


## “Low Side Chopper” IGBT SOT-227, 650 V, 100 A


**SOT-227**

**RoHS  
COMPLIANT**
**FEATURES**

- Trench IGBT technology
- Higher switching frequency up to 150 kHz
- Square RBSOA
- Low  $V_{CE(on)}$
- FRED Pt® Gen 4 clamping diode
- 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)

**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
- Lower conduction losses and switching losses
- Low EMI, requires less snubbing

**PRIMARY CHARACTERISTICS**

$V_{CES}$	650 V
$I_C$ DC	50 A at 117 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	1.72 V
$I_F$ DC	50 A at 90 °C
Package	SOT-227
Circuit configuration	Low side chopper

**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		650	V
Continuous collector current	$I_C$	$T_C = 25$ °C	94	A
		$T_C = 80$ °C	70	
Pulsed collector current	$I_{CM}$	$V_{GE} = 15$ V	240	
Clamped inductive load current	$I_{LM}$		250	
Diode continuous forward current	$I_F$	$T_C = 25$ °C	74	
		$T_C = 80$ °C	54	
Single pulse forward current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse, $T_J = 25$ °C	340	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Power dissipation, IGBT	$P_D$	$T_C = 25$ °C	230	W
		$T_C = 80$ °C	146	
Power dissipation, diode	$P_D$	$T_C = 25$ °C	143	
		$T_C = 80$ °C	90	
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ 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	$V_{BR(CE)}$	$V_{GE} = 0\text{ V}, I_C = 0.4\text{ mA}$	650	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.72	2.10	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.01	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 1.0\text{ mA}$	2.8	4.0	5.3	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1.0\text{ mA}$ (25 °C to 125 °C)	-	-9.73	-	mV/°C
Transfer characteristics	$V_{GE}$	$V_{CE} = 20\text{ V}, I_C = 100\text{ A}$	-	6.4	-	V
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	-	0.3	80	μA
		$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	30	-	
Diode reverse breakdown voltage	$V_{BR}$	$I_R = 1.0\text{ mA}$	650	-	-	V
Diode forward voltage drop	$V_{FM}$	$I_F = 100\text{ A}, V_{GE} = 0\text{ V}$	-	2.39	2.71	V
		$I_F = 100\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	2.07	-	
Diode reverse leakage current	$I_{RM}$	$V_R = 650\text{ V}$	-	0.4	60	μA
		$V_R = 650\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	100	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	± 300	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)	$Q_g$	$I_C = 100\text{ A}, V_{CC} = 520\text{ V}, V_{GE} = 15\text{ V}$	-	235	-	nC	
Gate to emitter charge (turn-on)	$Q_{ge}$		-	37	-		
Gate to collector charge (turn-on)	$Q_{gc}$		-	69	-		
Turn-on switching loss	$E_{on}$	$I_C = 100\text{ A}, V_{CC} = 325\text{ V}, V_{GE} = 15\text{ V}, R_g = 10\text{ }^\Omega, L = 500\text{ }^\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	2.7	-	mJ	
Turn-off switching loss	$E_{off}$		-	0.59	-		
Total switching loss	$E_{tot}$		-	3.29	-		
Turn-on delay time	$t_{d(on)}$		-	140	-		
Rise time	$t_r$		-	52	-		
Turn-off delay time	$t_{d(off)}$		-	149	-		
Fall time	$t_f$		-	12	-		
Turn-on switching loss	$E_{on}$		$I_C = 100\text{ A}, V_{CC} = 325\text{ V}, V_{GE} = 15\text{ V}, R_g = 10\text{ }^\Omega, L = 500\text{ }^\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	3.16		-
Turn-off switching loss	$E_{off}$			-	0.72		-
Total switching loss	$E_{tot}$			-	3.88		-
Turn-on delay time	$t_{d(on)}$	-		140	-		
Rise time	$t_r$	-		45	-		
Turn-off delay time	$t_{d(off)}$	-		159	-		
Fall time	$t_f$	-	16	-	ns		
Reverse bias safe operating area	RBSOA	$T_J = 175\text{ }^\circ\text{C}, I_C = 250\text{ A}, R_g = 10\text{ }^\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 400\text{ V}, V_P = 650\text{ V}$	Fullsquare				
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 500\text{ A}/\mu\text{s}, V_R = 400\text{ V}$	-	84	-	ns	
Diode peak reverse current	$I_{rr}$		-	7.2	-	A	
Diode recovery charge	$Q_{rr}$		-	300	-	nC	
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 500\text{ A}/\mu\text{s}, V_R = 400\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	143	-	ns	
Diode peak reverse current	$I_{rr}$		-	16	-	A	
Diode recovery charge	$Q_{rr}$		-	1135	-	nC	



THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		-40	-	175	°C
Junction to case	IGBT		-	-	0.65	°C/W
	Diode		-	-	1.05	
Case to heatsink	$R_{thCS}$	Flat, greased surface	-	0.05	-	
Weight			-	30	-	g
Mounting torque		Torque to terminal	-	-	1.1 (9.7)	Nm (lb.in)
		Torque to heatsink	-	-	1.8 (15.9)	Nm (lb.in)
Case style		SOT-227				

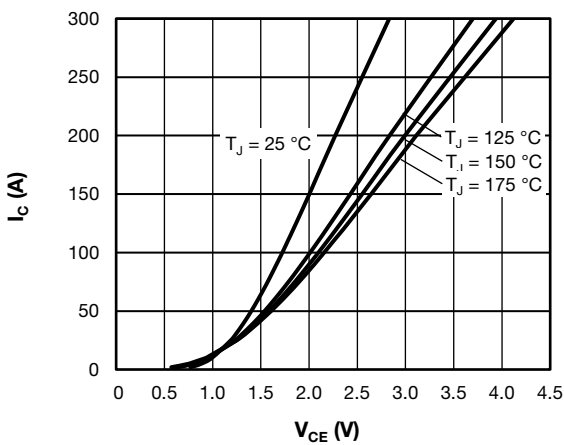


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

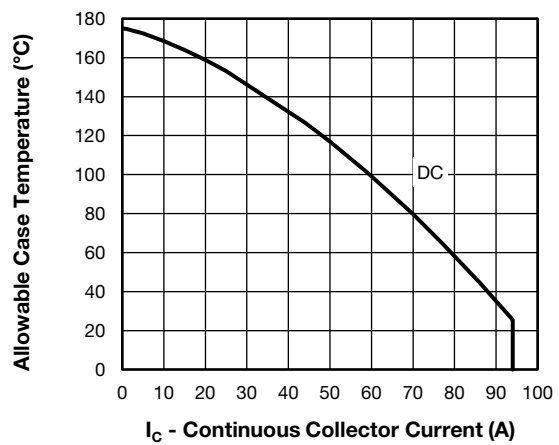


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

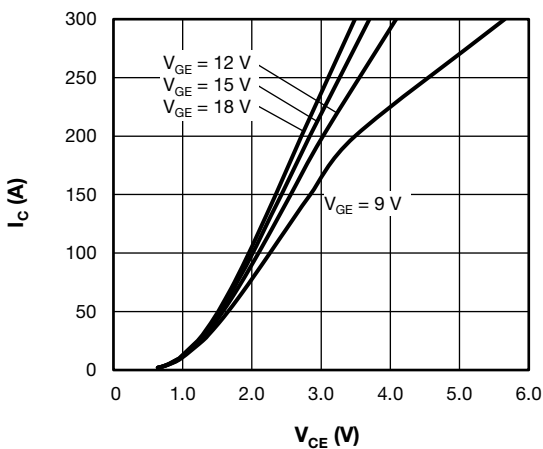


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$

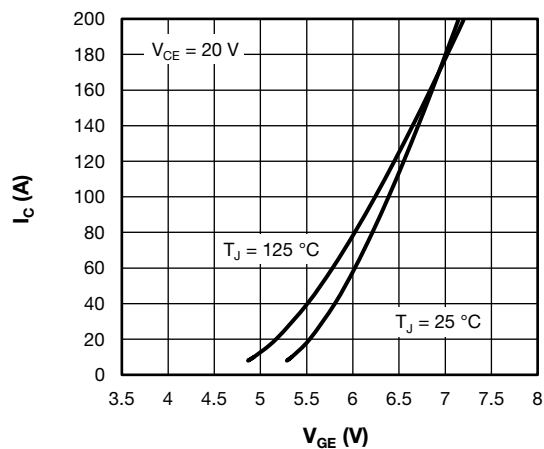


Fig. 4 - Typical Trench IGBT Transfer Characteristics

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 10\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

