


## Insulated Gate Bipolar Transistor (Ultrafast IGBT), 90 A



SOT-227

**FEATURES**

- NPT Generation V IGBT technology
- Square RBSOA
- HEXFRED® low  $Q_{rr}$ , low switching energy
- Positive  $V_{CE(on)}$  temperature coefficient
- Fully isolated package
- Speed 8 kHz to 60 kHz
- 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**
**PRODUCT SUMMARY**

$V_{CES}$	1200 V
$I_C$ DC	90 A at 90 °C
$V_{CE(on)}$ typical at 75 A, 25 °C	3.3 V
Package	SOT-227
Circuit	Single switch diode

**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	149	A
		$T_C = 90$ °C	90	
Pulsed collector current	$I_{CM}$		200	
Clamped inductive load current	$I_{LM}$		200	
Diode continuous forward current	$I_F$	$T_C = 25$ °C	76	V
		$T_C = 90$ °C	46	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	
Power dissipation, IGBT	$P_D$	$T_C = 25$ °C	862	W
		$T_C = 90$ °C	414	
Power dissipation, diode	$P_D$	$T_C = 25$ °C	357	
		$T_C = 90$ °C	171	
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	$V_{BR(CES)}$	$V_{GE} = 0\text{ V}, I_C = 250\text{ }\mu\text{A}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 75\text{ A}$	-	3.3	3.8	
		$V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.6	3.9	
		$V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.7	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	4	5	6	
		$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}, T_J = 125\text{ }^\circ\text{C}$	-	3.2	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$ (25 °C to 125 °C)	-	- 12	-	mV/°C
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	7	250	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.4	10	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	6.5	20	
Forward voltage drop, diode	$V_{FM}$	$V_{GE} = 0\text{ V}, I_F = 75\text{ A}$	-	3.4	5.0	V
		$V_{GE} = 0\text{ V}, I_F = 75\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.2	5.2	
		$V_{GE} = 0\text{ V}, I_F = 75\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	3.05	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 250$	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)	$Q_g$	$I_C = 50\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}$	-	690	-	nC		
Gate to emitter charge (turn-on)	$Q_{ge}$		-	65	-			
Gate to collector charge (turn-on)	$Q_{gc}$		-	250	-			
Turn-on switching loss	$E_{on}$	$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	1.2	-	mJ		
Turn-off switching loss	$E_{off}$		-	2.1	-			
Total switching loss	$E_{tot}$		-	3.3	-			
Turn-on delay time	$t_{d(on)}$		Energy losses include tail and diode recovery Diode used HFA16PB120	-	250	-	ns	
Rise time	$t_r$			-	38	-		
Turn-off delay time	$t_{d(off)}$			-	280	-		
Fall time	$t_f$			-	90	-		
Turn-on switching loss	$E_{on}$			$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	1.7	-	mJ
Turn-off switching loss	$E_{off}$				-	4.08	-	
Total switching loss	$E_{tot}$				-	5.78	-	
Turn-on delay time	$t_{d(on)}$	ns	-		245	-		
Rise time	$t_r$		-		48	-		
Turn-off delay time	$t_{d(off)}$		-		280	-		
Fall time	$t_f$	-	140	-				
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 200\text{ A}, R_g = 22\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 900\text{ V}, V_P = 1200\text{ V}, L = 500\text{ }\mu\text{H}$	Fullsquare					
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}$	-	140	-	ns		
Diode peak reverse current	$I_{rr}$		-	13	-	A		
Diode recovery charge	$Q_{rr}$		-	860	-	nC		
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	210	-	ns		
Diode peak reverse current	$I_{rr}$		-	19	-	A		
Diode recovery charge	$Q_{rr}$		-	1880	-	nC		



THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		- 40	-	150	°C
Junction to case	IGBT	$R_{thJC}$	-	-	0.145	°C/W
	Diode		-	-	0.35	
Case to heatsink	$R_{thCS}$	Flat, greased surface	-	0.05	-	
Weight			-	30	-	g
Mounting torque			-	-	1.3	Nm
Case style	SOT-227					

