

## IGBT SIP Module (Fast IGBT)



IMS-2

### FEATURES

- Fully isolated printed circuit board mount package
- Switching-loss rating includes all "tail" losses
- HEXFRED® soft ultrafast diodes
- Optimized for medium speed 1 to 10 kHz  
See fig. 1 for current vs. frequency curve
- Totally lead (Pb)-free
- Designed and qualified for industrial level



RoHS  
COMPLIANT

### PRODUCT SUMMARY

#### OUTPUT CURRENT IN A TYPICAL 5.0 kHz MOTOR DRIVE

$I_{RMS}$ per phase (3.1 kW total) with $T_C = 90\text{ }^\circ\text{C}$	11 A
$T_J$	125 $^\circ\text{C}$
Supply voltage (DC)	360 V
Power factor	0.8
Modulation depth See fig. 1	115 %
$V_{CE(on)}$ (typical) at $I_C = 4.8\text{ A}$ , 25 $^\circ\text{C}$	1.41 V

### DESCRIPTION

The IGBT technology is the key to the 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	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		600	V
Continuous collector current, each IGBT	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	8.8	A
		$T_C = 100\text{ }^\circ\text{C}$	4.8	
Pulsed collector current	$I_{CM}$	Repetitive rating; $V_{GE} = 20\text{ V}$ , pulse width limited by maximum junction temperature. See fig. 20	26	A
Clamped inductive load current	$I_{LM}$	$V_{CC} = 80\%$ ( $V_{CES}$ ), $V_{GE} = 20\text{ V}$ , $L = 10\text{ }\mu\text{H}$ , $R_G = 50\text{ }\Omega$ See fig. 19	800	
Diode continuous forward current	$I_F$	$T_C = 100\text{ }^\circ\text{C}$	3.4	
Diode maximum forward current	$I_{FM}$		26	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1\text{ min}$	2500	$V_{RMS}$
Maximum power dissipation, each IGBT	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	23	W
		$T_C = 100\text{ }^\circ\text{C}$	9.1	
Operating junction and storage temperature range	$T_J, T_{Stg}$		- 40 to + 150	$^\circ\text{C}$
Soldering temperature		For 10 s	300 (0.063" (1.6 mm) from case)	
Mounting torque		6-32 or M3 screw	5 to 7 (0.55 to 0.8)	lbf · in (N · m)

### THERMAL AND MECHANICAL SPECIFICATIONS

PARAMETER	SYMBOL	TYP.	MAX.	UNITS
Junction to case, each IGBT, one IGBT in conduction	$R_{thJC}$ (IGBT)	-	5.5	$^\circ\text{C/W}$
Junction to case, each diode, one diode in conduction	$R_{thJC}$ (diode)	-	9.0	
Case to sink, flat, greased surface	$R_{thCS}$ (module)	0.1	-	
Weight of module		20 (0.7)	-	g (oz.)



ELECTRICAL SPECIFICATIONS (T <sub>J</sub> = 25 °C unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	V <sub>(BR)CES</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA Pulse width ≤ 80 μs, duty factor ≤ 0.1 %	600	-	-	V
Temperature coeff. of breakdown voltage	ΔV <sub>(BR)CES</sub> / ΔT <sub>J</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 1.0 mA	-	0.72	-	V/°C
Collector to emitter saturation voltage	V <sub>CE(on)</sub>	I <sub>C</sub> = 4.8 A	-	1.41	1.7	V
		I <sub>C</sub> = 8.8 A	-	1.66	-	
		I <sub>C</sub> = 4.8 A, T <sub>J</sub> = 150 °C	-	1.42	-	
Gate threshold voltage	V <sub>GE(th)</sub>	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 μA	3.0	-	6.0	
Gate to emitter leakage current	I <sub>GES</sub>	V <sub>GE</sub> = ± 20 V	-	-	± 100	nA
Temperature coeff. of threshold voltage	ΔV <sub>GE(th)</sub> / ΔT <sub>J</sub>	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 1.0 mA	-	-11	-	mV/°C
Forward transconductance	g <sub>fe</sub>	V <sub>CE</sub> = 100 V, I <sub>C</sub> = 4.8 A Pulse width 5.0 μs; single shot	2.9	5.0	-	S
Zero gate voltage collector current	I <sub>CES</sub>	V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 600 V	-	-	250	μA
		V <sub>GE</sub> = 0 V, V <sub>CE</sub> = 600 V, T <sub>J</sub> = 150 °C	-	-	1700	
Diode forward voltage drop	V <sub>FM</sub>	I <sub>C</sub> = 8.0 A	-	1.4	1.7	V
		I <sub>C</sub> = 8.0 A, T <sub>J</sub> = 150 °C	-	1.3	1.6	

