


## Insulated Gate Bipolar Transistor (Ultrafast IGBT), 100 A


**SOT-227**
**FEATURES**

- Trench IGBT high speed
- Square RBSOA
- HEXFRED® low  $Q_{rr}$ , low switching energy
- Positive  $V_{CE(on)}$  temperature coefficient
- Fully isolated package
- Very low internal inductance ( $\leq 5$  nH typical)
- Industry standard outline
- UL approved file E78996 
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**
**PRIMARY CHARACTERISTICS**

$V_{CES}$	1200 V
$I_C$ DC	100 A at 108 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	1.93 V
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit configuration	Single switch

**BENEFITS**

- Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
- Easy to assemble and parallel
- Direct mounting on heatsink
- Plug-in compatible with other SOT-227 packages
- Low EMI, requires less snubbing

**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		1200	V
Continuous collector current	$I_C$ <sup>(1)</sup>	$T_C = 25$ °C	187	A
		$T_C = 90$ °C	123	
Pulsed collector current	$I_{CM}$		240	
Clamped inductive load current	$I_{LM}$		250	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Diode continuous forward current	$I_F$	$T_C = 25$ °C	97	A
		$T_C = 90$ °C	61	
Single pulse forward current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse, $T_J = 25$ °C	350	
Power dissipation, IGBT	$P_D$	$T_C = 25$ °C	890	W
		$T_C = 90$ °C	500	
Power dissipation, diode	$P_D$	$T_C = 25$ °C	429	W
		$T_C = 90$ °C	194	
Isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ min	2500	V

**Note**

<sup>(1)</sup> Maximum collector current admitted is 100 A, to do exceed the maximum temperature of terminals



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}, I_C = 3.8\text{ mA}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.93	2.55	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.26	-	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	2.35	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 3.8\text{ mA}$	4.5	5.8	7.0	
		$V_{CE} = V_{GE}, I_C = 3.8\text{ mA}, T_J = 125\text{ }^\circ\text{C}$	-	4.6	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 3.8\text{ mA}$ (25 °C to 125 °C)	-	-12	-	mV/°C
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	1.0	100	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.9	-	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	3.4	-	
Forward voltage drop, diode	$V_{FM}$	$V_{GE} = 0\text{ V}, I_F = 80\text{ A}$	-	2.8	3.5	V
		$V_{GE} = 0\text{ V}, I_F = 80\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.0	-	
		$V_{GE} = 0\text{ V}, I_F = 80\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.0	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 220$	nA

<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)	$Q_g$	$V_{GE} = -15\text{ V}, V_{GE} = +15\text{ V}$	-	800	-	nC	
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	-	6150	-	pF	
Reverse transfer capacitance	$C_{res}$		-	345	-		
Turn-on switching loss	$E_{on}$	$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 1.0\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	2.2	-	mJ	
Turn-off switching loss	$E_{off}$		-	3.0	-		
Total switching loss	$E_{tot}$		-	5.2	-		
Turn-on delay time	$t_{d(on)}$		Energy losses include tail and diode recovery Diode used HFA16PB120	-	131	-	ns
Rise time	$t_r$			-	55	-	
Turn-off delay time	$t_{d(off)}$			-	244	-	
Fall time	$t_f$	-		118	-		
Turn-on switching loss	$E_{on}$	$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 1.0\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$		-	2.9	-	mJ
Turn-off switching loss	$E_{off}$			-	5.3	-	
Total switching loss	$E_{tot}$		-	8.2	-		
Turn-on delay time	$t_{d(on)}$		Energy losses include tail and diode recovery Diode used HFA16PB120	-	147	-	ns
Rise time	$t_r$			-	61	-	
Turn-off delay time	$t_{d(off)}$			-	358	-	
Fall time	$t_f$	-		132	-		
Turn-on switching loss	$E_{on}$	$I_C = 100\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 1.0\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$		-	3.0	-	mJ
Turn-off switching loss	$E_{off}$			-	4.0	-	
Total switching loss	$E_{tot}$		-	7.0	-		
Turn-on delay time	$t_{d(on)}$		Energy losses include tail and diode recovery Diode used HFA16PB120	-	134	-	ns
Rise time	$t_r$			-	66	-	
Turn-off delay time	$t_{d(off)}$			-	242	-	
Fall time	$t_f$	-		108	-		



