


## “Low Side Chopper” IGBT SOT-227 (Trench IGBT), 47 A



SOT-227


**RoHS  
COMPLIANT**

### FEATURES

- Trench IGBT technology
- Square RBSOA
- HEXFRED® clamping diode
- 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)

### 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

### PRIMARY CHARACTERISTICS

$V_{CES}$	1200 V
$I_C$ DC	50 A at 73 °C
$V_{CE(on)}$ typical at 50 A, 25 °C	2.39 V
Package	SOT-227
Circuit configuration	Low side chopper

### ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS	
Collector to emitter voltage	$V_{CES}$		1200	V	
Continuous collector current	$I_C$	$T_C = 25\text{ °C}$	68	A	
		$T_C = 80\text{ °C}$	47		
Pulsed collector current	$I_{CM}$	$T_J = 150\text{ °C}$ , $T_p = 6\text{ ms}$ , $V_{GE} = 15\text{ V}$	150		
Clamped inductive load current	$I_{LM}$		250		
Diode continuous forward current	$I_F$	$T_C = 25\text{ °C}$	87		
		$T_C = 80\text{ °C}$	59		
Single pulse forward current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse, $T_J = 25\text{ °C}$	310		
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V	
Power dissipation, IGBT	$P_D$	$T_C = 25\text{ °C}$	291	W	
		$T_C = 80\text{ °C}$	163		
Power dissipation, diode	$P_D$	$T_C = 25\text{ °C}$	338		
		$T_C = 80\text{ °C}$	190		
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1\text{ min}$	2500		V



<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	$V_{BR(CES)}$	$V_{GE} = 0\text{ V}, I_C = 2\text{ mA}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 25\text{ A}$	-	1.95	-	
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}$	-	2.39	2.8	
		$V_{GE} = 15\text{ V}, I_C = 25\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.13	-	
		$V_{GE} = 15\text{ V}, I_C = 50\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.76	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$	4.6	5.8	7.6	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 2\text{ mA}$ ( $25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ )	-	-13	-	mV/ $^\circ\text{C}$
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$	-	1.7	50	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	26.2	-	
Diode reverse breakdown voltage	$V_{BR}$	$I_R = 1\text{ mA}$	1200	-	-	V
Diode forward voltage drop	$V_{FM}$	$I_F = 25\text{ A}, V_{GE} = 0\text{ V}$	-	2.11	2.42	V
		$I_F = 50\text{ A}, V_{GE} = 0\text{ V}$	-	2.72	-	
		$I_F = 25\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.04	-	
		$I_F = 50\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.83	-	
Diode reverse leakage current	$I_{RM}$	$V_R = 1200\text{ V}$	-	4	50	$\mu\text{A}$
		$T_J = 125\text{ }^\circ\text{C}, V_R = 1200\text{ V}$	-	0.8	-	mA
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)	$Q_g$	$I_C = 40\text{ A}, V_{CC} = 960\text{ V}, V_{GE} = 15\text{ V}$	-	171	-	nC	
Gate to emitter charge (turn-on)	$Q_{ge}$		-	22	-		
Gate to collector charge (turn-on)	$Q_{gc}$		-	86	-		
Turn-on switching loss	$E_{on}$	$I_C = 50\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$  Energy losses include tail and diode recovery	-	2.7	-	mJ	
Turn-off switching loss	$E_{off}$		-	1.4	-		
Total switching loss	$E_{tot}$		-	4.1	-		
Turn-on switching loss	$E_{on}$		-	4.1	-		
Turn-off switching loss	$E_{off}$		-	2.3	-		
Total switching loss	$E_{tot}$		-	6.4	-		
Turn-on delay time	$t_{d(on)}$		$I_C = 50\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 4.7\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	8	-	ns
Rise time	$t_r$			-	11	-	
Turn-off delay time	$t_{d(off)}$			-	81	-	
Fall time	$t_f$	-		179	-		
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 250\text{ A}, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 700\text{ V}, V_P = 1200\text{ V}$	Fullsquare				
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}$	-	129	-	ns	
Diode peak reverse current	$I_{rr}$		-	11	-	A	
Diode recovery charge	$Q_{rr}$		-	710	-	nC	
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	208	-	ns	
Diode peak reverse current	$I_{rr}$		-	17	-	A	
Diode recovery charge	$Q_{rr}$		-	1768	-	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		-	-	0.43	°C/W
	Diode		-	-	0.37	
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	-	-	1.8 (15.9)	Nm (lbf.in)
Case style		SOT-227				

