


## IGBT SIP Module (Fast IGBT)



IMS-2

PRODUCT SUMMARY	
OUTPUT CURRENT IN A TYPICAL 20 kHz MOTOR DRIVE	
$I_{RMS}$ per phase (3.1 kW total) with $T_C = 90\text{ }^{\circ}\text{C}$	4.6 $A_{RMS}$
$T_J$	125 $^{\circ}\text{C}$
Supply voltage	360 Vdc
Power factor	0.8
Modulation depth (see fig. 1)	115 %
$V_{CE(on)}$ (typical) at $I_C = 3.9\text{ A}$ , 25 $^{\circ}\text{C}$	1.7 V
Package	SIP
Circuit	Three Phase Inverter

### FEATURES

- Fully isolated printed circuit board mount package
- Switching-loss rating includes all “tail” losses
- HEXFRED® soft ultrafast diodes
- Optimized for high speed over 5 kHz  
See fig. 1 for current vs. frequency curve
- UL approved file E78996 
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT

### DESCRIPTION

The IGBT technology is the key to Vishay’s Semiconductors 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	$I_C$	$T_C = 25\text{ }^{\circ}\text{C}$	7.2	A
		$T_C = 100\text{ }^{\circ}\text{C}$	3.9	
Pulsed collector current	$I_{CM}^{(1)}$		22	
Clamped inductive load current	$I_{LM}^{(2)}$			
Diode continuous forward current	$I_F$	$T_C = 100\text{ }^{\circ}\text{C}$	3.4	
Diode maximum forward current	$I_{FM}$		22	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Isolation voltage	$V_{ISOL}$	1 minute, any terminal to case	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		10 s, (0.063" (1.6 mm) from case)	300	
Mounting torque		6-32 or M3 screw	5 to 7 (0.55 to 0.8)	lbf · in (N · m)

### Notes

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

(2)  $V_{CC} = 80\%$  ( $V_{GES}$ ),  $V_{GE} = 20\text{ V}$ ,  $L = 10\text{ }\mu\text{H}$ ,  $R_G = 50\text{ }\Omega$  (see fig.19)


**THERMAL AND MECHANICAL SPECIFICATIONS**

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

**ELECTRICAL SPECIFICATIONS ( $T_J = 25\text{ °C}$  unless otherwise noted)**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(VB)CES}^{(1)}$	$V_{GE} = 0\text{ V}$ , $I_C = 250\text{ }\mu\text{A}$	600	-	-	V
Temperature coefficient of breakdown voltage	$\Delta V_{(BR)CES}/\Delta T_J$	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	-	0.63	-	V/°C
Collector to emitter saturation voltage	$V_{CE(on)}$	$I_C = 3.9\text{ A}$	-	1.70	2.2	V
		$I_C = 7.2\text{ A}$	-	1.95	-	
		$I_C = 3.9\text{ A}$ , $T_J = 150\text{ °C}$	-	1.70	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$	3.0	-	6.0	mV/°C
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$		-	- 11	-	
Forward transconductance	$g_{fe}^{(2)}$	$V_{CE} = 100\text{ V}$ , $I_C = 6.5\text{ A}$	1.4	4.3	-	S
Zero gate voltage collector current	$I_{CES}$	$V_{GE} = 0\text{ V}$ , $V_{CE} = 600\text{ V}$	-	-	250	$\mu\text{A}$
		$V_{GE} = 0\text{ V}$ , $V_{CE} = 600\text{ V}$ , $T_J = 150\text{ °C}$	-	-	2500	
Diode forward voltage drop	$V_{FM}$	$I_C = 8.0\text{ A}$	-	1.4	1.7	V
		$I_C = 8.0\text{ A}$ , $T_J = 150\text{ °C}$	-	1.3	1.6	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 100$	nA

**Notes**

<sup>(3)</sup> Pulse width  $\leq 80\text{ }\mu\text{s}$ ; duty factor  $\leq 0.1\%$