<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)									
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS		
Turn-on switching loss	$E_{on}$	$I_C = 100\text{ A}$ , $V_{CC} = 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , $R_g = 1.0\text{ }\Omega$ , $L = 500\text{ }\mu\text{H}$ , $T_J = 125\text{ }^\circ\text{C}$	Energy losses include tail and diode recovery  Diode used HFA16PB120	-	3.9	-	mJ		
Turn-off switching loss	$E_{off}$			-	7.1	-			
Total switching loss	$E_{tot}$			-	11.0	-			
Turn-on delay time	$t_{d(on)}$					-	154	-	ns
Rise time	$t_r$					-	72	-	
Turn-off delay time	$t_{d(off)}$					-	346	-	
Fall time	$t_f$					-	120	-	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}$ , $I_C = 250\text{ A}$ , $R_g = 1.0\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ to $0\text{ V}$ , $V_{CC} = 800\text{ V}$ , $V_P = 1200\text{ V}$ , $L = 500\text{ }\mu\text{H}$		Fullsquare					
Short circuit safe operating area	SCSOA	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ , $V_{CE\text{ max.}} = 1200\text{ V}$ , $T_{VJ} = 150\text{ }^\circ\text{C}$		-	-	10	$\mu\text{s}$		
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}$ , $dI_F/dt = 200\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$		-	183	-	ns		
Diode peak reverse current	$I_{rr}$			-	12	-	A		
Diode recovery charge	$Q_{rr}$			-	1093	-	nC		
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}$ , $dI_F/dt = 200\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$		-	278	-	ns		
Diode peak reverse current	$I_{rr}$			-	18.2	-	A		
Diode recovery charge	$Q_{rr}$			-	2541	-	nC		

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		-40	-	150	$^\circ\text{C}$
Junction to case	IGBT					$^\circ\text{C}/\text{W}$
	Diode					
Case to heatsink	$R_{thCS}$	Flat, greased surface	-	0.1	-	
Weight			-	30	-	g
Mounting torque		Torque to terminal	-	-	1.1 (9.7)	Nm (lbf. in)
		Torque to heatsink	-	-	1.3 (11.5)	Nm (lbf. in)
Case style	SOT-227					