SWITCHING CHARACTERISTICS (T <sub>J</sub> = 25 °C unless otherwise specified)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS	
Total gate charge (turn on)	Q <sub>g</sub>	I <sub>C</sub> = 4.8 A	-	30	45	nC	
Gate to emitter charge (turn on)	Q <sub>ge</sub>	V <sub>CC</sub> = 400 V	-	4.0	6.0		
Gate to collector charge	Q <sub>gc</sub>	See fig. 8	-	13	20		
Turn-on delay time	t <sub>d(on)</sub>	T <sub>J</sub> = 25 °C I <sub>C</sub> = 4.8 A, V <sub>CC</sub> = 480 V V <sub>GE</sub> = 15 V, R <sub>G</sub> = 50 Ω Energy losses include "tail" and diode reverse recovery.	-	49	-	ns	
Rise time	t <sub>r</sub>		-	22	-		
Turn-off delay time	t <sub>d(off)</sub>		-	200	300		
Fall time	t <sub>f</sub>		-	214	320		
Turn-on switching loss	E <sub>on</sub>	See fig. 9, 10, 18	-	0.23	-	mJ	
Turn-off switching loss	E <sub>off</sub>		-	0.33	-		
Total switching loss	E <sub>ts</sub>		-	0.45	0.70		
Turn-on delay time	t <sub>d(on)</sub>	T <sub>J</sub> = 150 °C, I <sub>C</sub> = 4.8 A, V <sub>CC</sub> = 480 V V <sub>GE</sub> = 15 V, R <sub>G</sub> = 50 Ω Energy losses include "tail" and diode reverse recovery	-	48	-	ns	
Rise time	t <sub>r</sub>		-	25	-		
Turn-off delay time	t <sub>d(off)</sub>		-	435	-		
Fall time	t <sub>f</sub>		-	364	-		
Total switching loss	E <sub>ts</sub>	See fig. 10, 11, 18	-	0.93	-	mJ	
Input capacitance	C <sub>ies</sub>	V <sub>GE</sub> = 0 V V <sub>CC</sub> = 30 V	See fig. 7	-	340	-	pF
Output capacitance	C <sub>oes</sub>			-	63	-	
Reverse transfer capacitance	C <sub>res</sub>			-	5.9	-	
Diode reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C	See fig. 14	-	37	55	ns
		T <sub>J</sub> = 125 °C			55	90	
Diode peak reverse recovery current	I <sub>rr</sub>	T <sub>J</sub> = 25 °C	See fig. 15	I <sub>F</sub> = 8.0 A V <sub>R</sub> = 200 V di/dt = 200 A/μs	3.5	50	A
		T <sub>J</sub> = 125 °C			4.5	8.0	
Diode reverse recovery charge	Q <sub>rr</sub>	T <sub>J</sub> = 25 °C	See fig. 16	-	65	138	nC
		T <sub>J</sub> = 125 °C			124	360	
Diode peak rate of fall of recovery during t <sub>b</sub>	dl <sub>(rec)M</sub> / dt	T <sub>J</sub> = 25 °C	See fig. 17	-	240	-	A/μs
		T <sub>J</sub> = 125 °C			210	-	

