

## Insulated Gate Bipolar Transistor (Trench IGBT), 175 A



**SOT-227**

PRODUCT SUMMARY	
$V_{CES}$	1200 V
$I_{C(DC)}$	175 A at 90 °C <sup>(1)</sup>
$V_{CE(on)}$ typical at 100 A, 25 °C	1.73 V
$I_{F(DC)}$	32 A at 90 °C
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit	Single switch diode

**Note**

<sup>(1)</sup> Maximum collector current admitted is 100 A, to not exceed the maximum temperature of terminals

**FEATURES**

- Trench IGBT technology with positive temperature coefficient
- Square RBSOA
- 10  $\mu$ s short circuit capability
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- $T_J$  maximum = 150 °C
- 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**
**BENEFITS**

- Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
- Easy to assemble and parallel
- Direct mounting to heatsink
- Plug-in compatible with other SOT-227 packages
- Very low  $V_{CE(on)}$
- 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	288	A
		$T_C = 90$ °C	175	
Pulsed collector current	$I_{CM}$		450	
Clamped inductive load current	$I_{LM}$		450	
Diode continuous forward current	$I_F$	$T_C = 25$ °C	54	
		$T_C = 90$ °C	32	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Power dissipation, IGBT	$P_D$	$T_C = 25$ °C	1087	W
		$T_C = 90$ °C	522	
Power dissipation, diode	$P_D$	$T_C = 25$ °C	219	
		$T_C = 90$ °C	105	
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 not 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	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.73	2.1		
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.98	2.2		
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	2.05	-		
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	-	5	-		
		$V_{CE} = V_{GE}, I_C = 7.5\text{ mA}$	4.9	5.9	7.9		
		$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}, T_J = 125\text{ }^\circ\text{C}$	-	2.9	-		
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$ ( $25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ )	-	-17.6	-		mV/ $^\circ\text{C}$
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	0.9	100		$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.85	10	mA	
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	4	20		
Forward voltage drop, diode	$V_{FM}$	$I_F = 40\text{ A}, V_{GE} = 0\text{ V}$	-	3.12	3.44	V	
		$I_F = 40\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	3.15	3.47		
		$I_F = 40\text{ A}, V_{GE} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	3.25	-		
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	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)	$Q_g$	$I_C = 150\text{ A}$ ( $t_p < 400\text{ }\mu\text{s}, D < 2\%$ ), $V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}$	-	830	-	nC		
Gate to emitter charge (turn-on)	$Q_{ge}$		-	180	-			
Gate to collector charge (turn-on)	$Q_{gc}$		-	380	-			
Turn-on switching loss	$E_{on}$	$I_C = 100\text{ A}, V_{CC} = 720\text{ V},$ $V_{GE} = 15\text{ V}, R_g = 2.2\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	4.8	-	mJ		
Turn-off switching loss	$E_{off}$		-	7.0	-			
Total switching loss	$E_{tot}$		-	11.8	-			
Turn-on delay time	$t_{d(on)}$		Energy losses include tail and diode recovery Diode used HFA16PB120	-	274	-	ns	
Rise time	$t_r$			-	67	-		
Turn-off delay time	$t_{d(off)}$			-	271	-		
Fall time	$t_f$			-	177	-		
Turn-on switching loss	$E_{on}$			$I_C = 100\text{ A}, V_{CC} = 720\text{ V},$ $V_{GE} = 15\text{ V}, R_g = 2.2\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	6.0	-	mJ
Turn-off switching loss	$E_{off}$				-	10.4	-	
Total switching loss	$E_{tot}$	-			16.4	-		
Turn-on delay time	$t_{d(on)}$	-			285	-	ns	
Rise time	$t_r$	-			75	-		
Turn-off delay time	$t_{d(off)}$	-	306		-			
Fall time	$t_f$	-	244	-				
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 450\text{ A}, R_g = 4.7\text{ }\Omega,$ $V_{GE} = 15\text{ V}$ to $0\text{ V}, V_{CC} = 600\text{ V},$ $V_P = 1200\text{ V}, L = 500\text{ }\mu\text{H}$	Fullsquare					
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}, V_R = 400\text{ V}$	-	164	-	ns		
Diode peak reverse current	$I_{rr}$		-	12	-	A		
Diode recovery charge	$Q_{rr}$		-	994	-	nC		
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s},$ $V_R = 400\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	230	-	ns		
Diode peak reverse current	$I_{rr}$		-	16.5	-	A		
Diode recovery charge	$Q_{rr}$		-	1864	-	nC		
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}, R_g = 22\text{ }\Omega,$ $V_{GE} = 15\text{ V}$ to $0\text{ V}, V_{CC} = 900\text{ V},$ $V_P = 1200\text{ V}$	10			$\mu\text{s}$		



