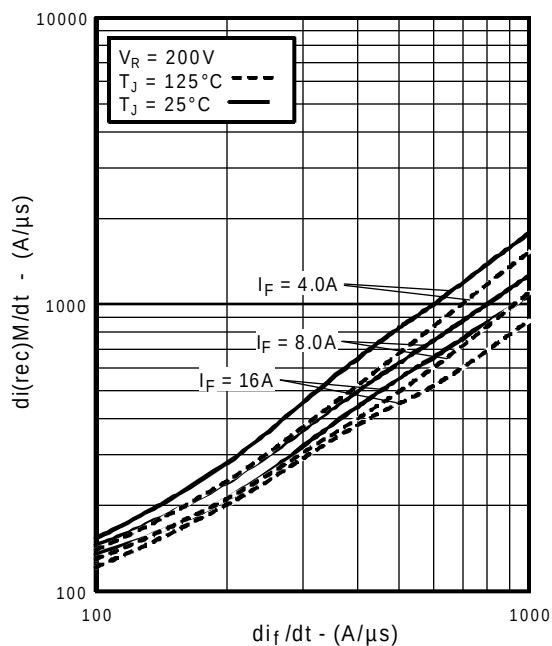
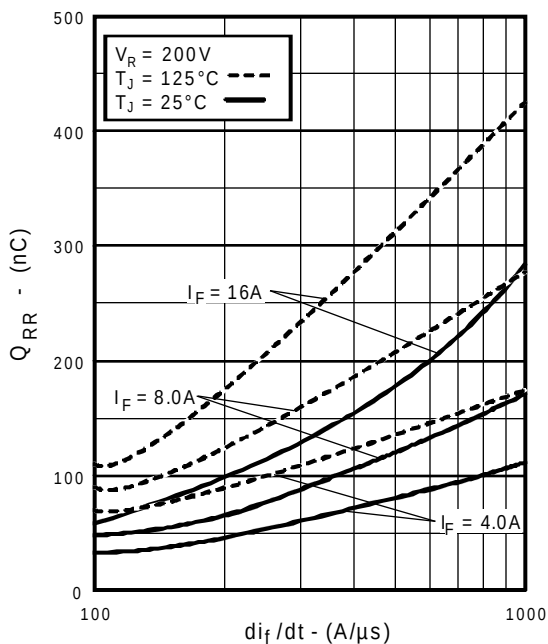
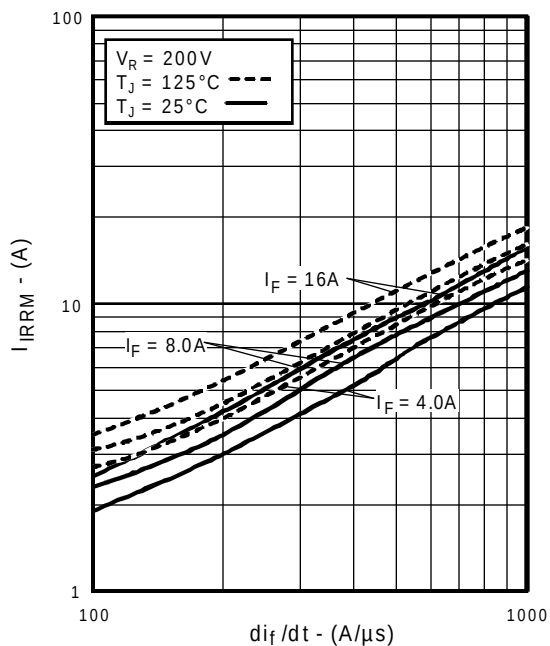
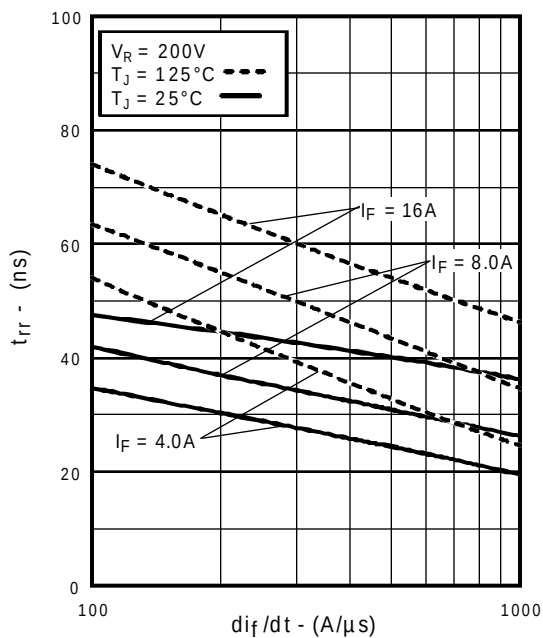