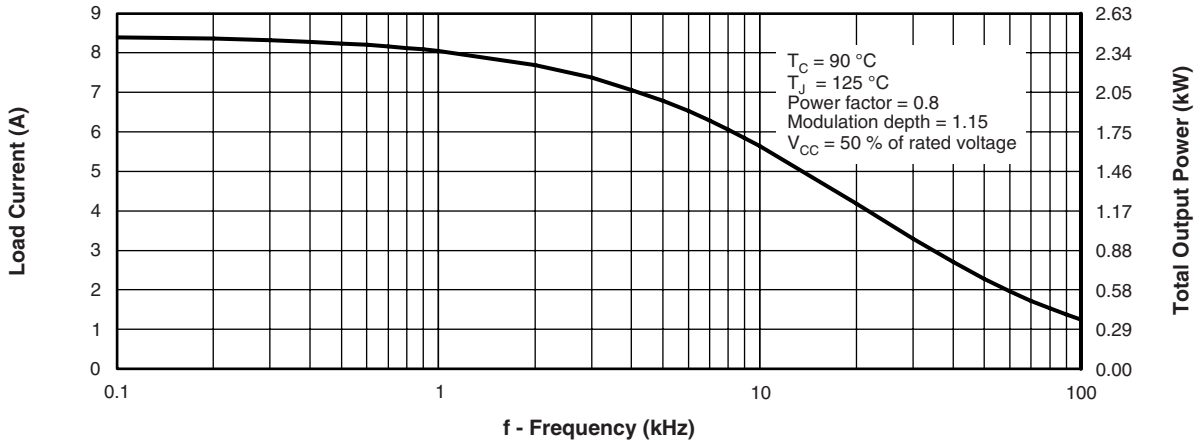


Fig. 1 - Typical Load Current vs. Frequency  
 (Load Current =  $I_{RMS}$  of Fundamental)