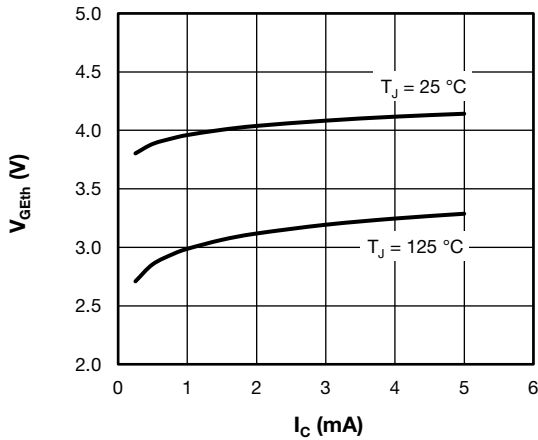


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

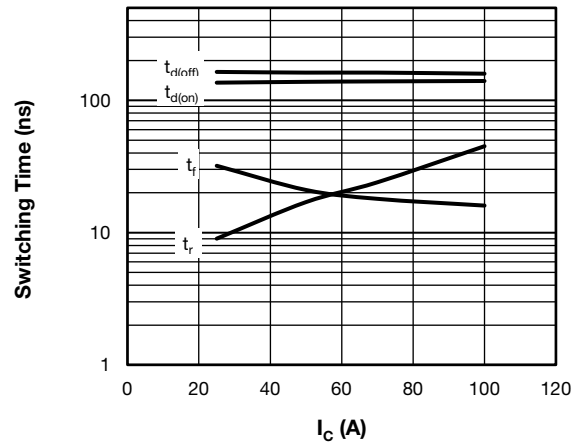


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$  (with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 10\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

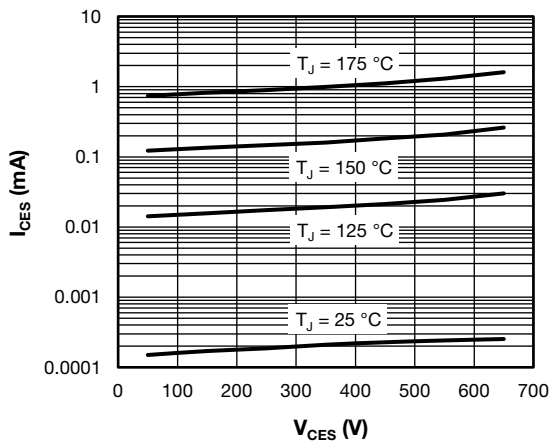


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

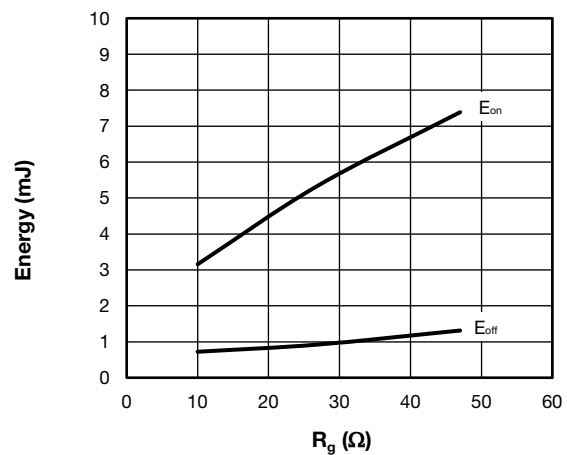


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$  (with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

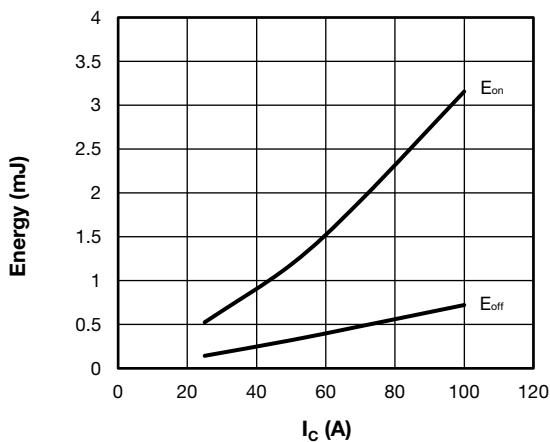


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$  (with Antiparallel Diode)