<sup>(4)</sup> Pulse width  $5.0\text{ }\mu\text{s}$ , single shot



<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS
Total gate charge (turn-on)	$O_g$	$I_C = 3.9\text{ A}$ $V_{CC} = 400\text{ V}$ $V_{GE} = 15\text{ V}$		-	31	47	nC
Gate to emitter charge (turn-on)	$O_{GE}$			-	5.0	7.5	
Gate to collector charge (turn-on)	$O_{gc}$			-	13	20	
Turn-on delay time	$t_{d(on)}$	$T_J = 25\text{ }^{\circ}\text{C}$ $I_C = 3.9\text{ A}$ , $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ , $R_G = 50\text{ }\Omega$ Energy losses include "tail" and diode reverse recovery See fig. 9, 10, 11, 18		-	45	-	ns
Rise time	$t_r$			-	22	-	
Turn-off delay time	$t_{d(off)}$			-	100	160	
Fall time	$t_f$			-	120	180	
Turn-on switching loss	$E_{on}$			-	0.13	-	mJ
Turn-off switching loss	$E_{off}$			-	0.07	-	
Total switching loss	$E_{ts}$			-	0.20	0.3	
Turn-on delay time	$t_{d(on)}$			-	42	-	ns
Rise time	$t_r$			-	22	-	
Turn-off delay time	$t_{d(off)}$			-	120	-	
Fall time	$t_f$			-	250	-	
Total switching loss	$E_{ts}$			-	0.35	-	mJ
Input capacitance	$C_{ies}$	$V_{GE} = 0\text{ V}$ $V_{CC} = 30\text{ V}$ $f = 1.0\text{ MHz}$	See fig. 7	-	530	-	pF
Output capacitance	$C_{oes}$			-	39	-	
Reverse transfer capacitance	$C_{res}$			-	7.4	-	
Diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	See fig. 14	-	37	55	ns
		$T_J = 125\text{ }^{\circ}\text{C}$		-	55	90	
Diode peak reverse recovery current	$I_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	See fig. 15	-	3.5	5.0	A
		$T_J = 125\text{ }^{\circ}\text{C}$		-	4.5	8.0	
Diode reverse recovery charge	$Q_{rr}$	$T_J = 25\text{ }^{\circ}\text{C}$	See fig. 16	-	65	138	nC
		$T_J = 125\text{ }^{\circ}\text{C}$		-	124	360	
Diode peak rate of fall of recovery during $t_b$	$dl_{(rec)M}/dt$	$T_J = 25\text{ }^{\circ}\text{C}$	See fig. 17	-	240	-	A/ $\mu\text{s}$
		$T_J = 125\text{ }^{\circ}\text{C}$		-	210	-	

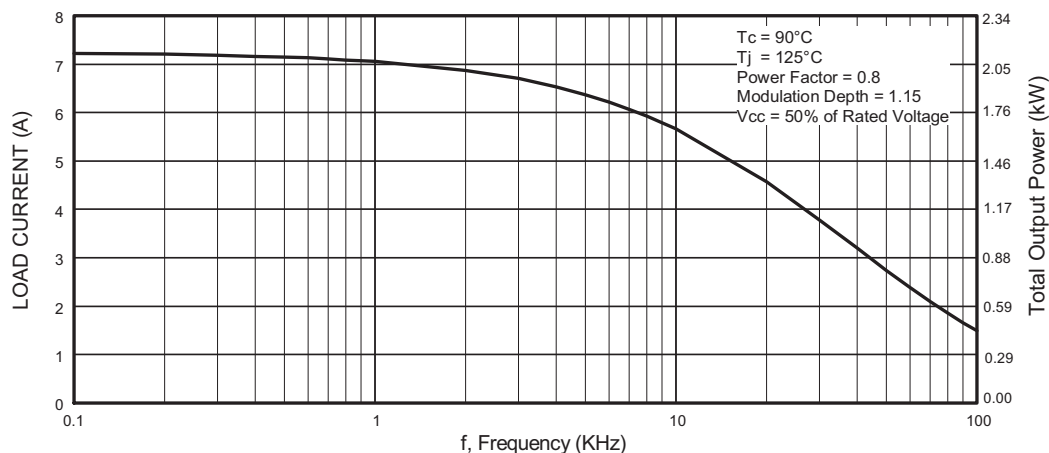


Fig. 1 - Typical Load Current vs. Frequency  
(Load Current =  $I_{RMS}$  of Fundamental)