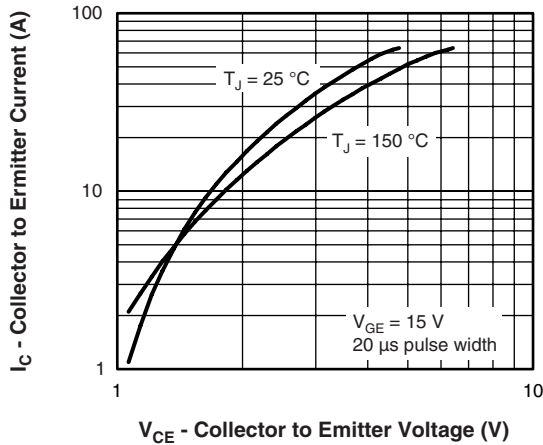


Fig. 2 - Typical Output Characteristics

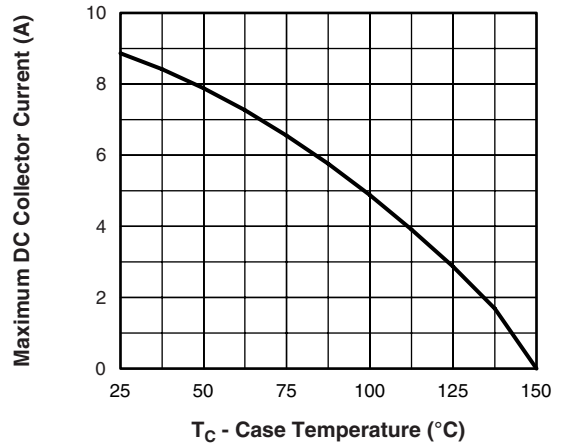


Fig. 4 - Maximum Collector Current vs. Case Temperature

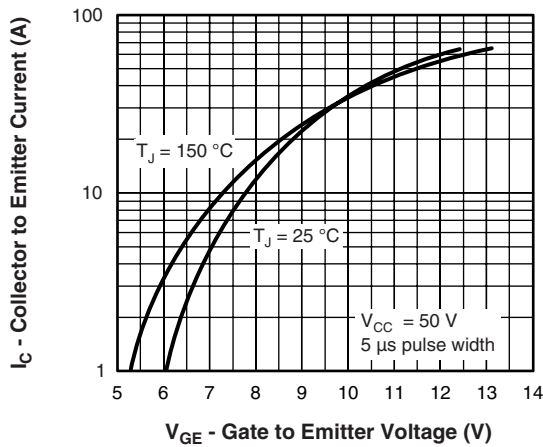


Fig. 3 - Typical Transfer Characteristics

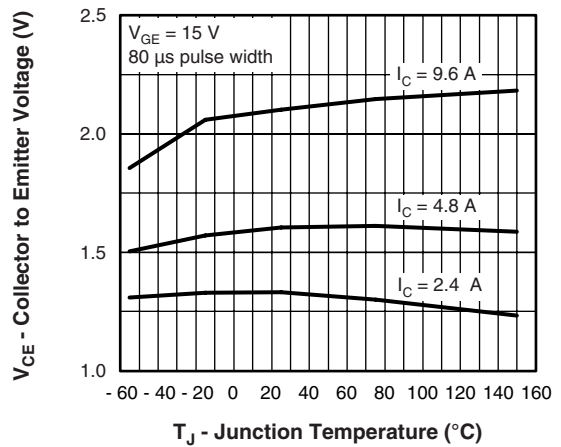


Fig. 5 - Typical Collector to Emitter Voltage vs. Junction Temperature

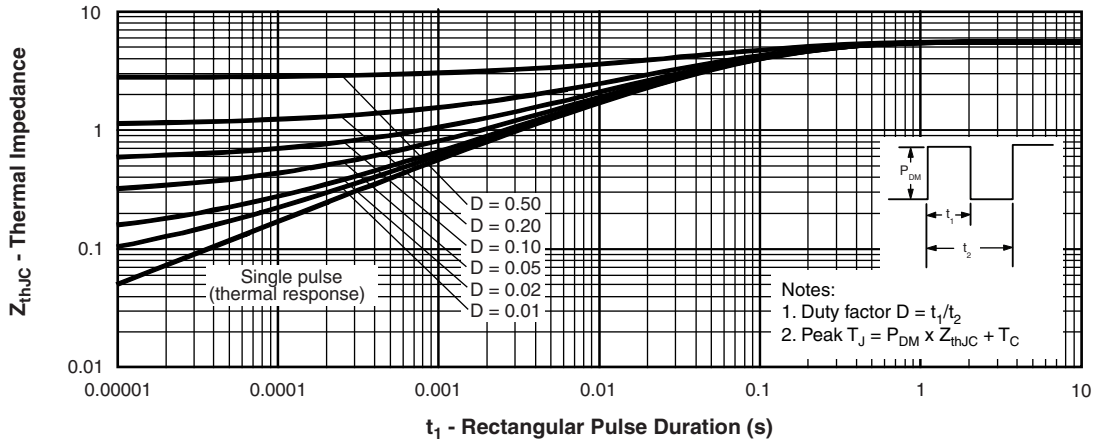


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction to Case

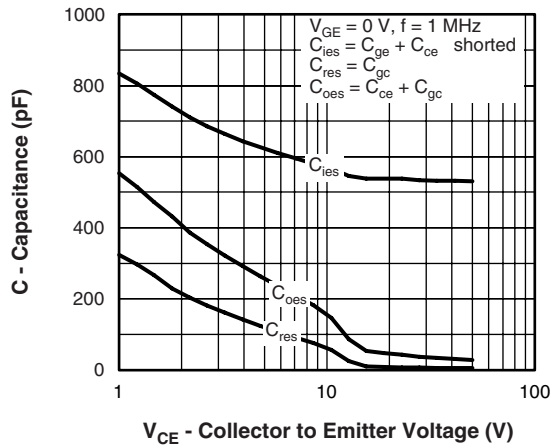


Fig. 7 - Typical Capacitance vs. Collector to Emitter Voltage