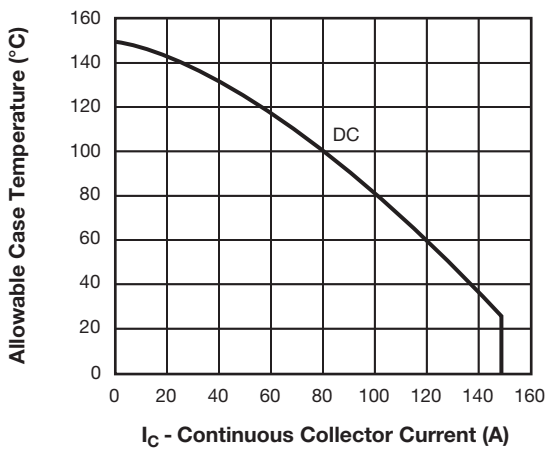


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

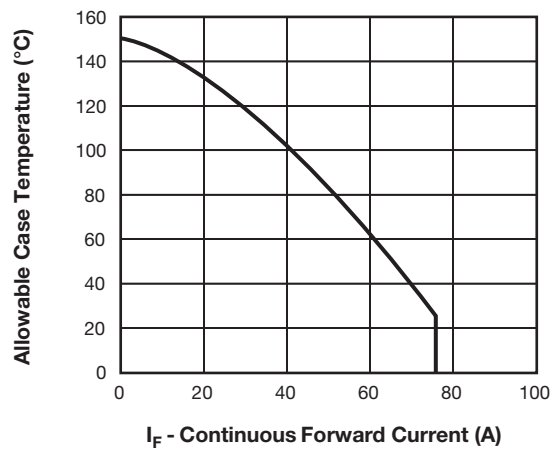


Fig. 3 - Allowable Forward Current vs. Case Temperature Diode Leg

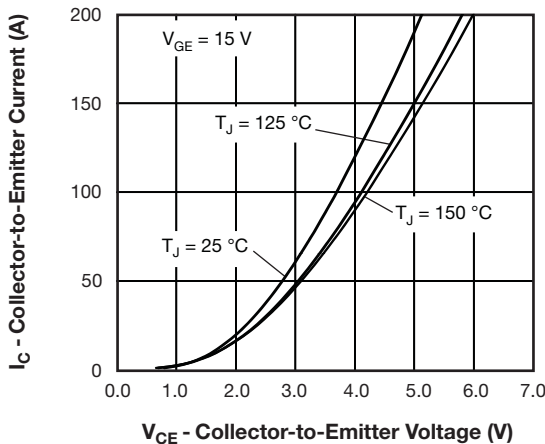


Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

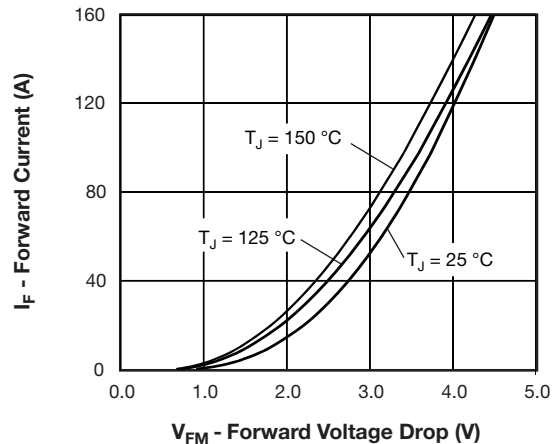


Fig. 4 - Typical Diode Forward Voltage Drop Characteristics

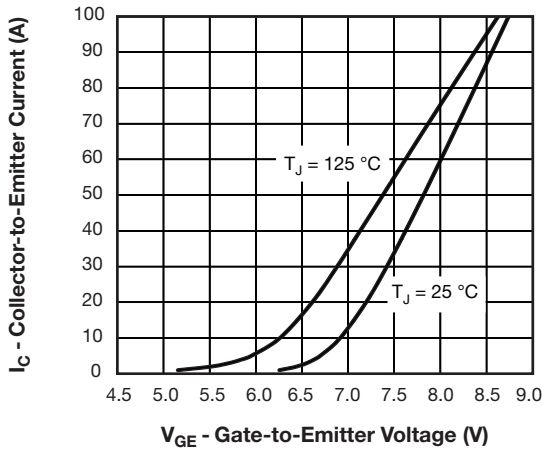


Fig. 5 - Typical IGBT Transfer Characteristics

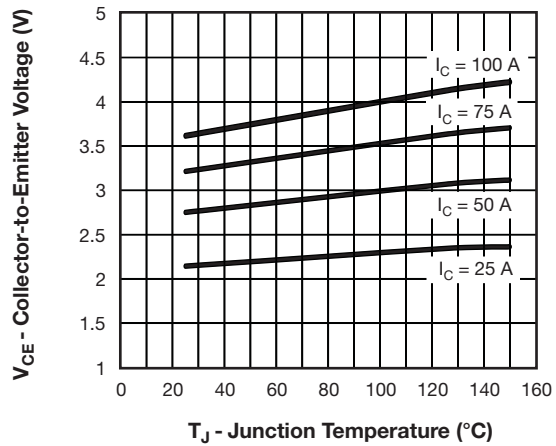


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature,  $V_{GE} = 15\text{ V}$