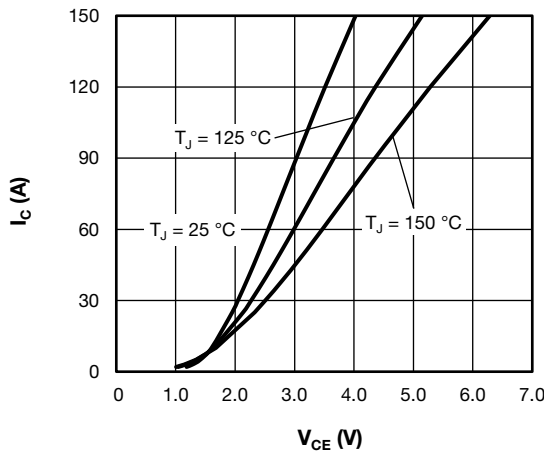


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

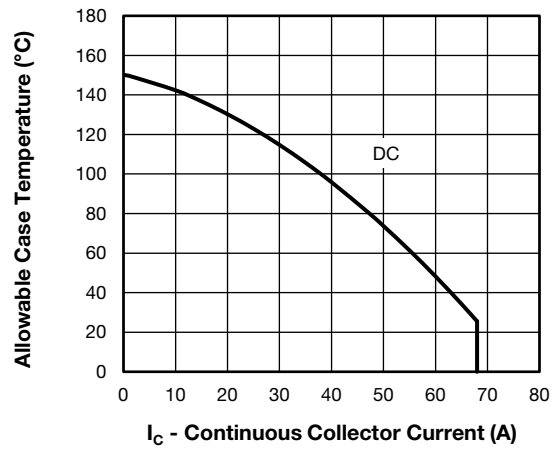


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

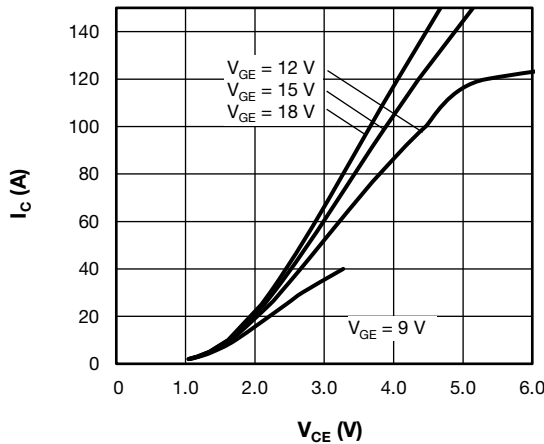


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$

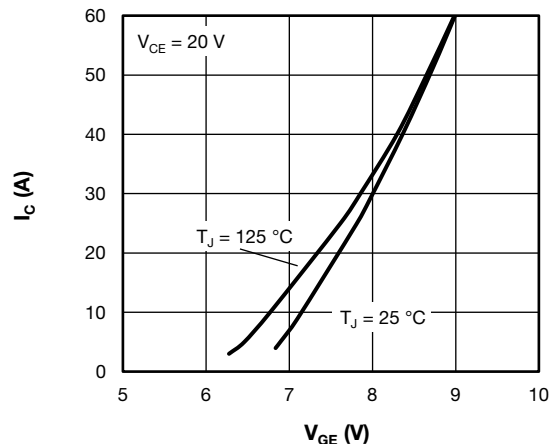


Fig. 4 - Typical Trench IGBT Transfer Characteristic

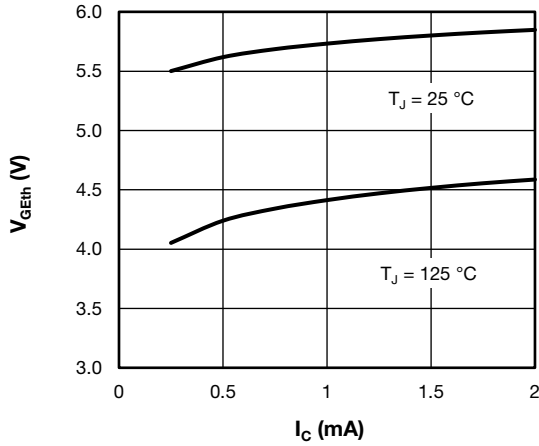