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					°C/W
	Diode					
Case to heatsink	$R_{thCS}$	Flat, greased surface	-	0.05	-	
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					

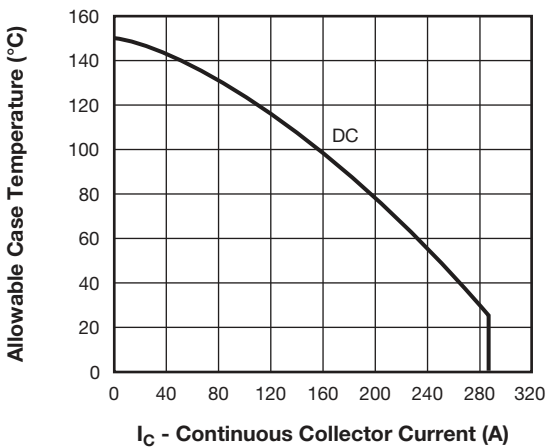


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

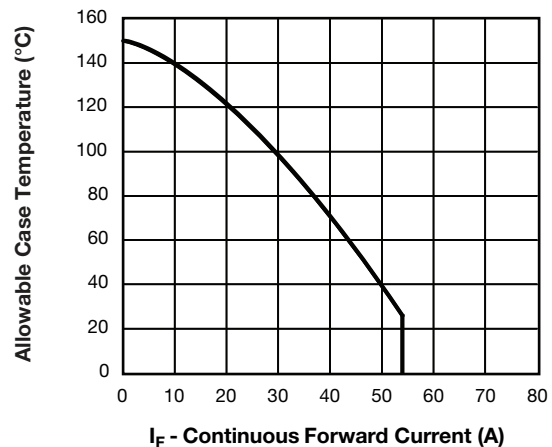


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature Diode Leg

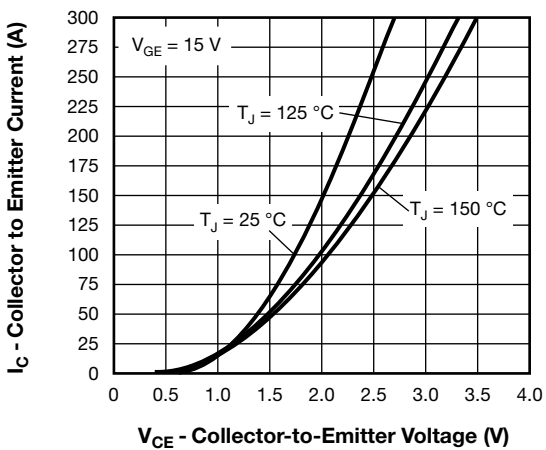


Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

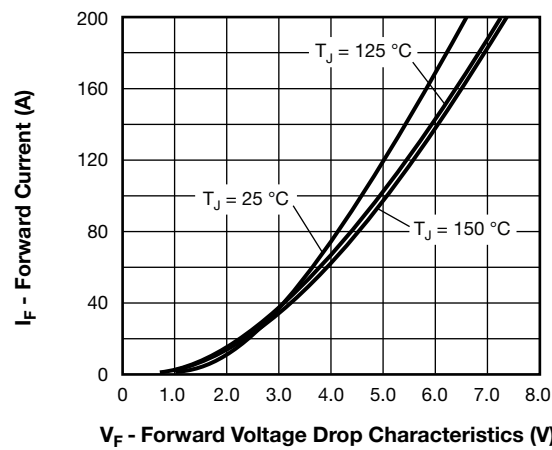


Fig. 4 - Typical Diode Forward Voltage Drop Characteristics