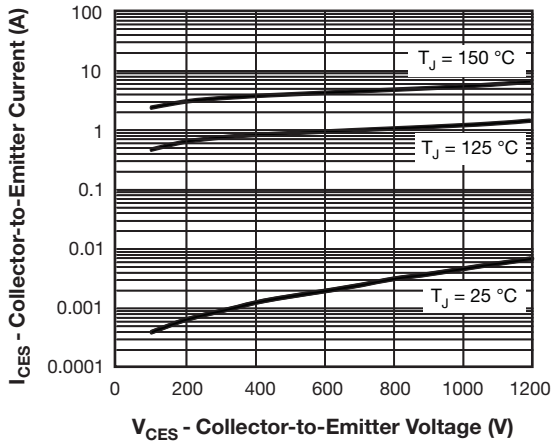


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

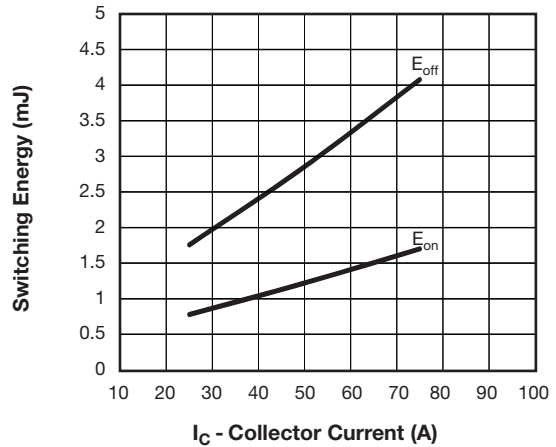


Fig. 9 - Typical IGBT Energy Losses vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 600\text{ V}$ ,  
 $R_g = 5\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$ , Diode used HFA16PB120

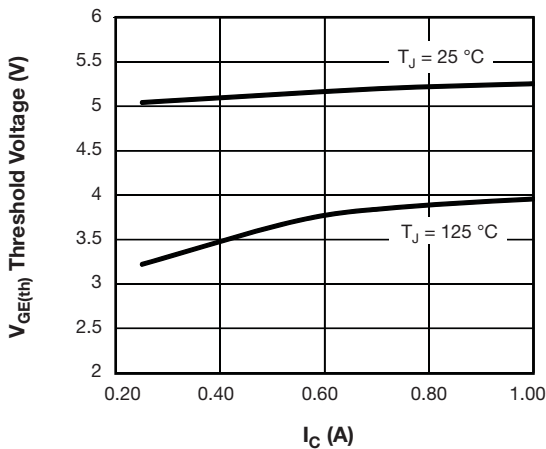


Fig. 7 - Typical IGBT Threshold Voltage

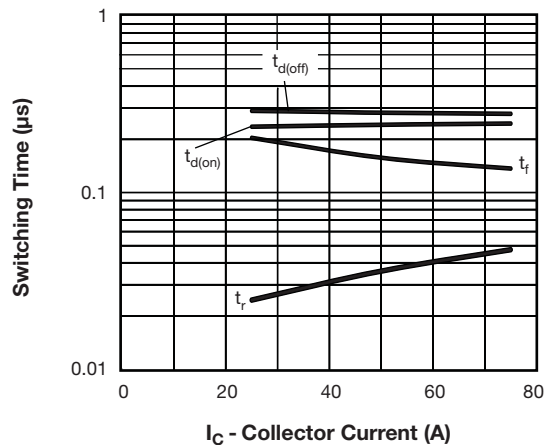


Fig. 10 - Typical IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 600\text{ V}$ ,  
 $R_g = 5\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$ , Diode used HFA16PB120