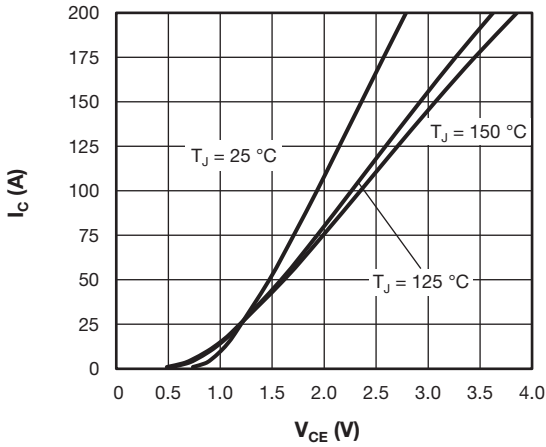


Fig. 1 - Typical IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

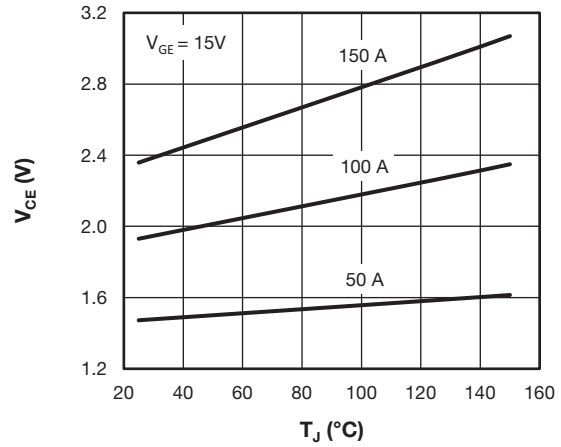


Fig. 4 - Collector to Emitter Voltage vs. Junction Temperature

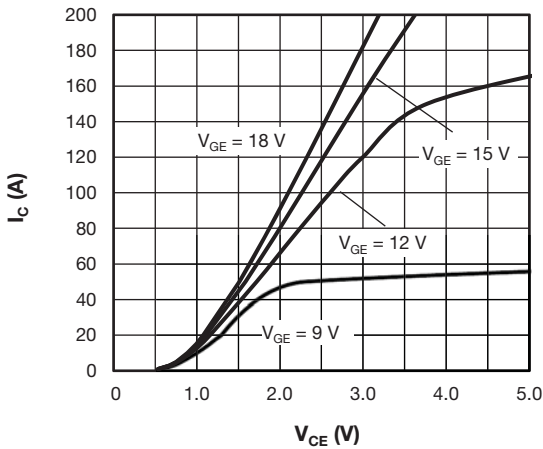


Fig. 2 - Typical IGBT Output Characteristics,  $T_J = 125\text{ °C}$

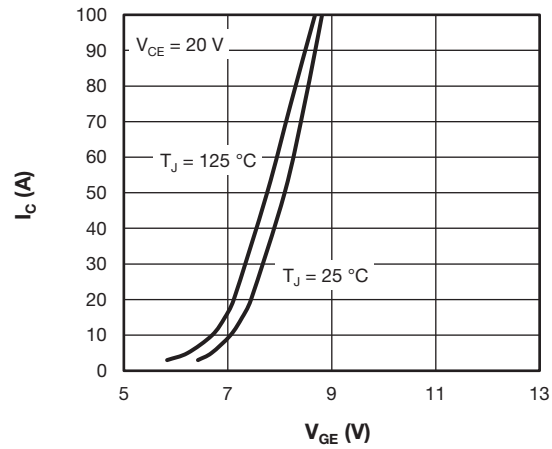


Fig. 5 - Typical IGBT Transfer Characteristics

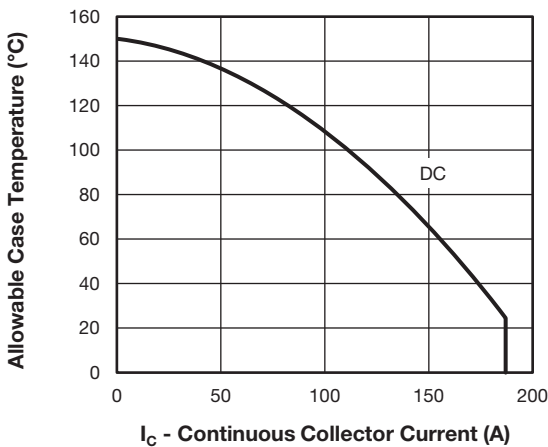


Fig. 3 - Maximum IGBT Continuous Collector Current vs. Case Temperature

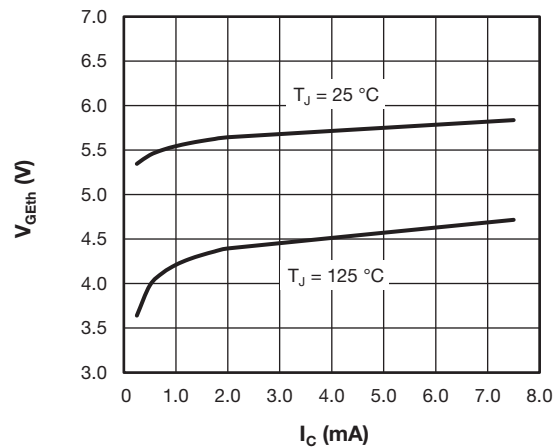


Fig. 6 - Typical IGBT Gate Threshold Voltage

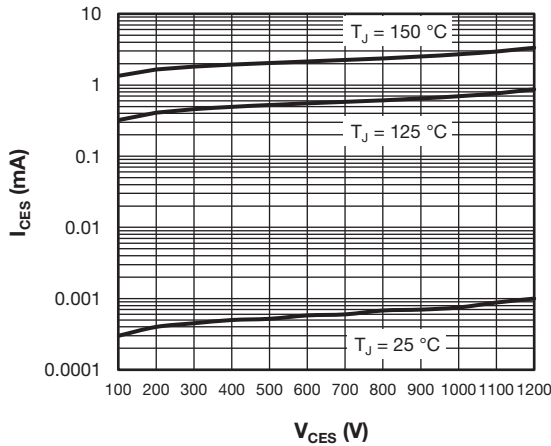


Fig. 7 - Typical IGBT Zero Gate Voltage Collector Current