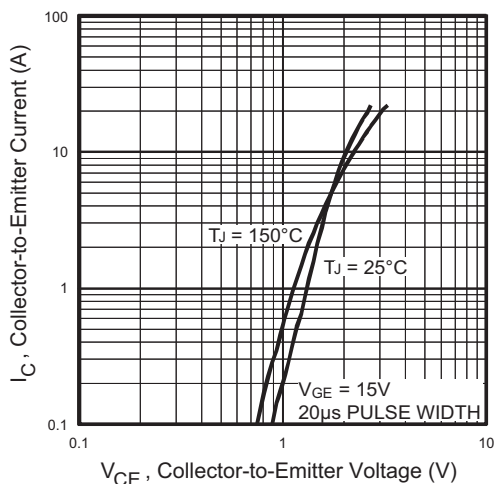


Fig. 2 - Typical Output Characteristics

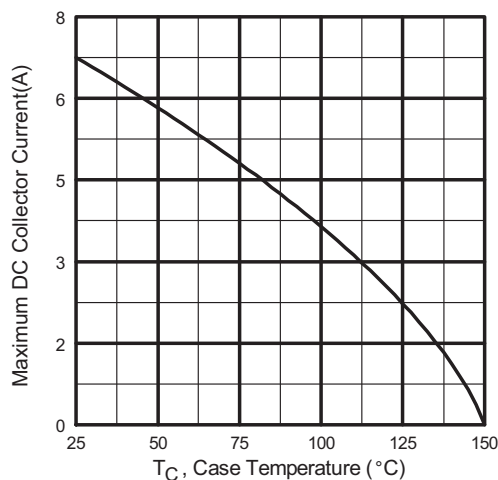


Fig. 4 - Maximum Collector Current vs.  
Case Temperature

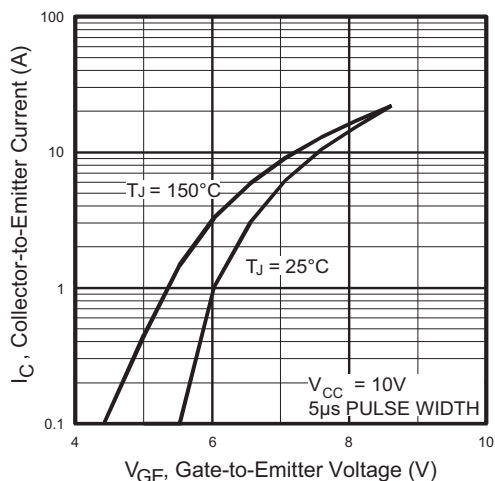


Fig. 3 - Typical Transfer Characteristics

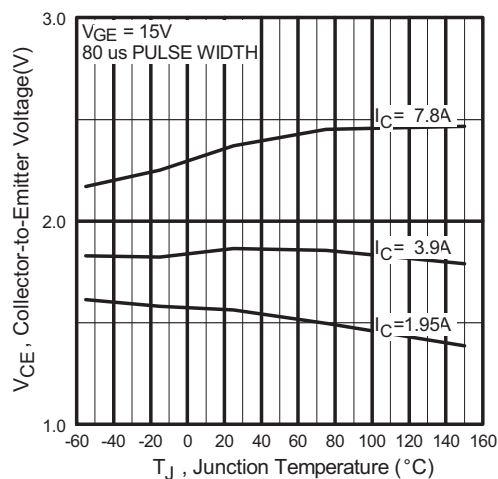


Fig. 5 - Typical Collector to Emitter Voltage vs.  
Junction Temperature

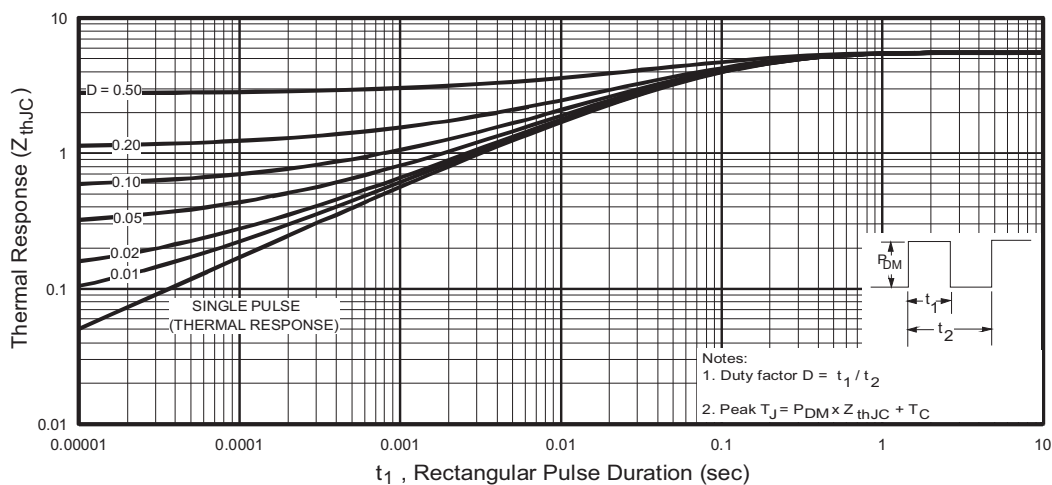