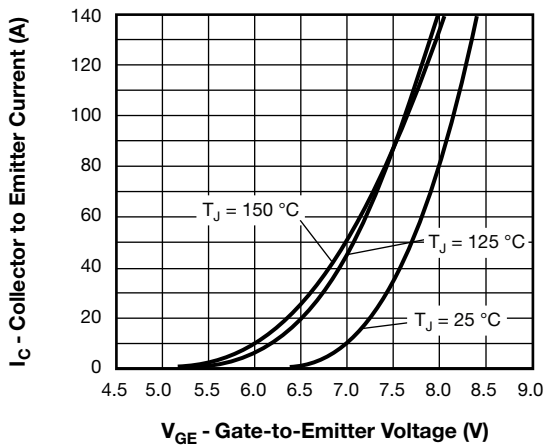


Fig. 5 - Typical IGBT Transfer Characteristics

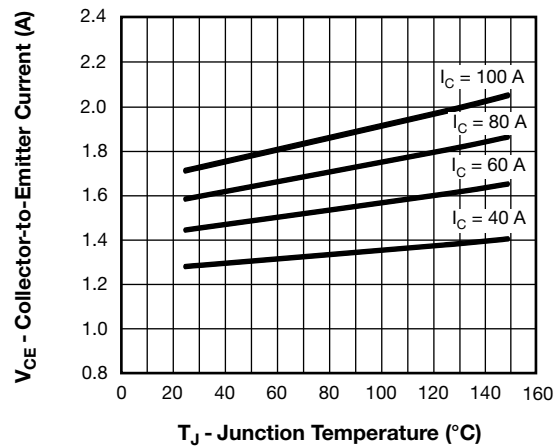


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature,  $V_{GE} = 15\text{ V}$

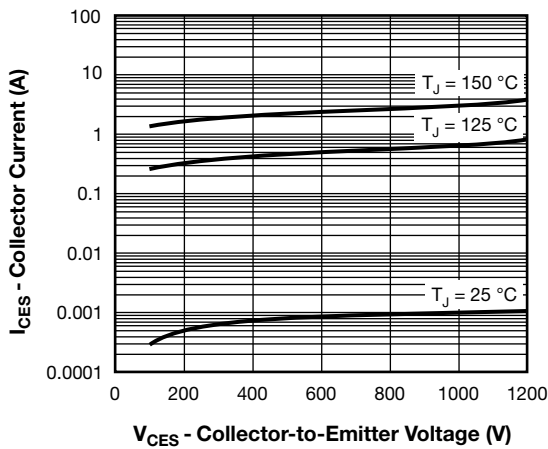


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

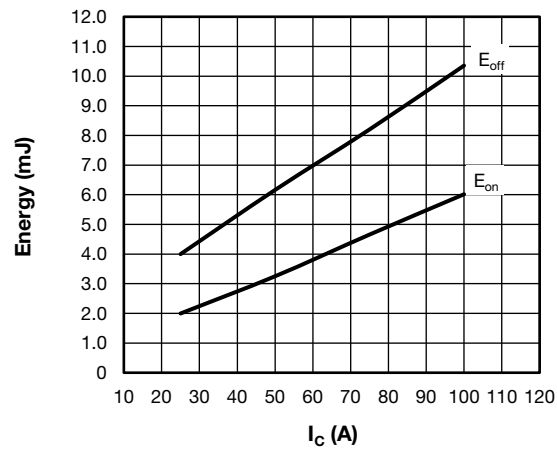


Fig. 9 - Typical IGBT Energy Losses vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 720\text{ V}$ ,  $R_g = 2.2\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$   
 Diode used: HFA16PB120