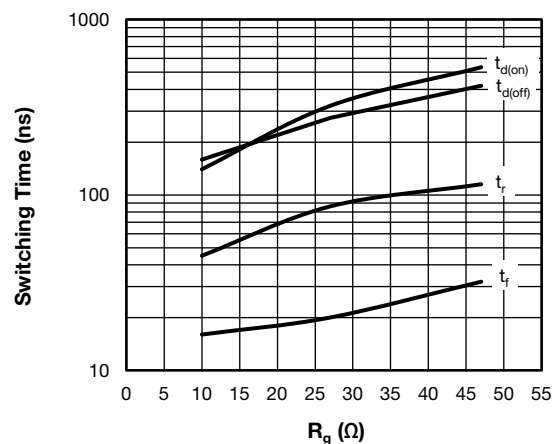




Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
(with Antiparallel Diode)

$T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

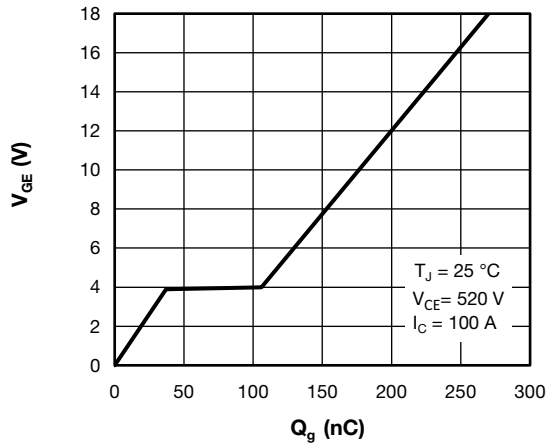


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

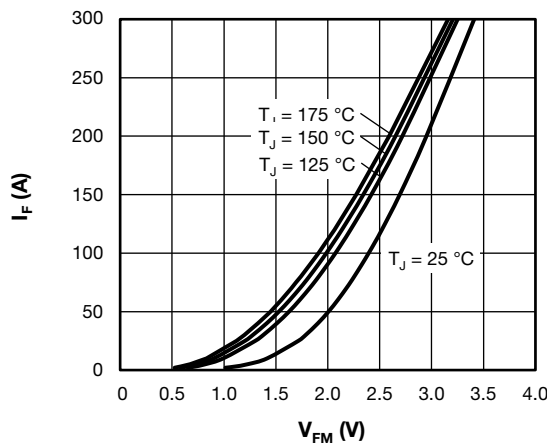


Fig. 12 - Typical Diode Forward Characteristics

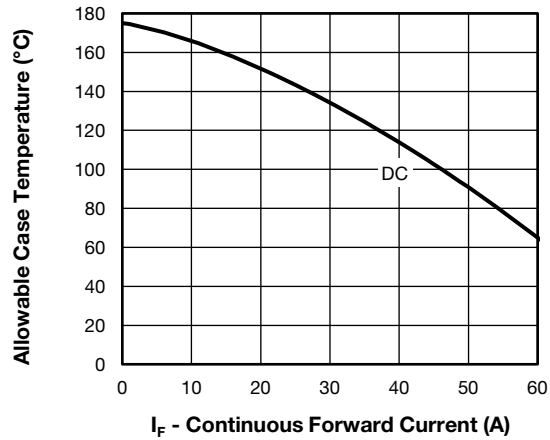


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

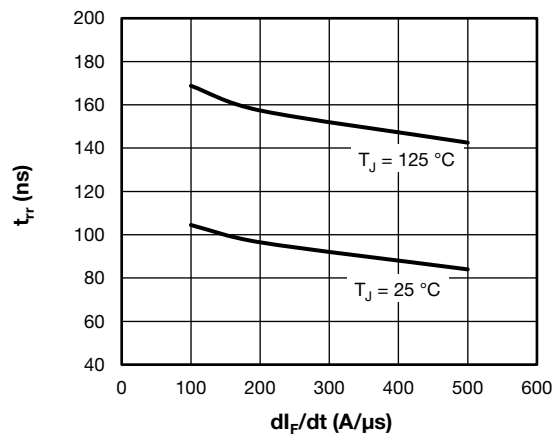


Fig. 14 - Typical Diode Reverse Recovery Time vs.  $di_F/dt$   
 $I_F = 50\text{ A}$ ,  $V_{CC} = 400\text{ V}$