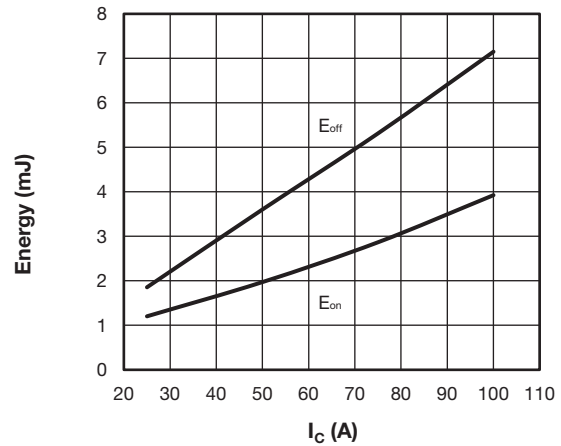


Fig. 10 - Typical IGBT Energy Loss vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 1.0\ \Omega$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$

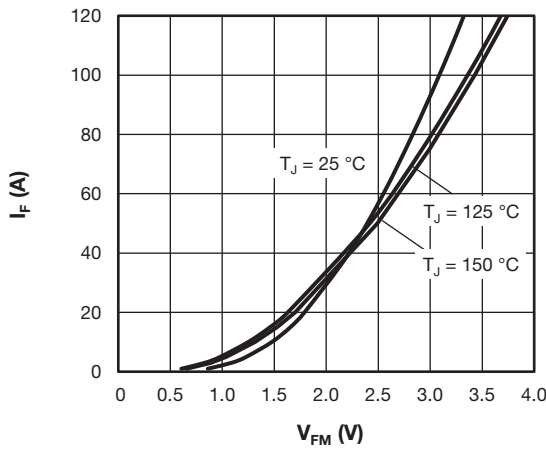


Fig. 8 - Typical Diode Forward Characteristics

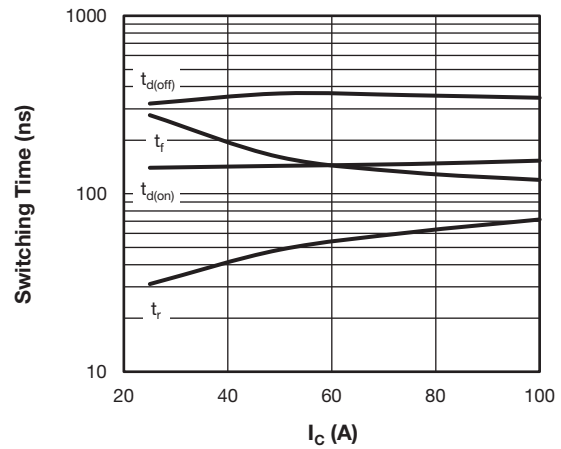


Fig. 11 - Typical IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 1.0\ \Omega$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$

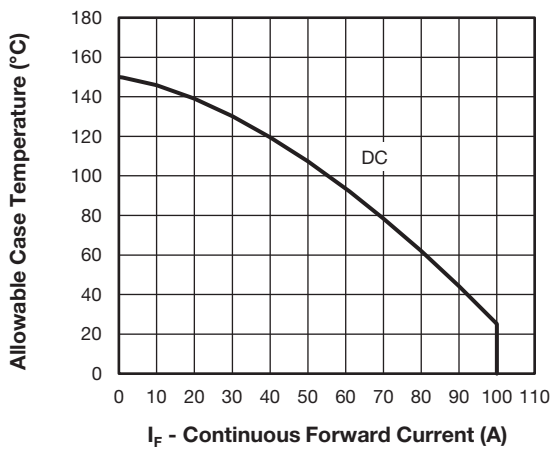


Fig. 9 - Maximum Diode Continuous Forward Current vs. Case Temperature

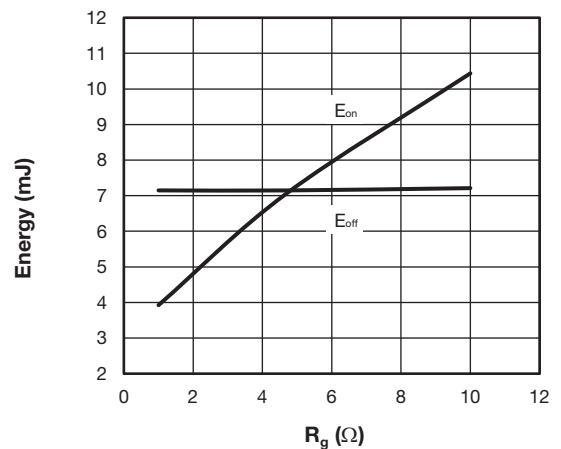


Fig. 12 - Typical IGBT Energy Loss vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$