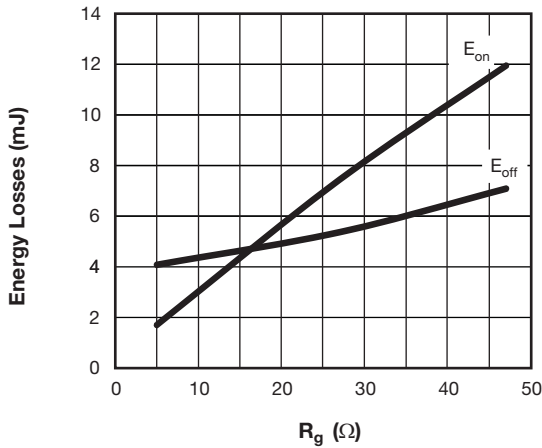


Fig. 11 - Typical IGBT Energy Loss vs.  $R_g$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $I_C = 75\text{ A}$ ,  $L = 500\text{ }\mu\text{H}$ ,  
 $V_{CC} = 600\text{ V}$ ,  $V_{GE} = 15\text{ V}$ , Diode used HFA16PB120

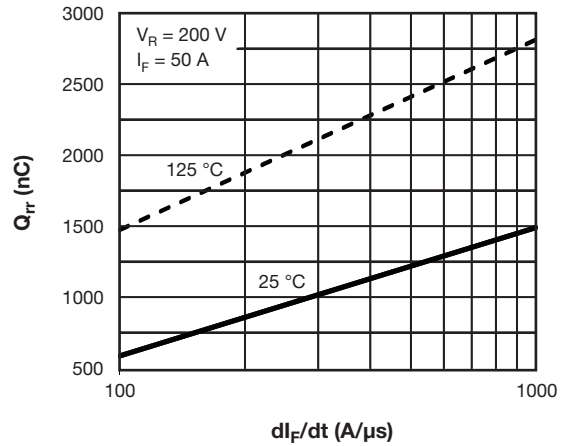


Fig. 14 - Stored Charge vs.  $dI_F/dt$  of Diode

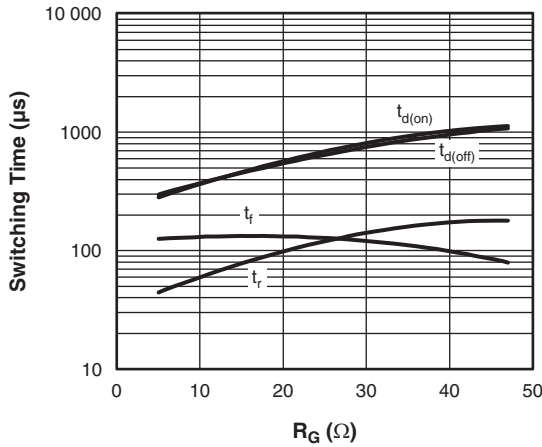


Fig. 12 - Typical IGBT Switching Time vs.  $R_g$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 600\text{ V}$ ,  
 $R_g = 5\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$