Fig. 16 - Typical Stored Charge vs. di_f/dt

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

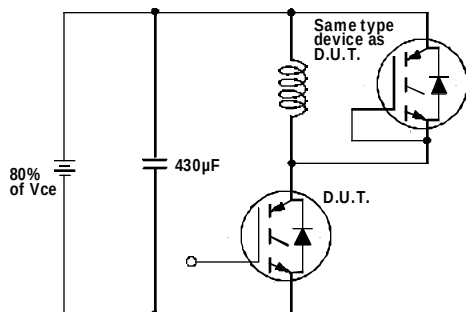


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

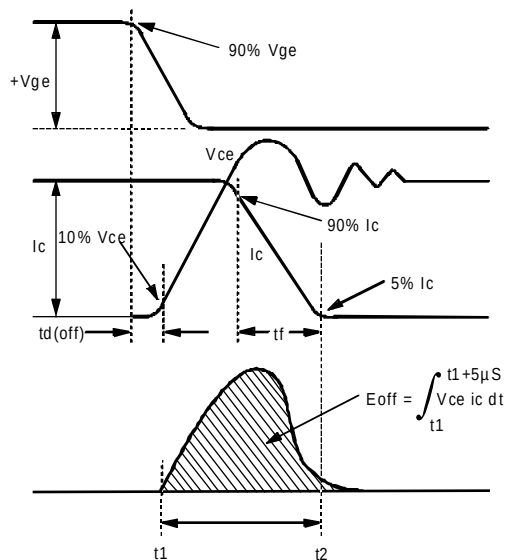


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

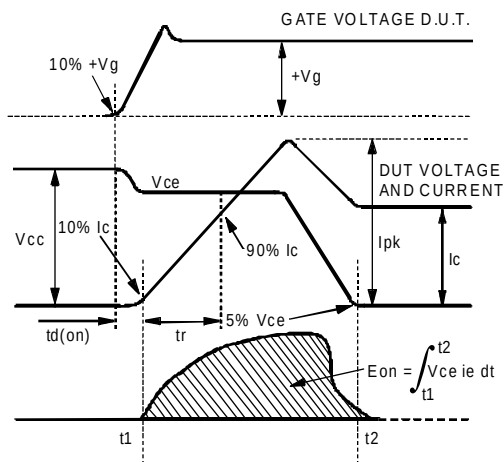


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

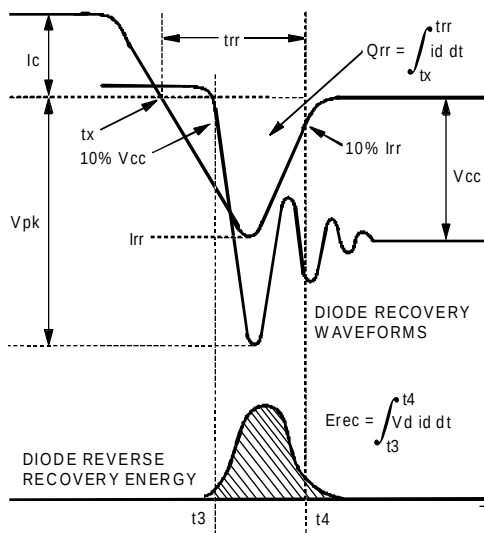


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

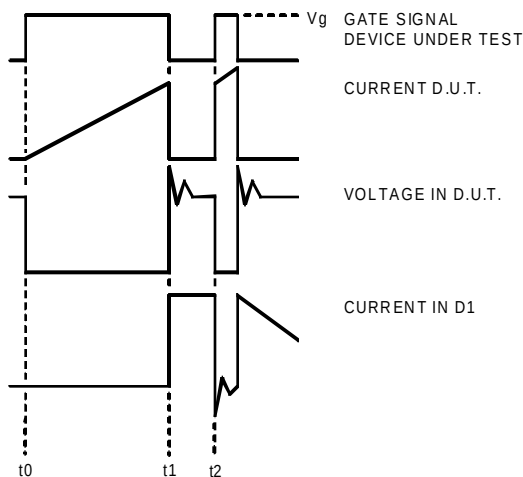


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

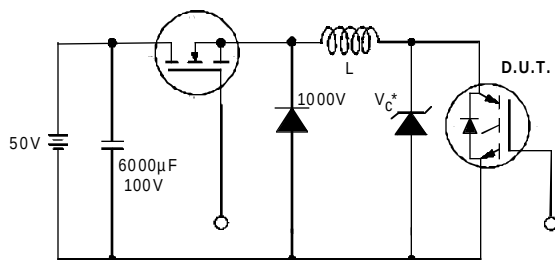


Figure 19. Clamped Inductive Load Test Circuit

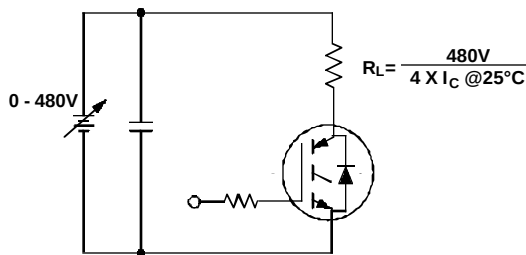


Figure 20. Pulsed Collector Current Test Circuit

Notes:

- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G = 50\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

Case Outline — IMS-2