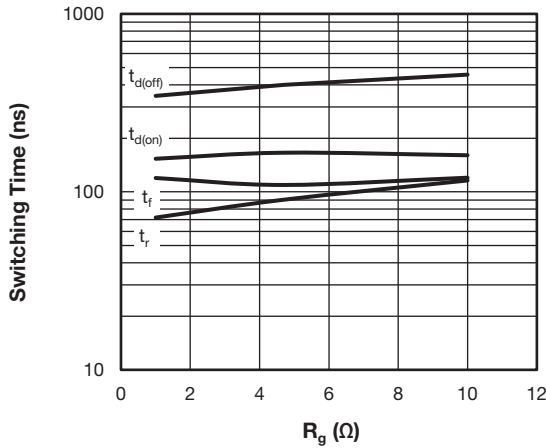


Fig. 13 - Typical IGBT Switching Time vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$

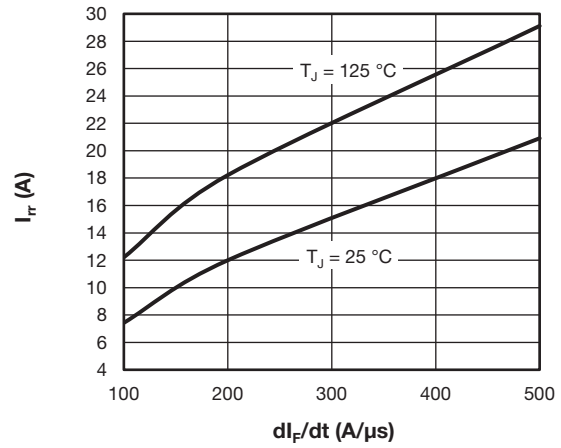


Fig. 15 - Typical Diode Reverse Recovery Current vs.  $di/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 50\text{ A}$

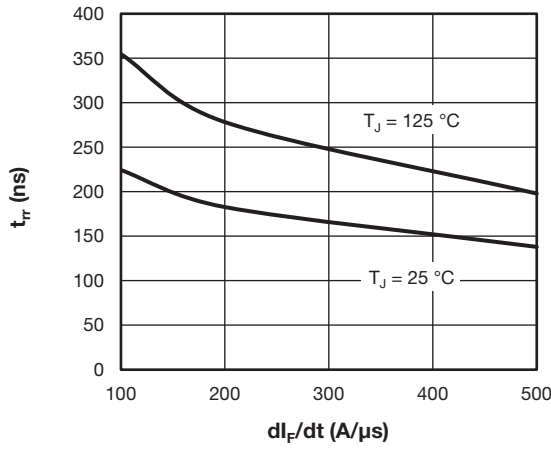


Fig. 14 - Typical Diode Reverse Recovery Time vs.  $di/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 50\text{ A}$

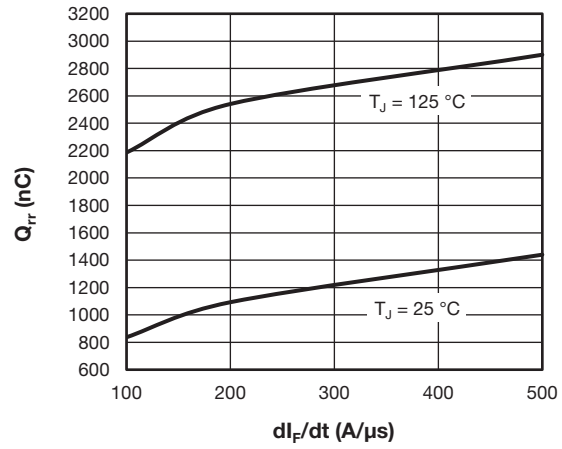


Fig. 16 - Typical Diode Reverse Recovery Charge vs.  $di/dt$   
 $V_{rr} = 400\text{ V}$ ,  $I_F = 50\text{ A}$