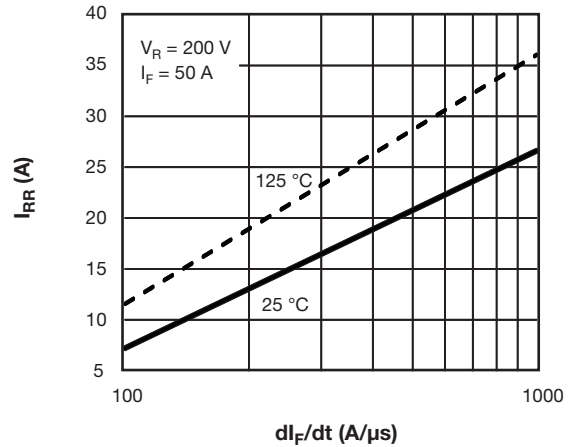


Fig. 15 - Typical Reverse Recovery Current vs.  $dI_F/dt$  of Diode

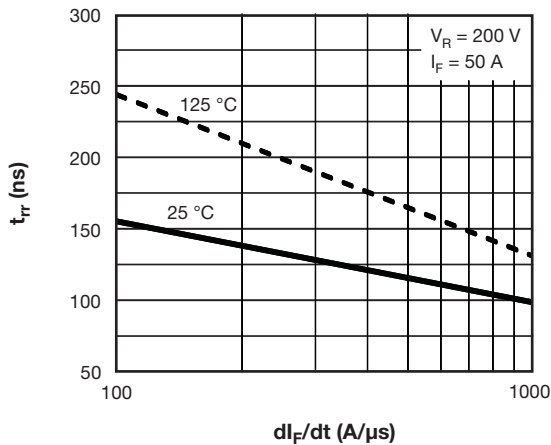


Fig. 13 - Typical  $t_r$  Diode vs.  $dI_F/dt$   
 $V_{RR} = 200\text{ V}$ ,  $I_F = 50\text{ A}$

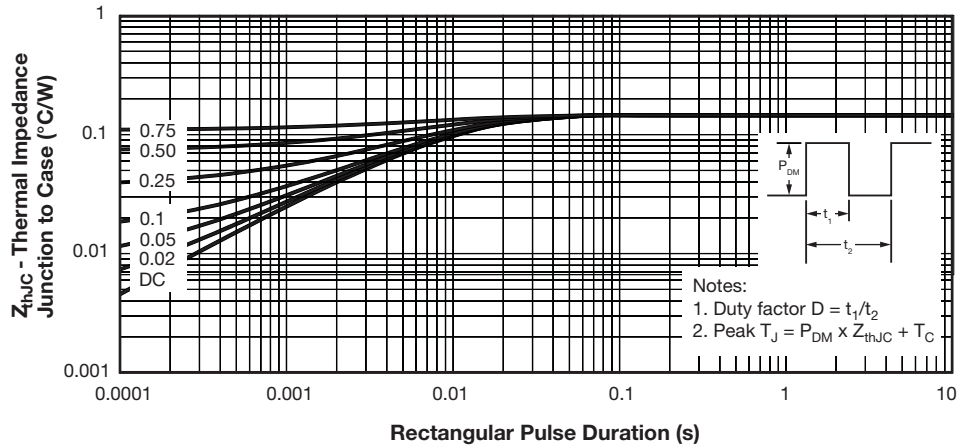


Fig. 16 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (IGBT)

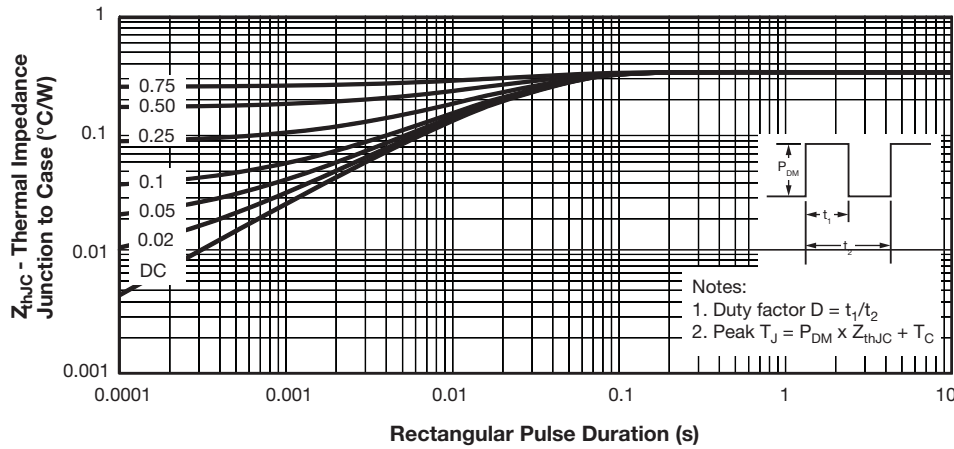


Fig. 17 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (Diode)