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction to Case

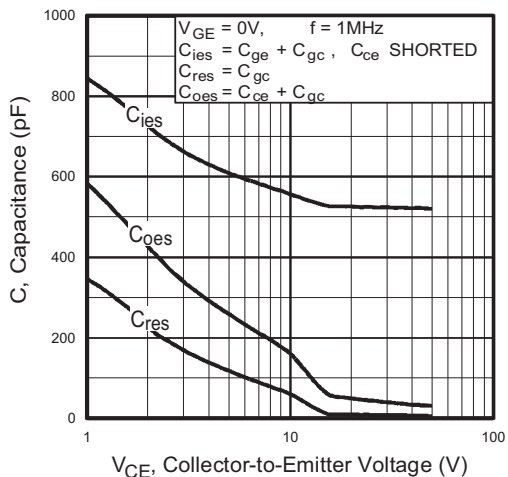


Fig. 7 - Typical Capacitance vs. Collector to Emitter Voltage

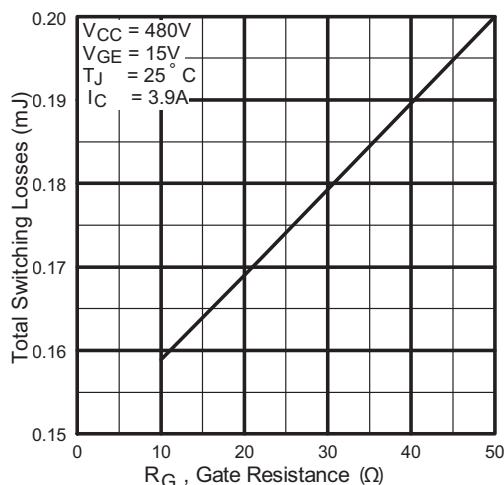


Fig. 9 - Typical Switching Losses vs. Gate Resistance

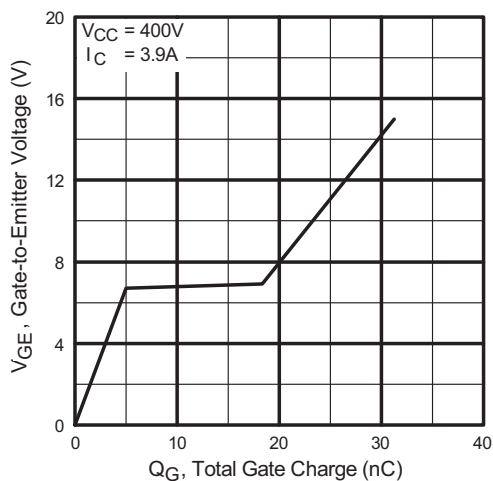


Fig. 8 - Typical Gate Charge vs. Gate to Emitter Voltage

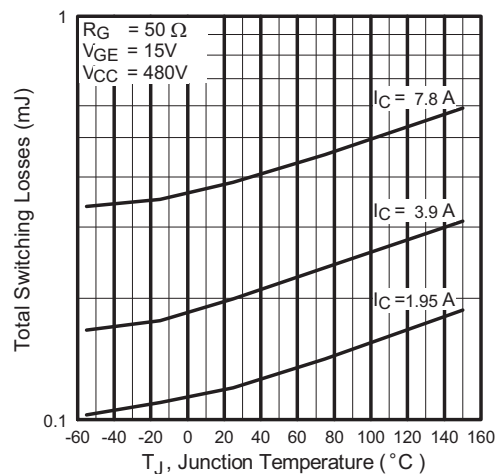