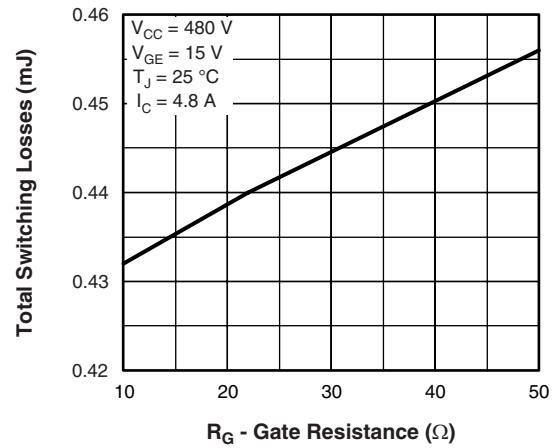


Fig. 9 - Typical Switching Losses vs. Gate Resistance

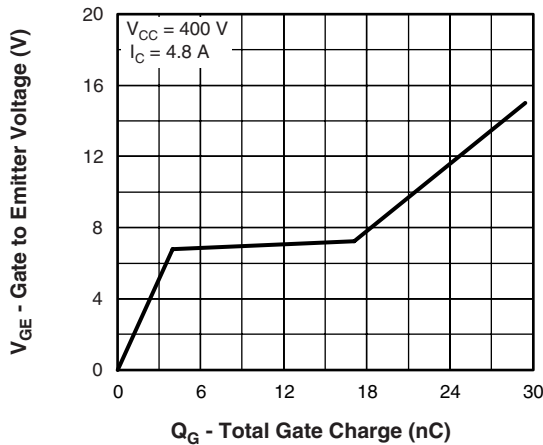


Fig. 8 - Typical Gate Charge vs. Gate to Emitter Voltage

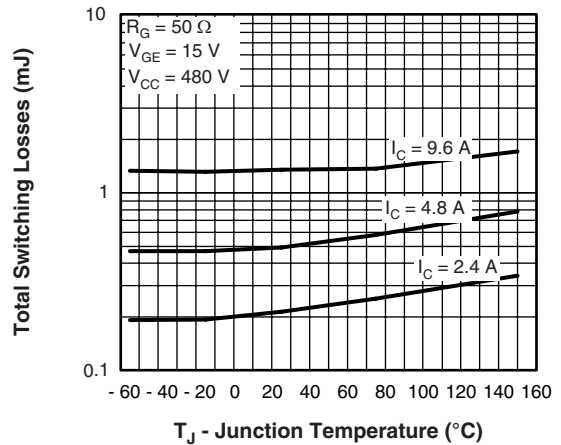


Fig. 10 - Typical Switching Losses vs. Junction Temperature

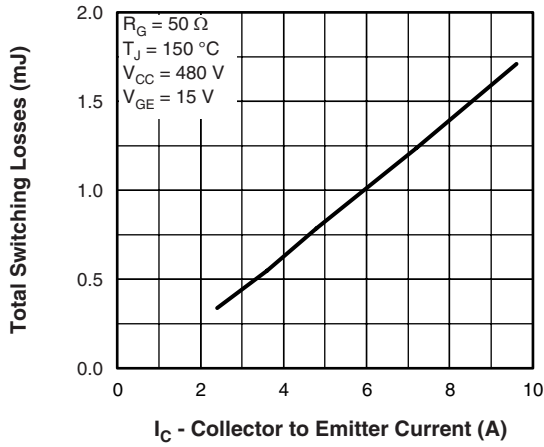


Fig. 11 - Typical Switching Losses vs. Collector to Emitter Current

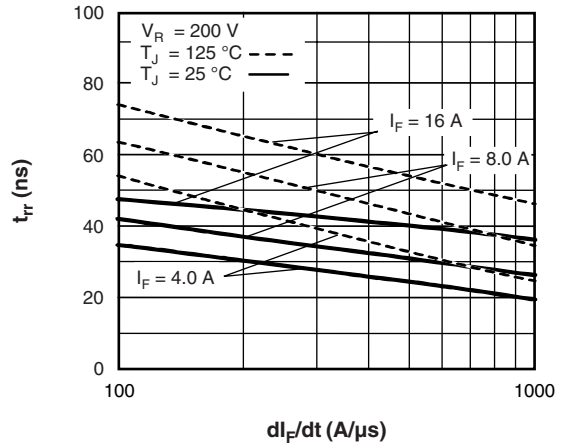


Fig. 14 - Typical Reverse Recovery Time vs.  $di_F/dt$

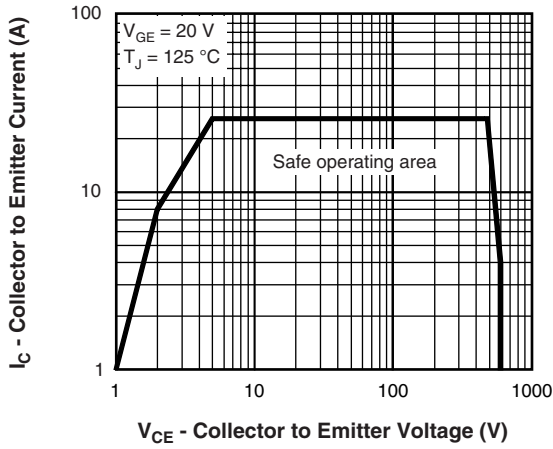


Fig. 12 - Turn-Off SOA

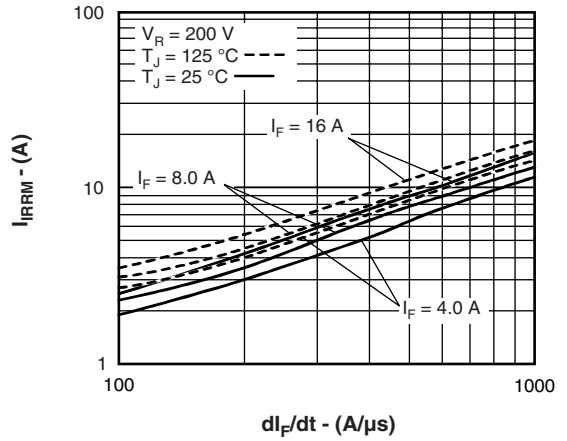