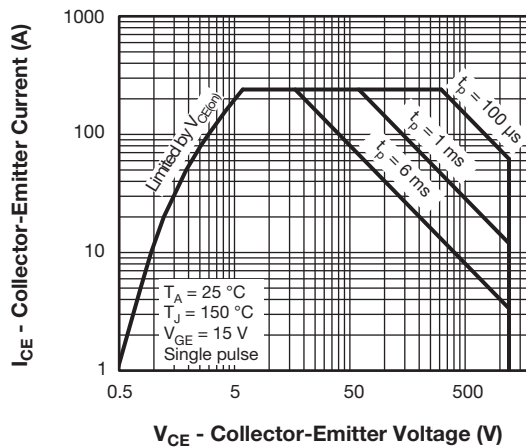


Fig. 17 - IGBT Safe Operating Area

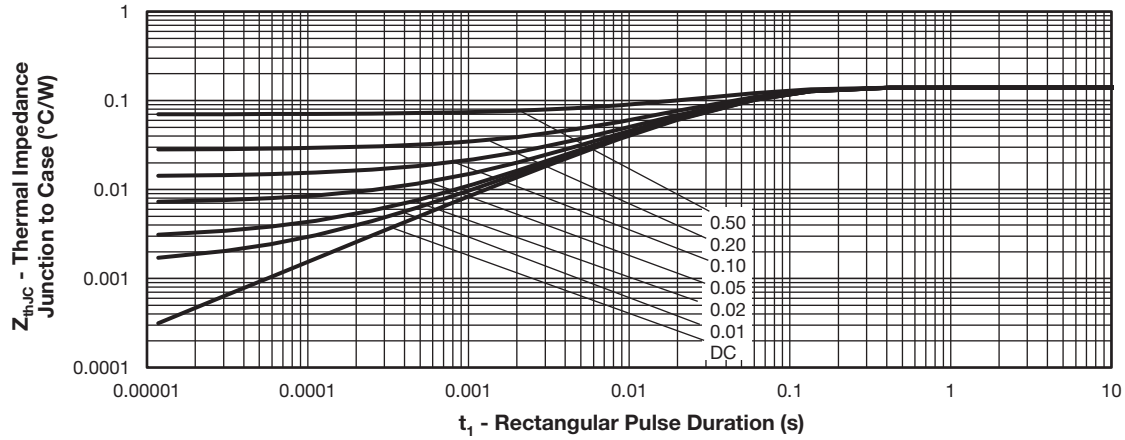


Fig. 18 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics - (IGBT)

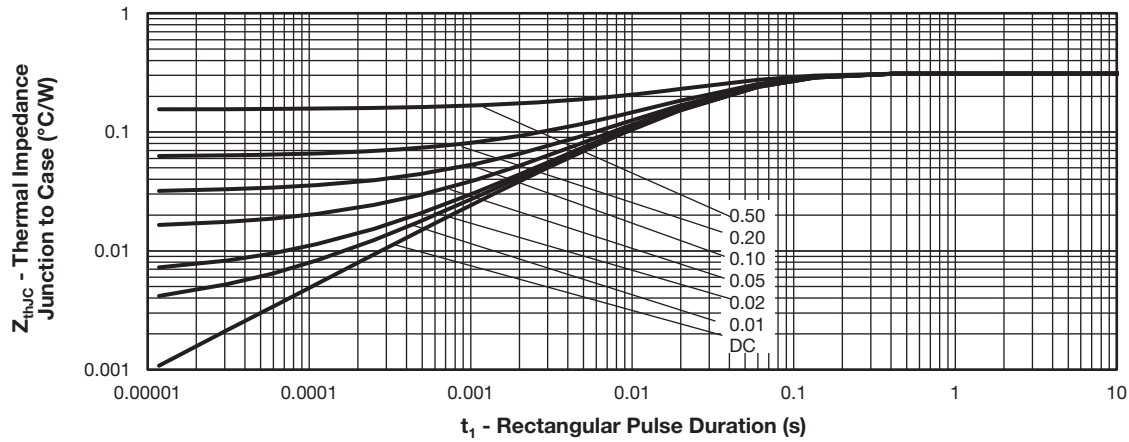


Fig. 19 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics - (Diode)