Fig. 10 - Typical Switching Losses vs. Junction Temperature

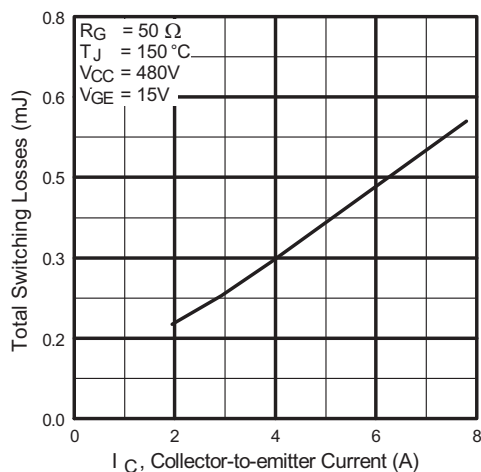


Fig. 11 - Typical Switching Losses vs. Collector to Emitter Current

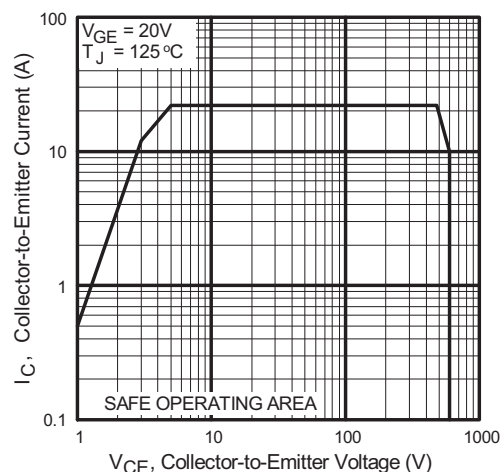


Fig. 12 - Turn-Off SOA

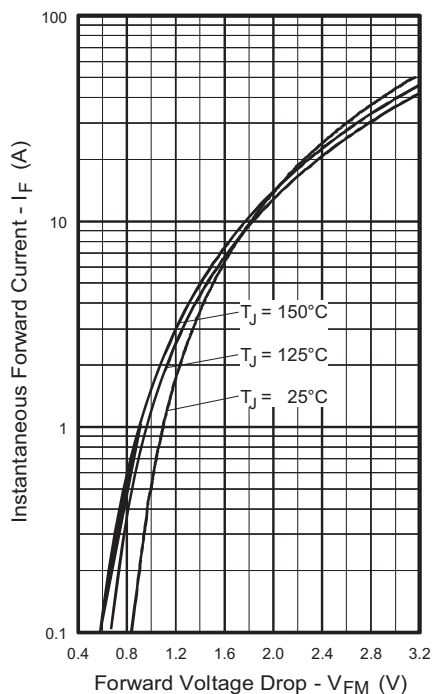


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

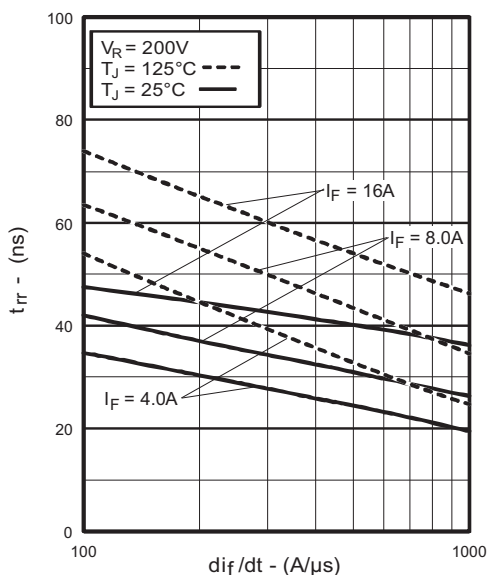


Fig. 14 - Typical Reverse Recovery Time vs.  $dI_F/dt$