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

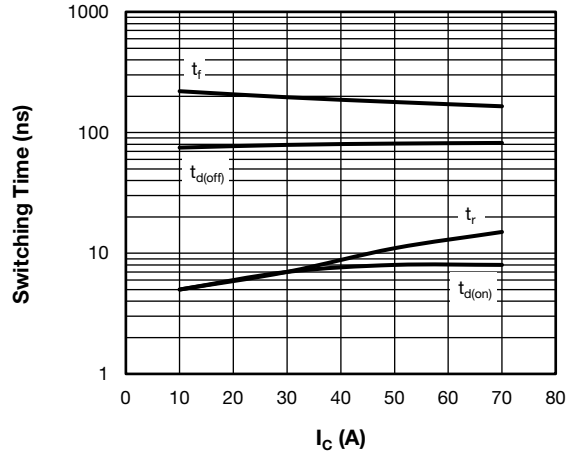


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

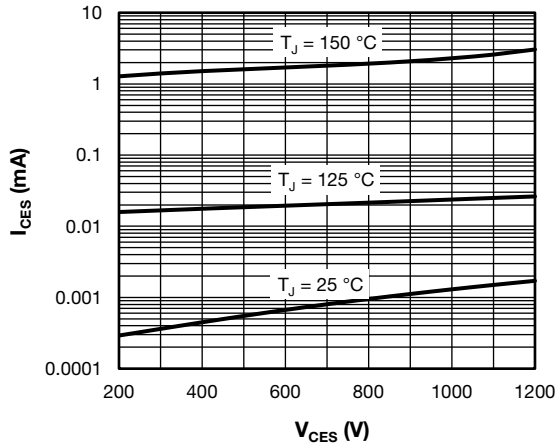


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

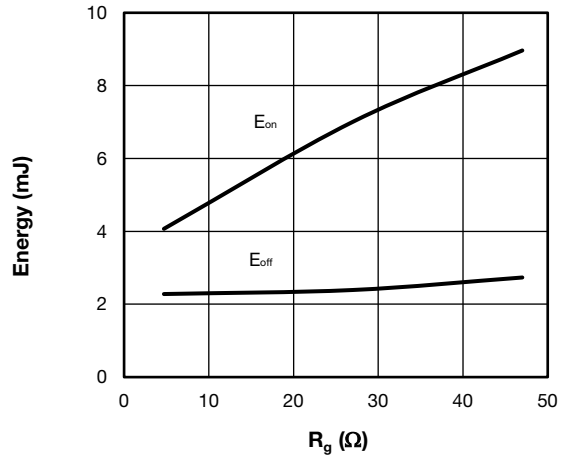


Fig. 9 - Typical Trench IGBT Energy Losses vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 50\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