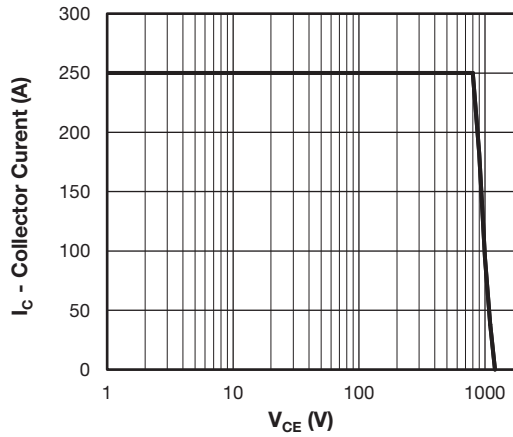
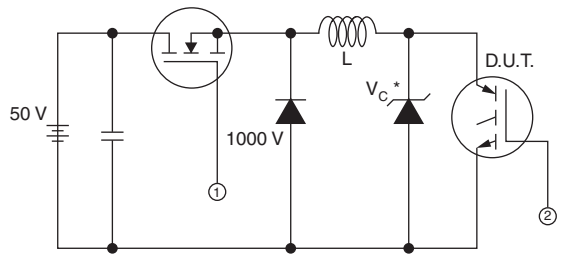


Fig. 20 - IGBT Reverse Bias SOA  
 $V_{GE} = 15\text{ V}$ ,  $T_J = 150^\circ\text{C}$



\* Driver same type as D.U.T.;  $V_C = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain  $I_d$

Fig. 21 - Clamped Inductive Load Test Circuit

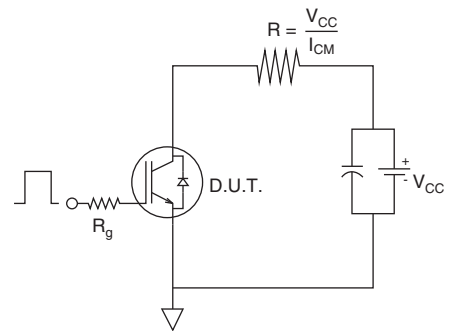


Fig. 22 - Pulsed Collector Current Test Circuit

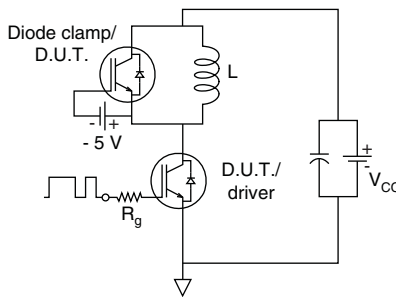


Fig. 23 - Switching Loss Test Circuit

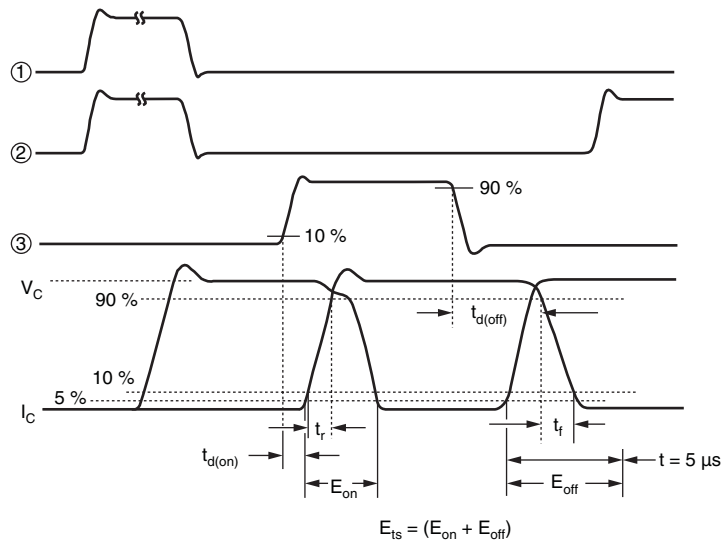


Fig. 24 - Switching Loss Waveforms Test Circuit





**ORDERING INFORMATION TABLE**

Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>100</b>	<b>D</b>	<b>A</b>	<b>120</b>	<b>UF</b>
	1	2	3	4	5	6	7	8