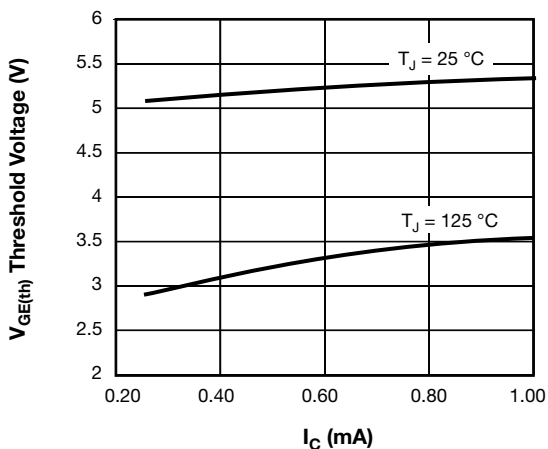


Fig. 7 - Typical IGBT Threshold Voltage

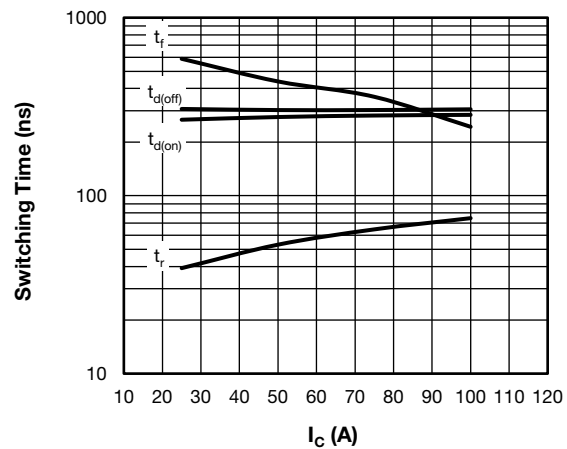


Fig. 10 - Typical IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 720\text{ V}$ ,  $R_g = 2.2\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$   
 Diode used: HFA16PB120

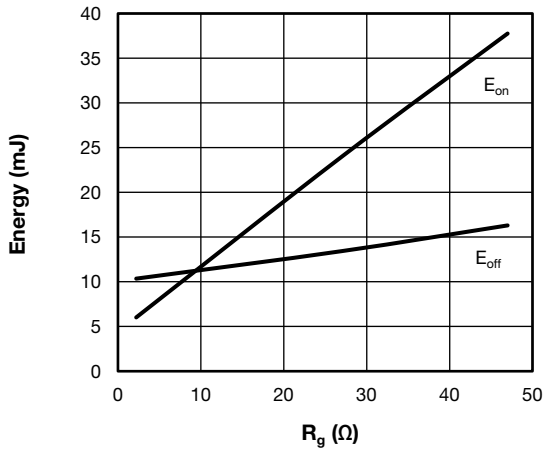


Fig. 11 - Typical IGBT Energy Losses vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $I_C = 100\text{ A}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 720\text{ V}$ ,  $V_{GE} = 15\text{ V}$   
 Diode used: HFA16PB120

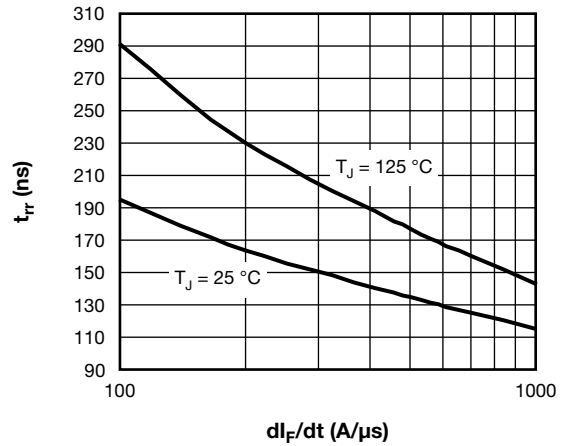


Fig. 13 - Typical Reverse Recovery Time vs.  $dI_F/dt$ , of Diode,  
 at  $I_F = 50\text{ A}$ ,  $V_R = 400\text{ V}$

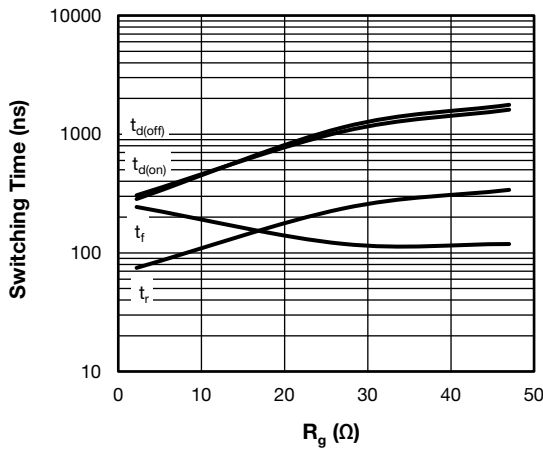


Fig. 12 - Typical IGBT Switching Time vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 720\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = 15\text{ V}$   
 Diode used: HFA16PB120