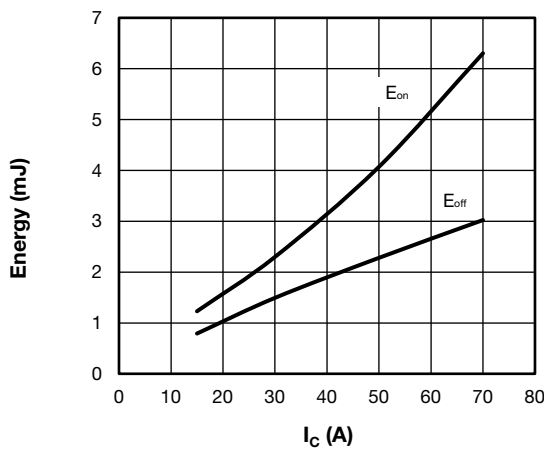


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

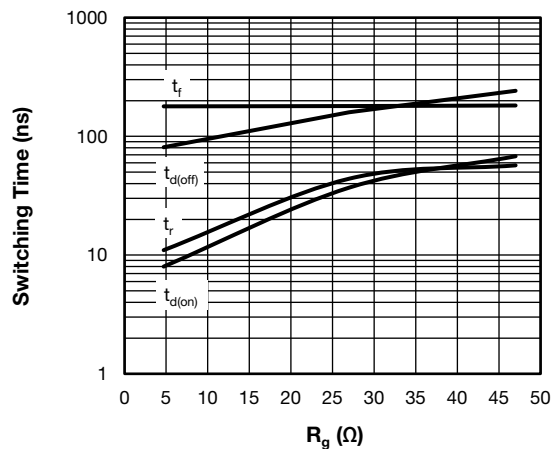


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 50\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