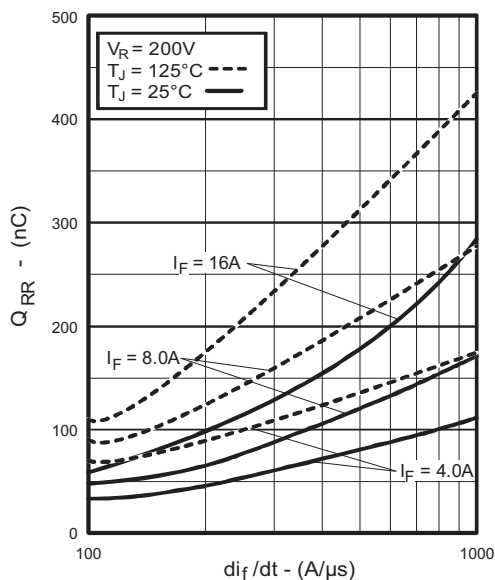


Fig. 16 - Typical Stored Charge vs.  $dI_F/dt$

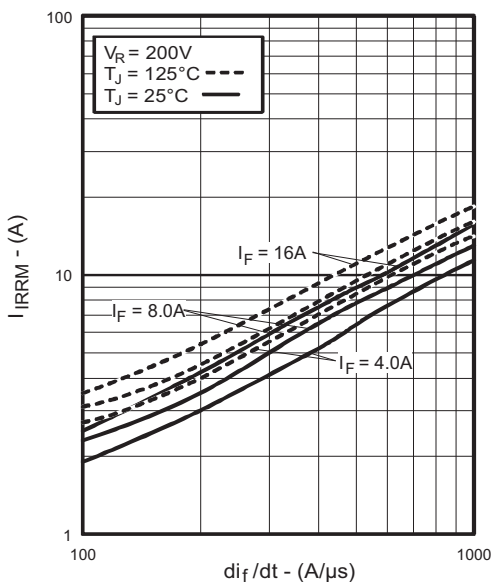


Fig. 15 - Typical Recovery Current vs.  $dI_F/dt$

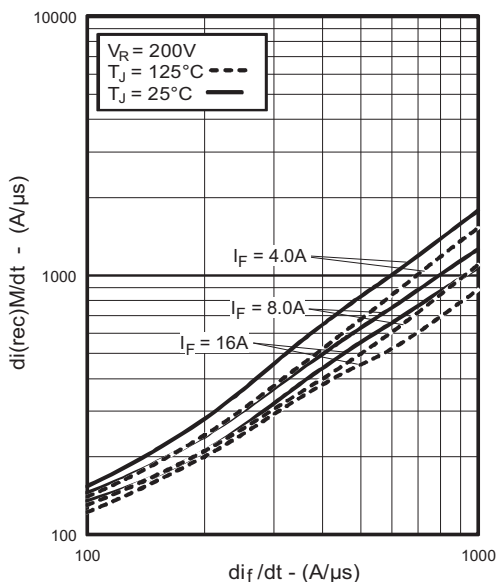


Fig. 17 - Typical  $dI_{(rec)}M/dt$  vs.  $dI_F/dt$

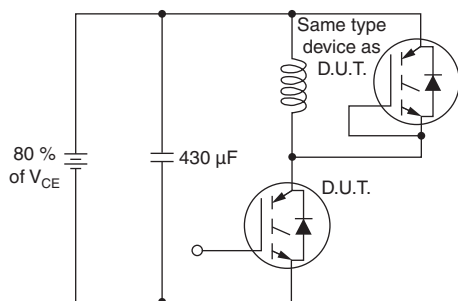


Fig. 18a - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off(diode)}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$