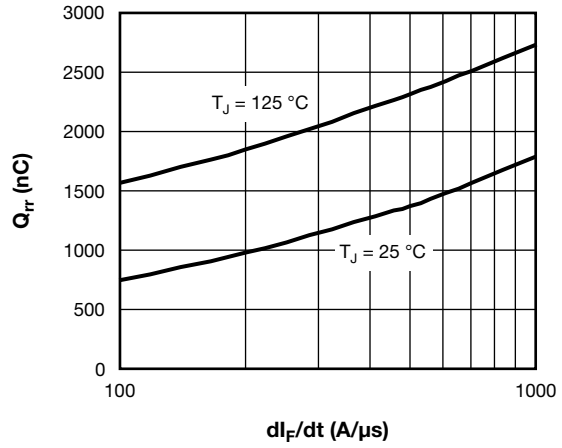


Fig. 14 - Typical Stored Charge vs.  $dI_F/dt$  of Diode,  
 at  $I_F = 50\text{ A}$ ,  $V_R = 400\text{ V}$

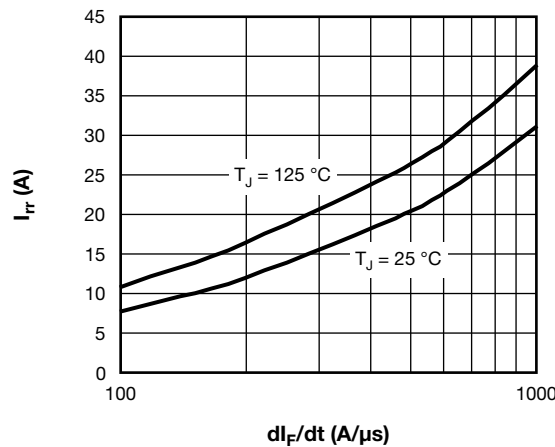


Fig. 15 - Typical Reverse Recovery Current vs.  $dI_F/dt$ , of Diode,  
 at  $I_F = 50\text{ A}$ ,  $V_R = 400\text{ V}$

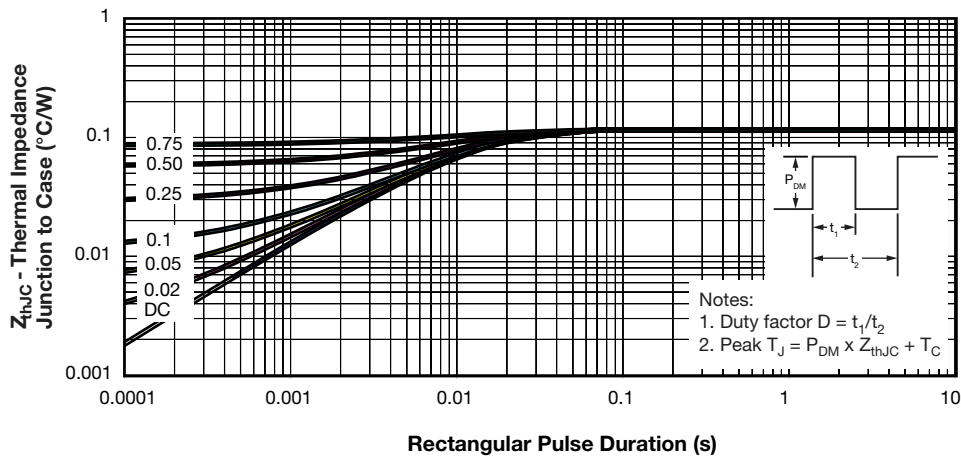


Fig. 16 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (IGBT)