Fig. 15 - Typical Recovery Current vs.  $di_F/dt$

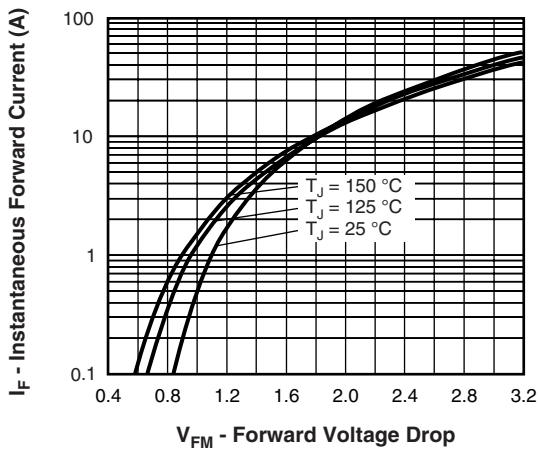


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

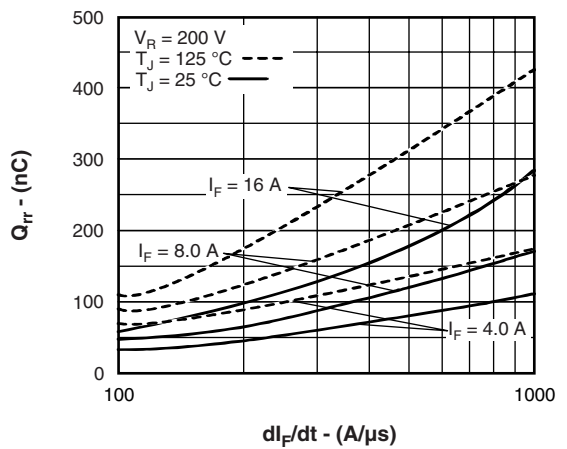


Fig. 16 - Typical Stored Charge vs.  $di_F/dt$

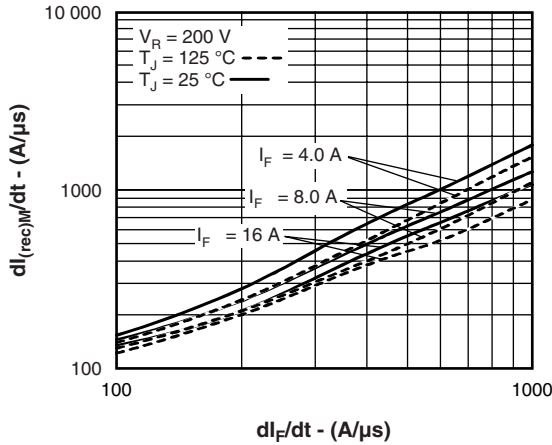


Fig. 17 - Typical  $dI_{(REC)M}/dt$  vs  $dI_F/dt$

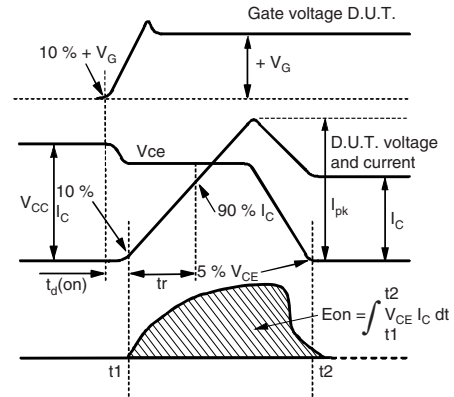


Fig. 18c - Test Waveforms of Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$

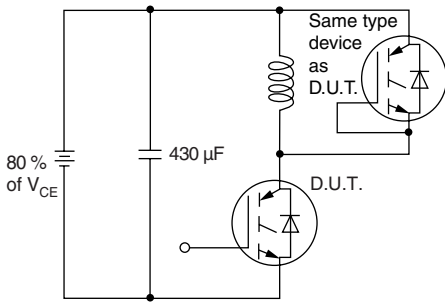


Fig. 18a - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off(diode)}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$