- 1** - Vishay Semiconductors product
- 2** - Insulated Gate Bipolar Transistor (IGBT)
- 3** - Trench IGBT technology
- 4** - Current rating (100 = 100 A)
- 5** - Circuit configuration (D = single switch with antiparallel diode)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (120 = 1200 V)
- 8** - Speed/type (UF = Trench ultrafast IGBT)

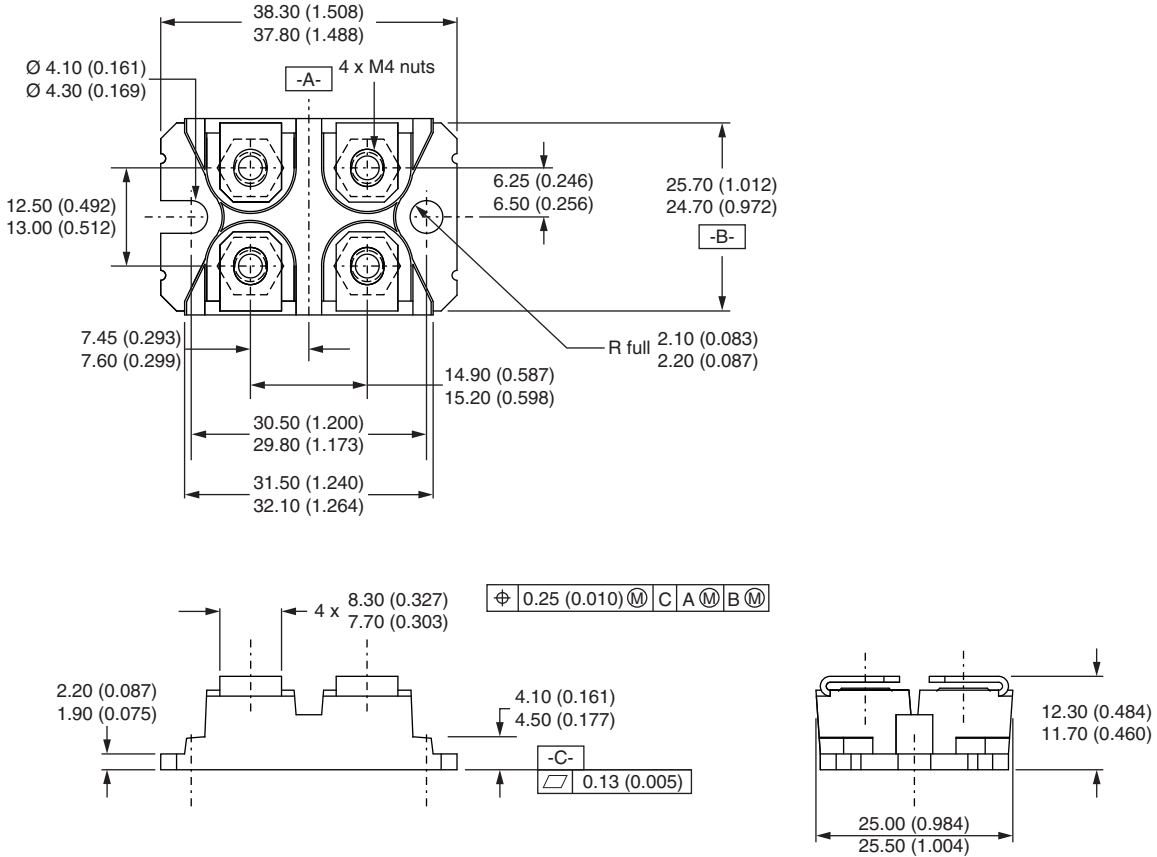
<b>CIRCUIT CONFIGURATION</b>		
<b>CIRCUIT</b>	<b>CIRCUIT CONFIGURATION CODE</b>	<b>CIRCUIT DRAWING</b>
Single switch with antiparallel diode	D	 

<b>LINKS TO RELATED DOCUMENTS</b>	
Dimensions	<a href="http://www.vishay.com/doc?95423">www.vishay.com/doc?95423</a>
Packaging information	<a href="http://www.vishay.com/doc?95425">www.vishay.com/doc?95425</a>



### SOT-227 Generation II

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter



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