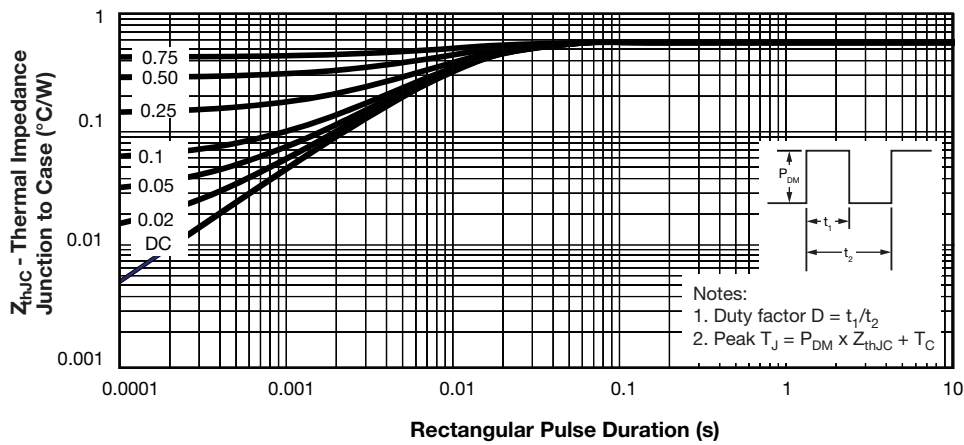


Fig. 17 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (Diode)

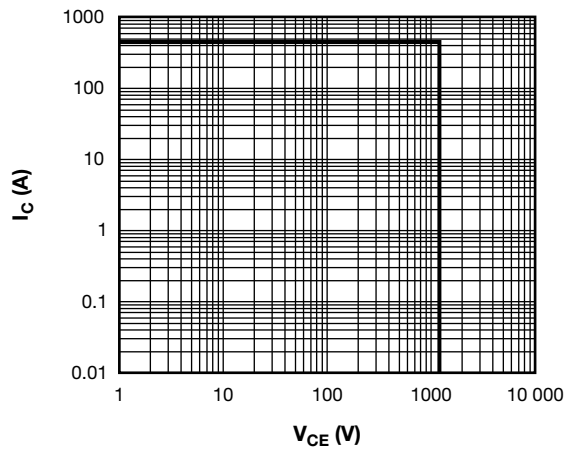


Fig. 18 - IGBT Reverse Bias SOA,  $T_J = 150\text{ }^\circ\text{C}$ ,  $V_{GE} = 15\text{ V}$