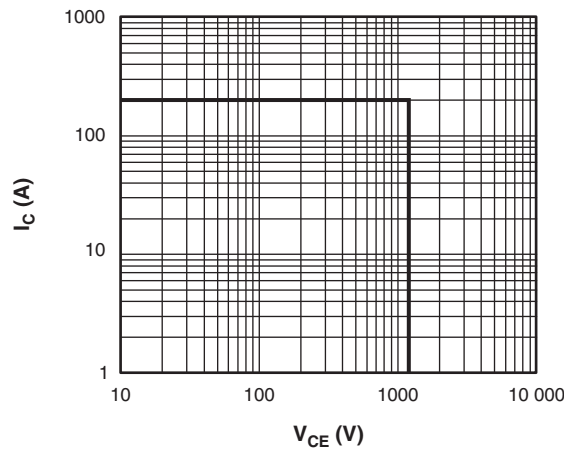
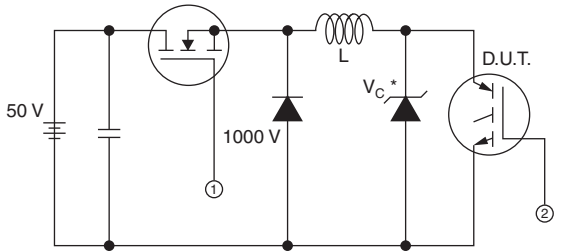


Fig. 18 - IGBT Reverse Bias SOA,  $T_J = 150\text{ }^\circ\text{C}$ ,  $V_{GE} = 15\text{ V}$ ,



\* 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. 19a - Clamped Inductive Load Test Circuit

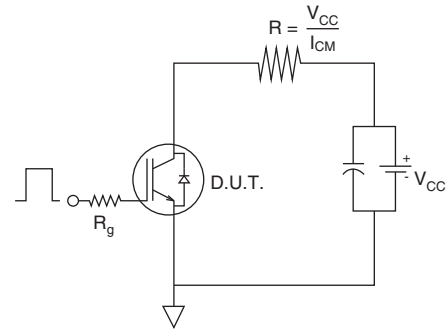


Fig. 19b - Pulsed Collector Current Test Circuit

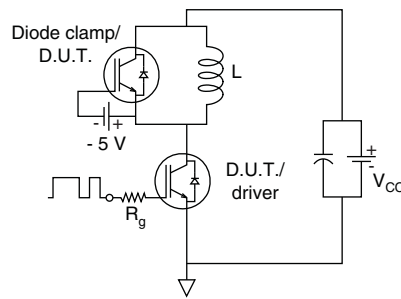


Fig. 20a - Switching Loss Test Circuit

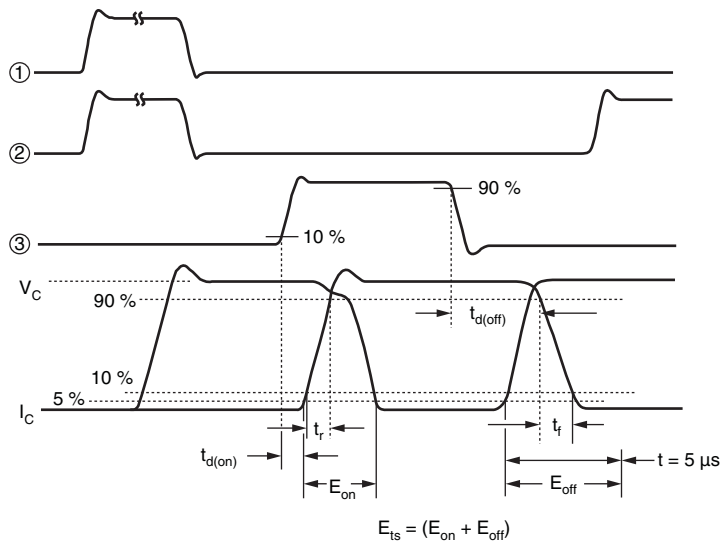


Fig. 20b - Switching Loss Waveforms Test Circuit

## ORDERING INFORMATION TABLE

Device code	<b>VS-</b>	<b>G</b>	<b>B</b>	<b>90</b>	<b>D</b>	<b>A</b>	<b>120</b>	<b>U</b>
	①	②	③	④	⑤	⑥	⑦	⑧