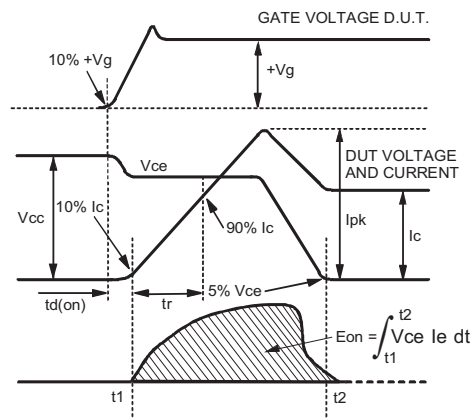


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$

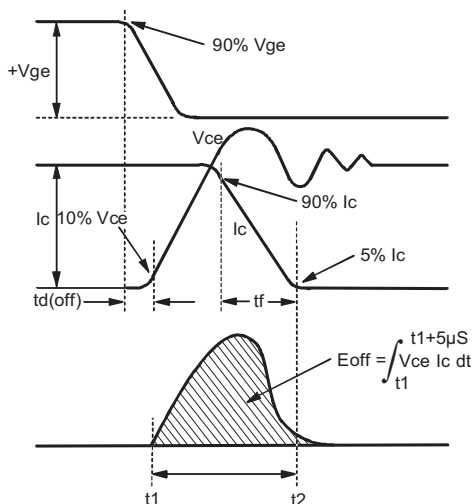


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$

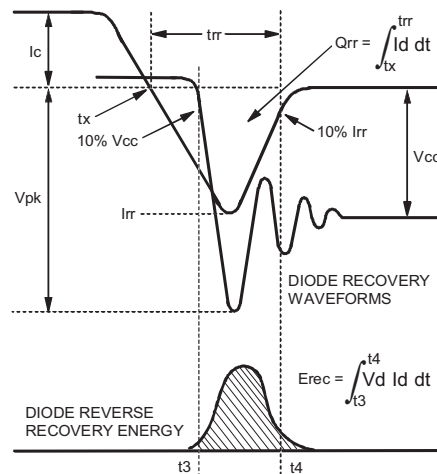


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

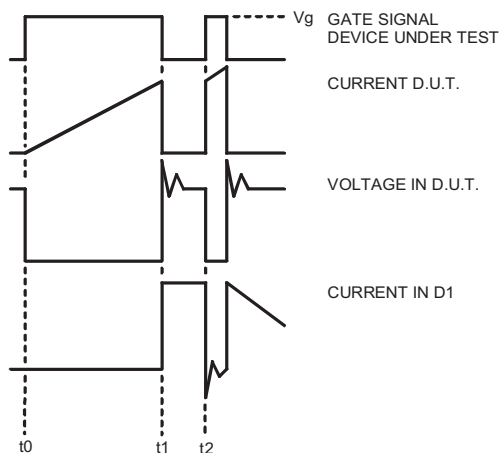


Fig. 18e - Macro Waveforms for Fig. 18a's Test Circuit

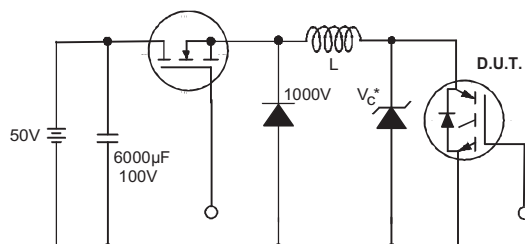


Fig. 19 - Clamped Inductive Load Test Circuit

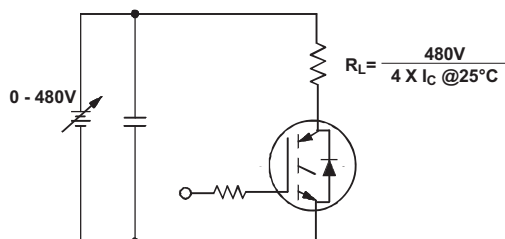
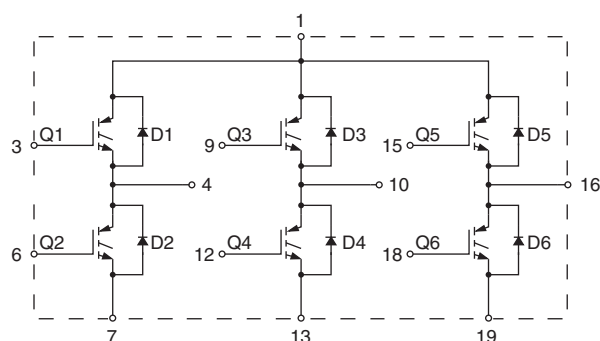


Fig. 20 - Pulsed Collector Current Test Circuit

## CIRCUIT CONFIGURATION



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

**DIMENSIONS** in millimeters (inches)



- (1) Tolerance unless otherwise specified  $\pm 0.254$  mm (0.010")  
(2) Controlling dimension: inch  
(3) Terminal numbers are shown for reference only



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➤ Sales :

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QQ         800077892  
  
Skype       ameyasales1 ameyasales2

➤ Customer Service :

Email       service@ameya360.com

➤ Partnership :

Tel         +86 (21) 64016692-8333  
  
Email       mkt@ameya360.com