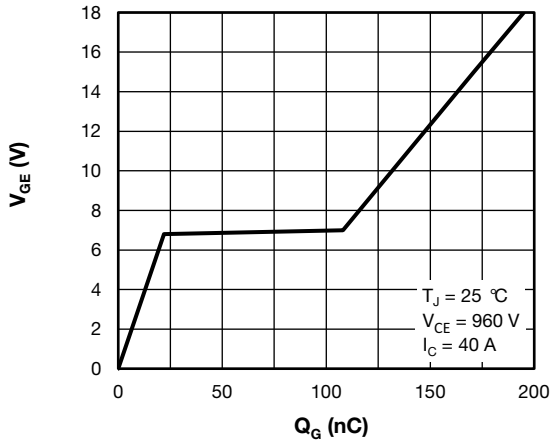


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

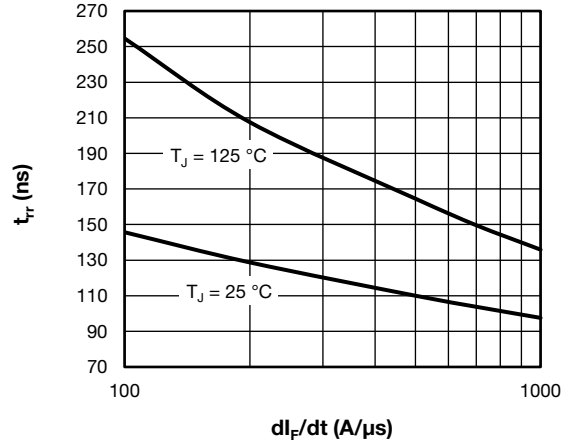


Fig. 14 - Typical Diode Reverse Recovery Time vs.  $dI_F/dt$

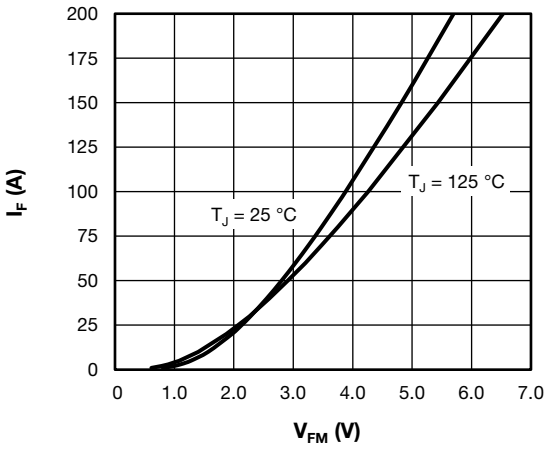


Fig. 12 - Typical Diode Forward Characteristic

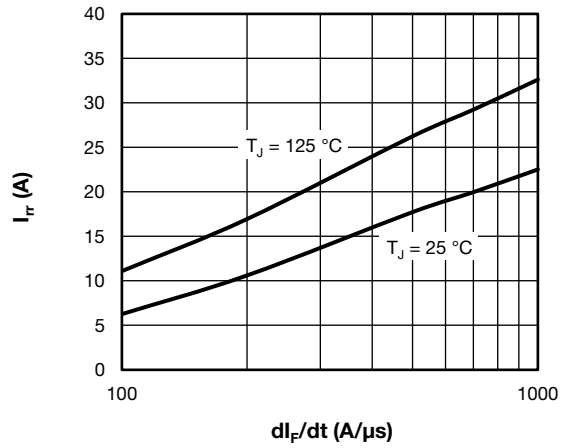


Fig. 15 - Typical Diode Reverse Recovery Current vs.  $dI_F/dt$

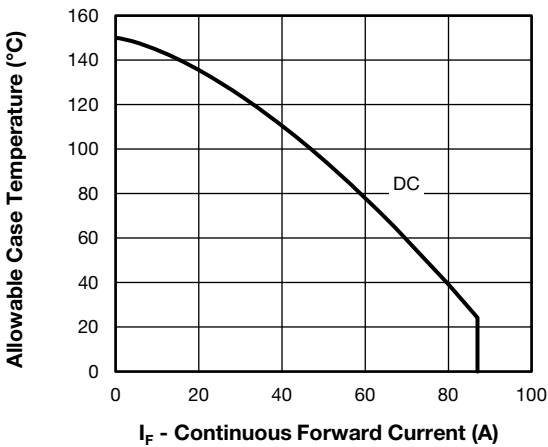


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

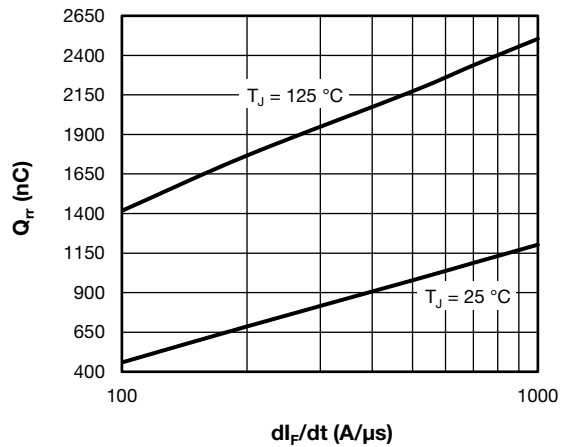


Fig. 16 - Typical Diode Reverse Recovery Charge vs.  $dI_F/dt$

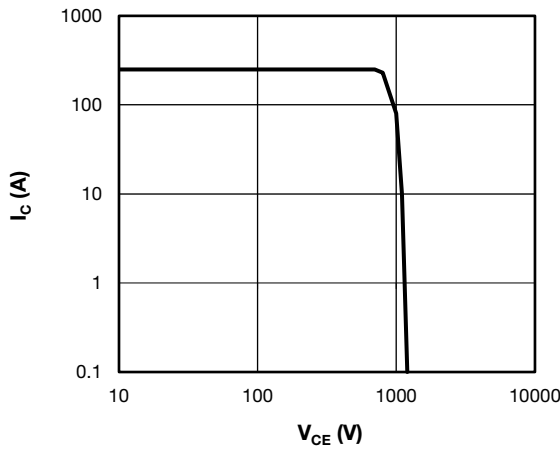


Fig. 17 - Trench IGBT Reverse BIAS SOA  
 $T_J = 150\text{ }^\circ\text{C}$ ,  $I_C = 250\text{ A}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V/0 V}$ ,  
 $V_{CC} = 700\text{ V}$ ,  $V_p = 1200\text{ V}$