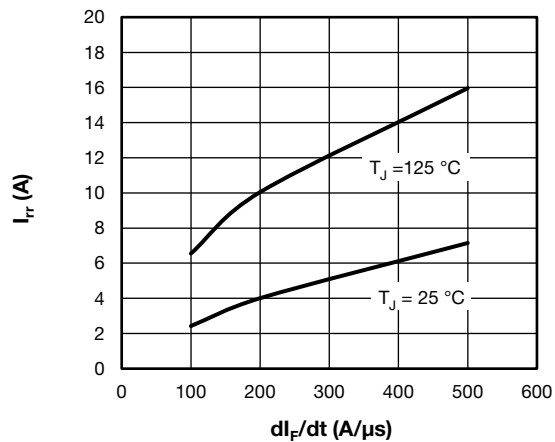


Fig. 15 - Typical Diode Reverse Recovery Current vs.  $di_F/dt$   
 $I_F = 50\text{ A}$ ,  $V_{CC} = 400\text{ V}$

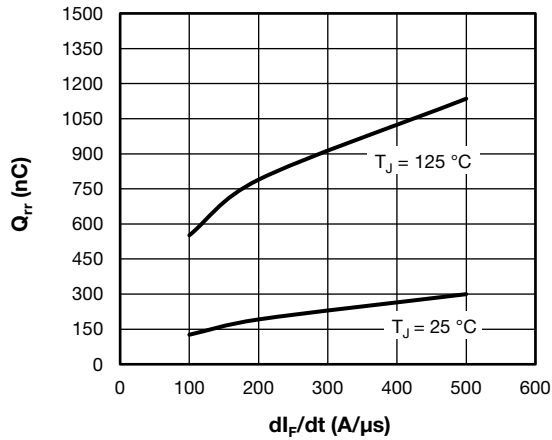


Fig. 16 - Typical Diode Reverse Recovery Charge vs.  $di_F/dt$   
 $I_F = 50 \text{ A}$ ,  $V_{CC} = 400 \text{ V}$

Fig. 17 - Trench IGBT Reverse BIAS SOA  
 $T_J = 175 \text{ }^\circ\text{C}$ ,  $I_C = 250 \text{ A}$ ,  $R_g = 10 \text{ } \Omega$ ,  $V_{GE} = +15 \text{ V/0 V}$ ,  $V_{CC} = 400 \text{ V}$ ,  
 $V_p = 650 \text{ V}$

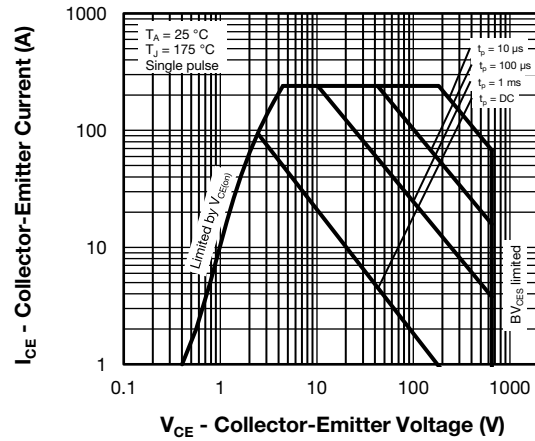


Fig. 18 - Trench IGBT Safe Operating Area

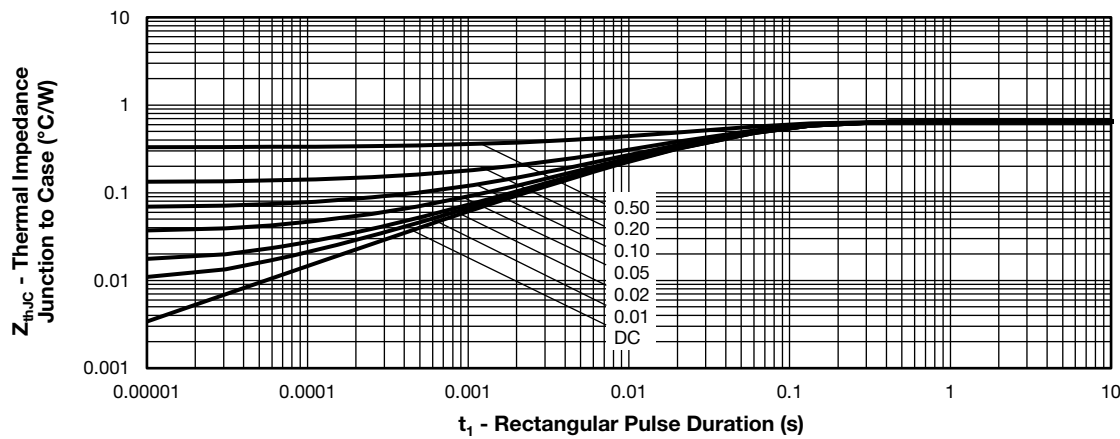
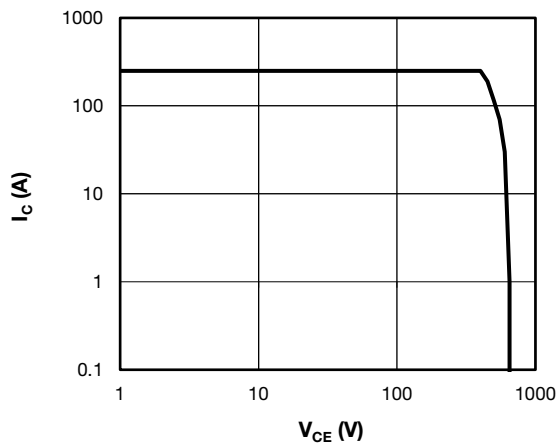