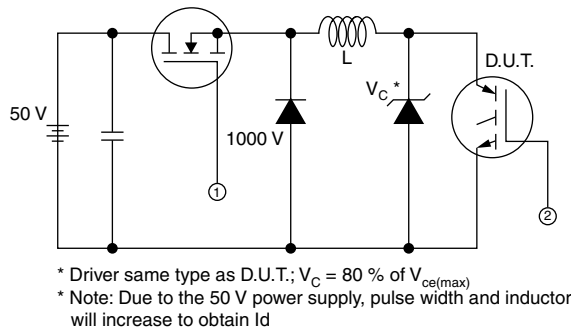


Fig. 19 - Clamped Inductive Load Test Circuit

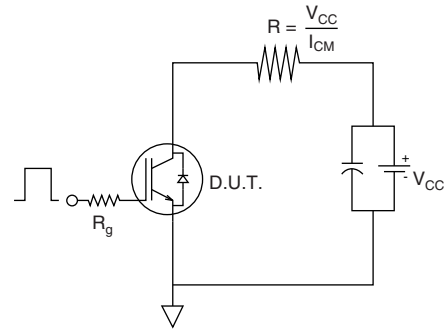


Fig. 19b - Pulsed Collector Current Test Circuit

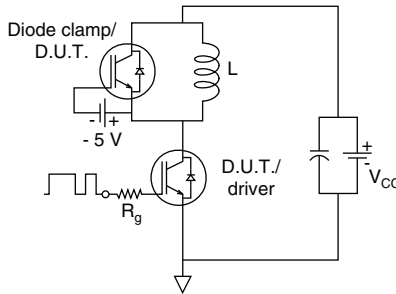


Fig. 20a - Switching Loss Test Circuit

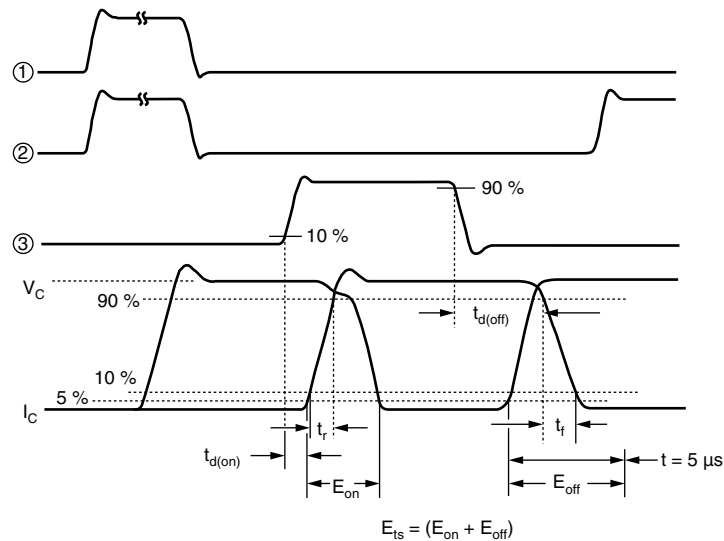


Fig. 20b - Switching Loss Waveforms Test Circuit

**ORDERING INFORMATION TABLE**

Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>175</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** - Trench IGBT technology
- 4** - Current rating (175 = 175 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)

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

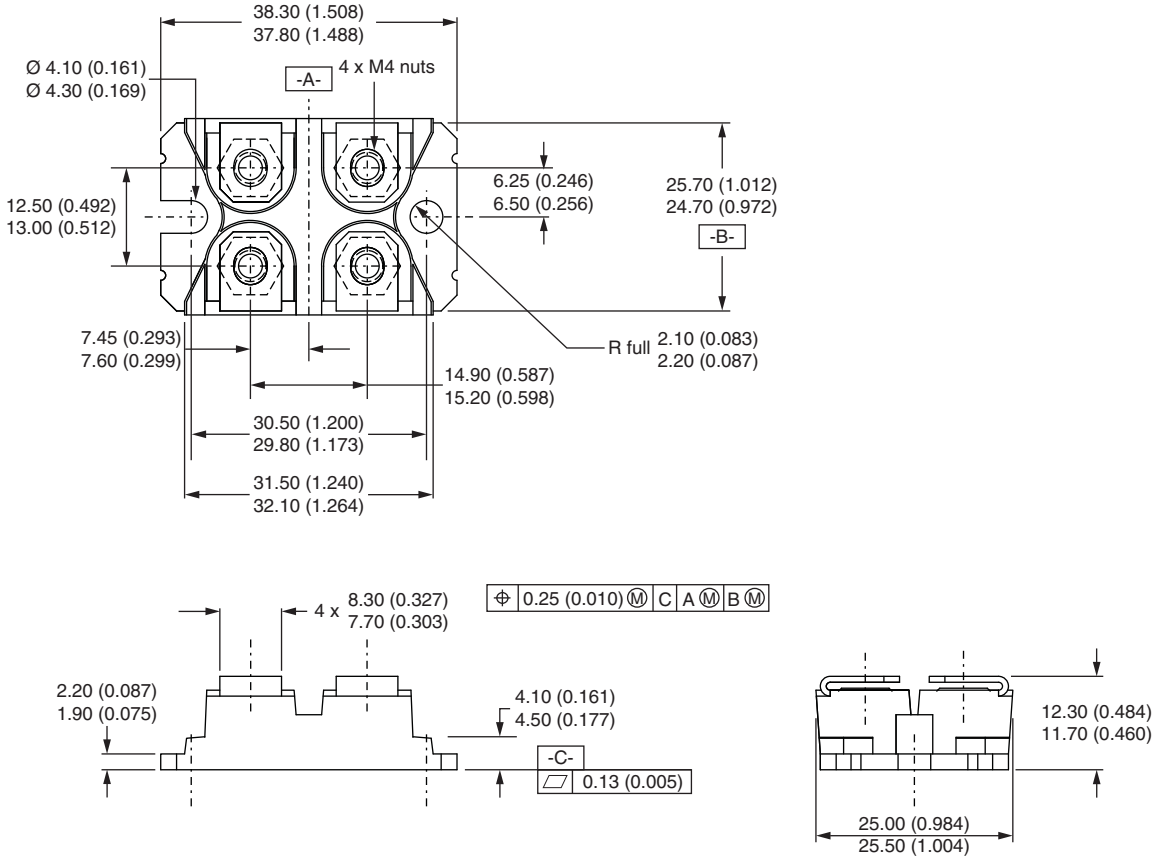
LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95423">www.vishay.com/doc?95423</a>
Packaging information	<a href="http://www.vishay.com/doc?95425">www.vishay.com/doc?95425</a>





### SOT-227 Generation II

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter



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