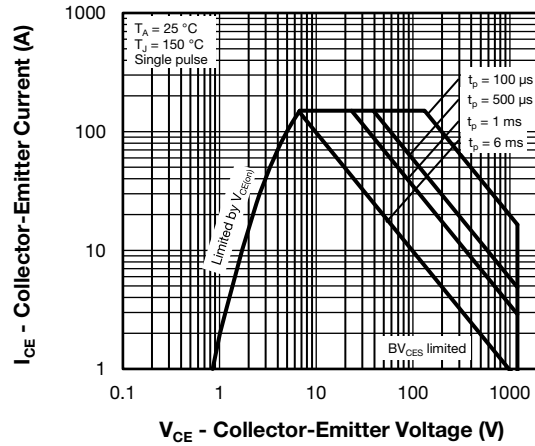


Fig. 18 - Trench IGBT Safe Operating Area

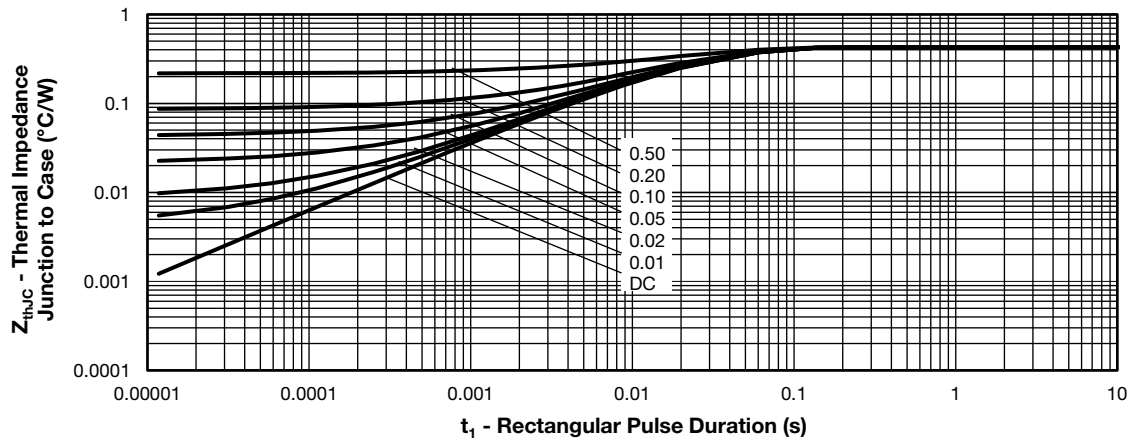


Fig. 19 - Maximum Trench IGBT Thermal Impedance  $Z_{thJC}$  Characteristics

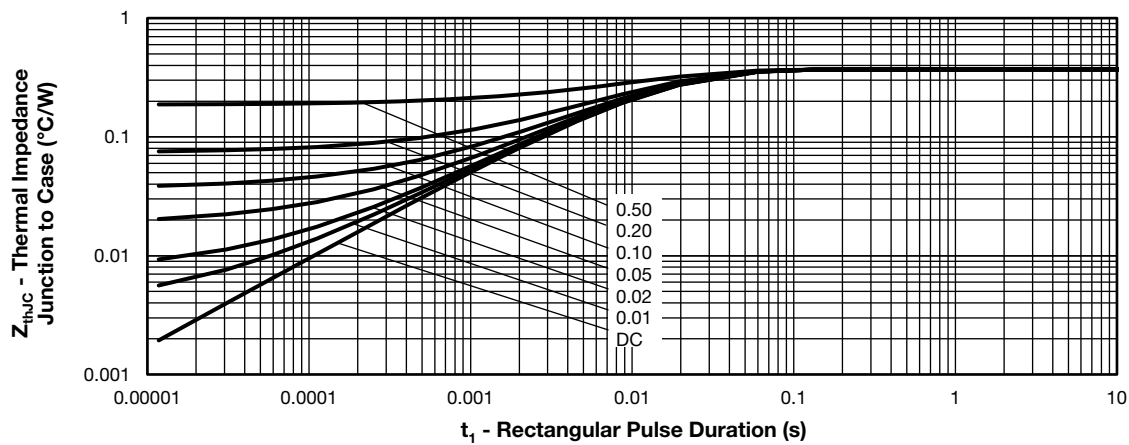


Fig. 20 - Maximum Diode Thermal Impedance  $Z_{thJC}$  Characteristics

## ORDERING INFORMATION TABLE

Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>55</b>	<b>L</b>	<b>A</b>	<b>120</b>	<b>U</b>	<b>X</b>
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - T = trench IGBT
- 4** - Current rating (55 = 55 A)
- 5** - Circuit configuration (L = low side chopper)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (120 = 1200 V)
- 8** - Speed/type (U = ultrafast IGBT)
- 9** - Diode (X = HEXFRED<sup>®</sup> diode)