Fig. 19 - Maximum Trench IGBT Thermal Impedance  $Z_{thJC}$  Characteristics

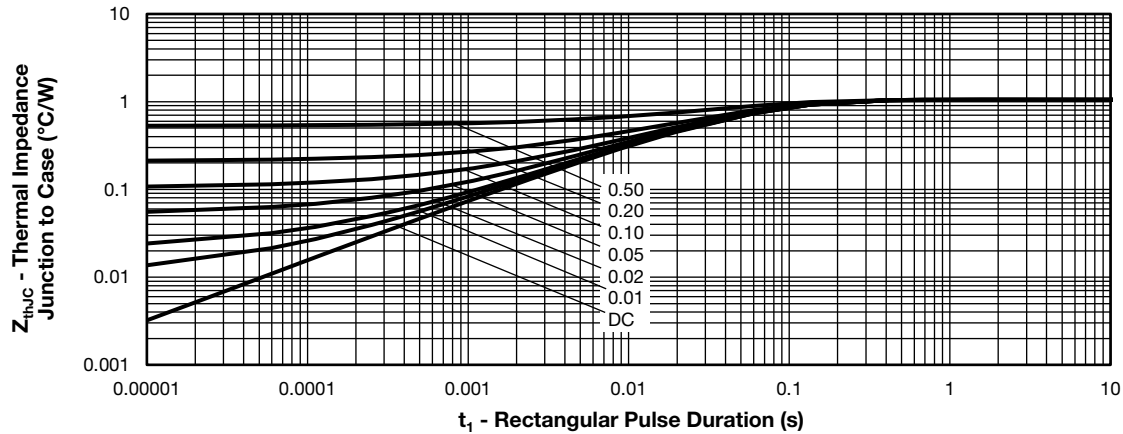


Fig. 20 - Maximum Diode Thermal Impedance  $Z_{thJC}$  Characteristics

### ORDERING INFORMATION TABLE

Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>100</b>	<b>L</b>	<b>A</b>	<b>65</b>	<b>U</b>	<b>F</b>
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