- 1** - Vishay Semiconductors product
- 2** - Insulated Gate Bipolar Transistor (IGBT)
- 3** - B = IGBT Generation 5
- 4** - Current rating (90 = 90 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 (U = Ultrafast IGBT)

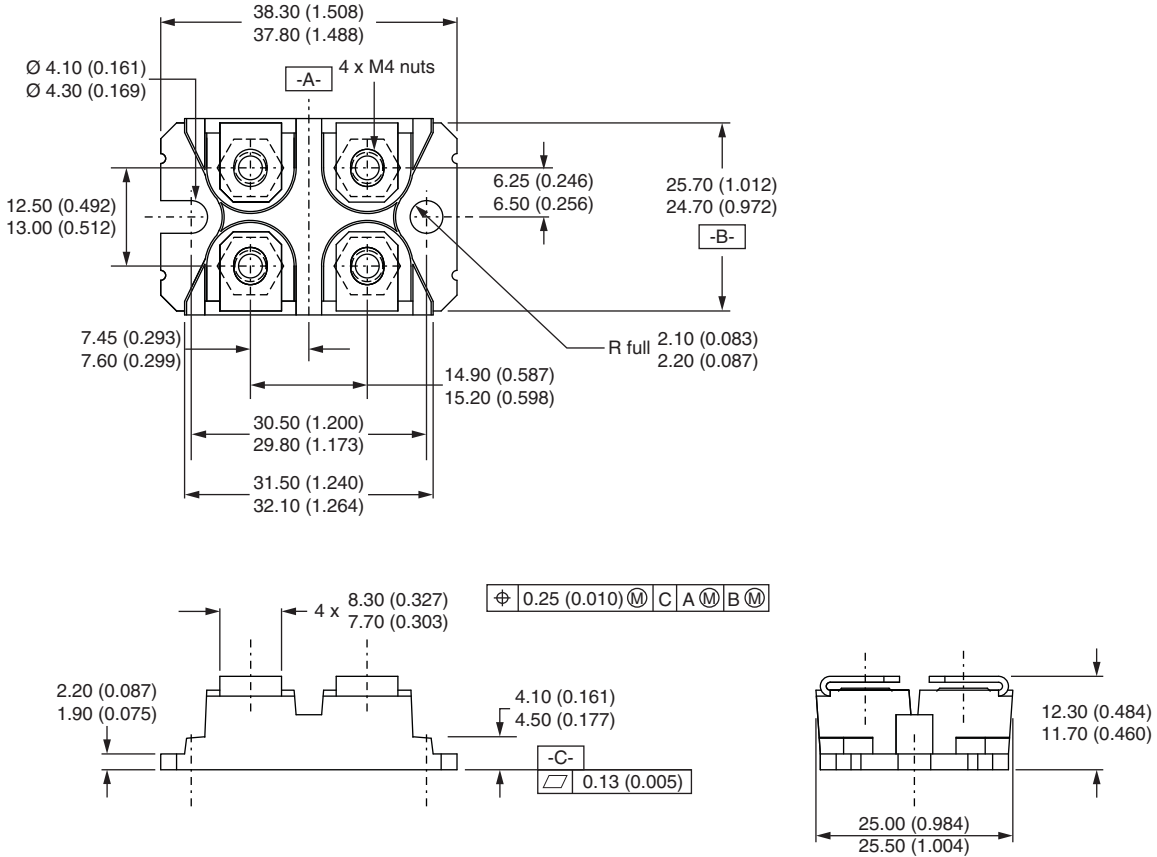
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch with antiparallel diode	D	<div style="display: inline-block; vertical-align: top; margin-left: 20px;"> <p>Lead Assignment</p> </div>

LINKS TO RELATED DOCUMENTS	
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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