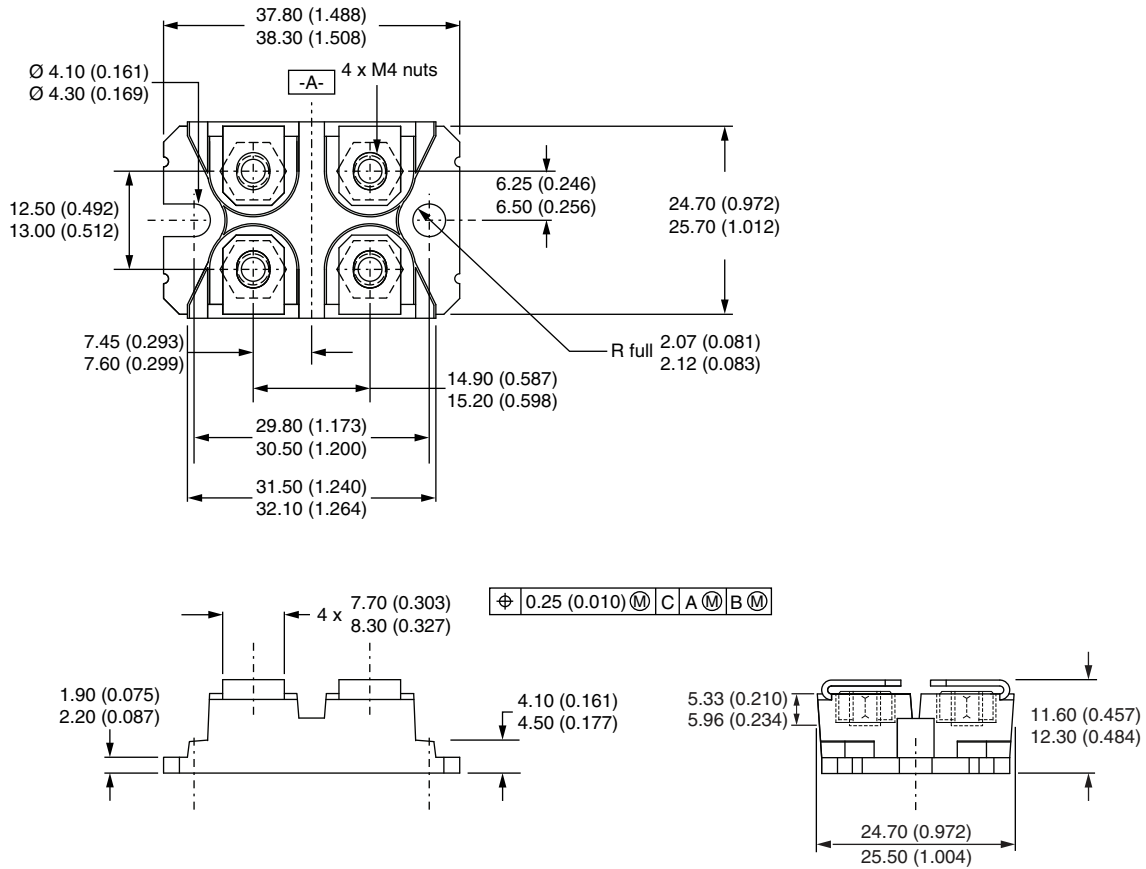
CIRCUIT CONFIGURATION			
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING	
Low side chopper	L		Lead Assignment 

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 2

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter





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