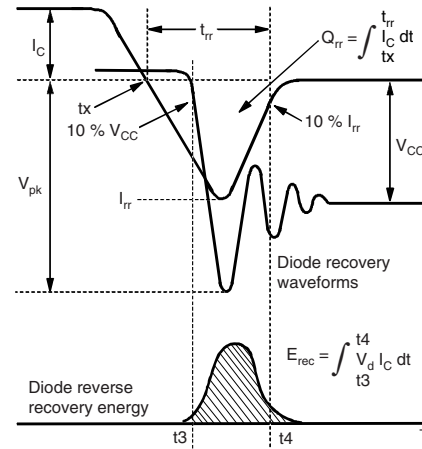


Fig. 18d - Test Waveforms of Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

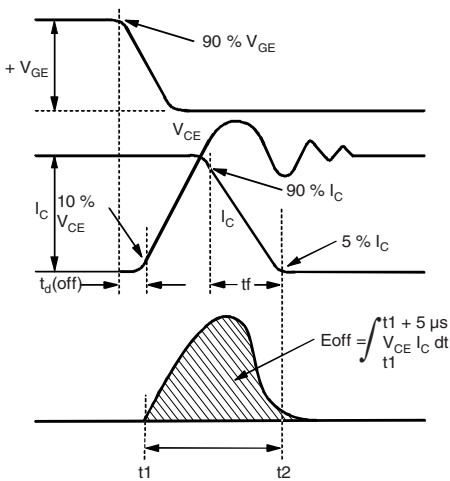


Fig. 18b - Test Waveforms of Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$

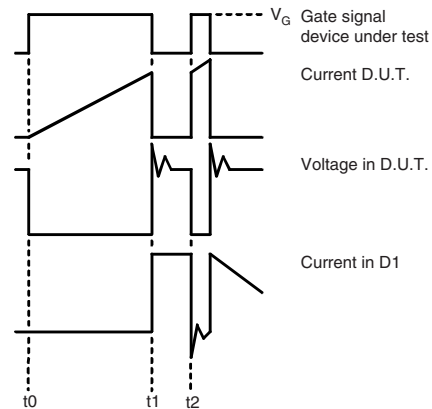


Fig. 18e - Macro Waveforms for Figure 18a's Test Circuit

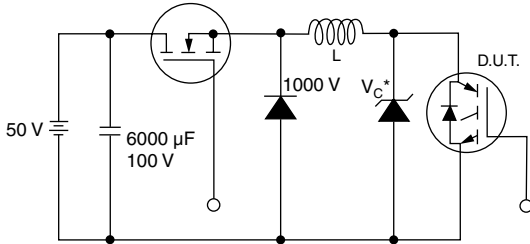


Fig. 19 - Clamped Inductive Load Test Circuit

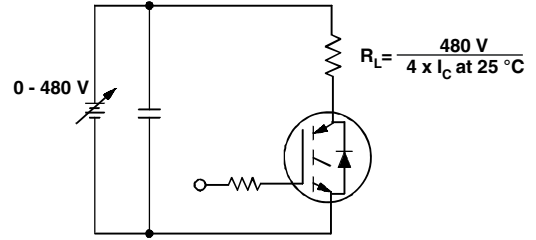
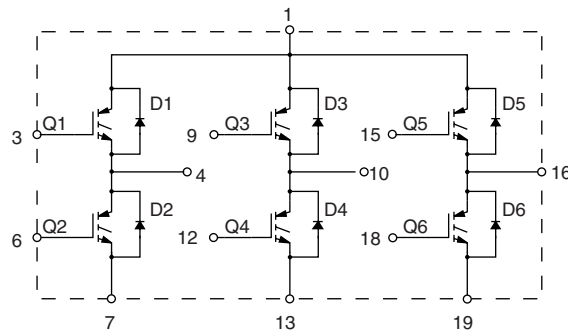


Fig. 20 - Pulsed Collector Current Test Circuit

**CIRCUIT CONFIGURATION**



**LINKS TO RELATED DOCUMENTS**

Dimensions	<a href="http://www.vishay.com/doc?95066">http://www.vishay.com/doc?95066</a>
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