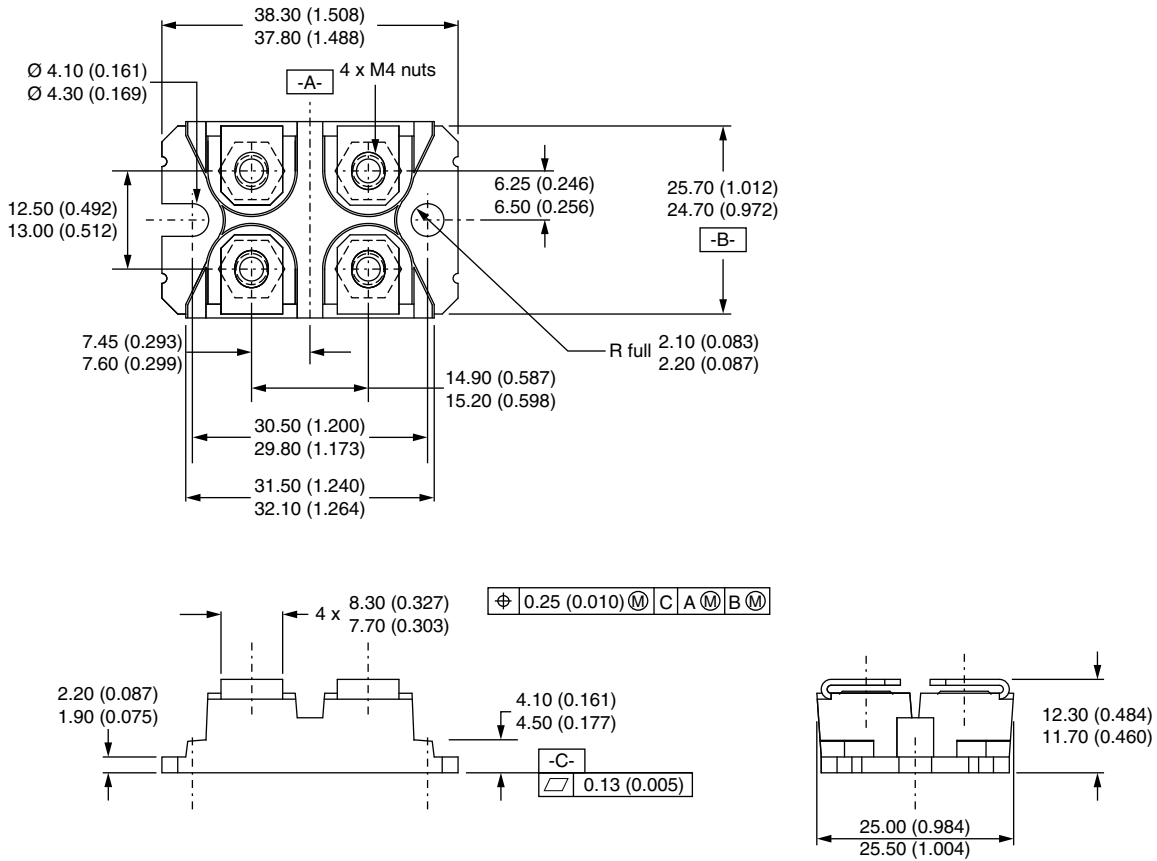
- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - T = Trench IGBT technology
- 4** - Current rating (100 = 100 A)
- 5** - Circuit configuration (L = low side chopper)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (65 = 650 V)
- 8** - Speed/type (U = ultrafast IGBT)
- 9** - Diode (F = FRED Pt<sup>®</sup> diode)

CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Low side chopper	L	<p>Lead Assignment</p>



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>
Application note	<a href="http://www.vishay.com/doc?95527">www.vishay.com/doc?95527</a>

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling

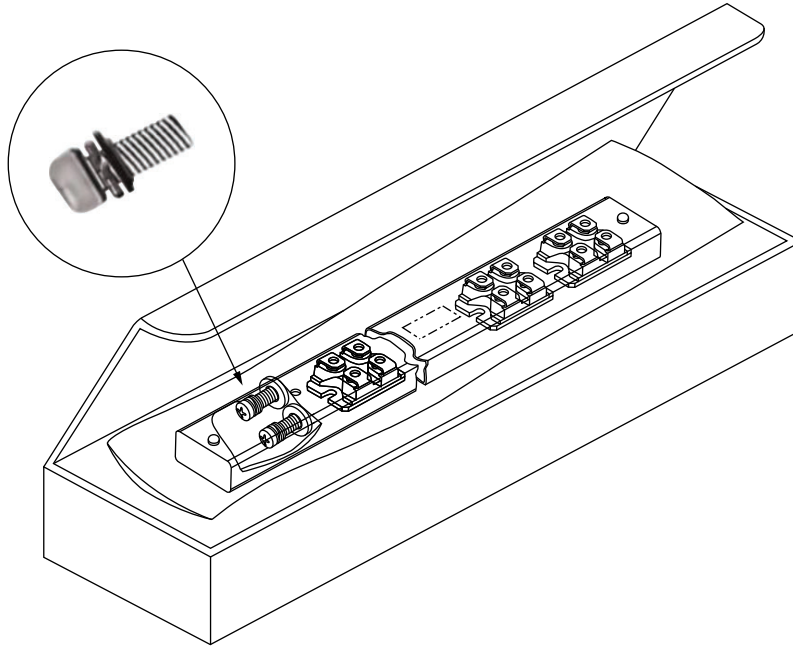
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millimeter





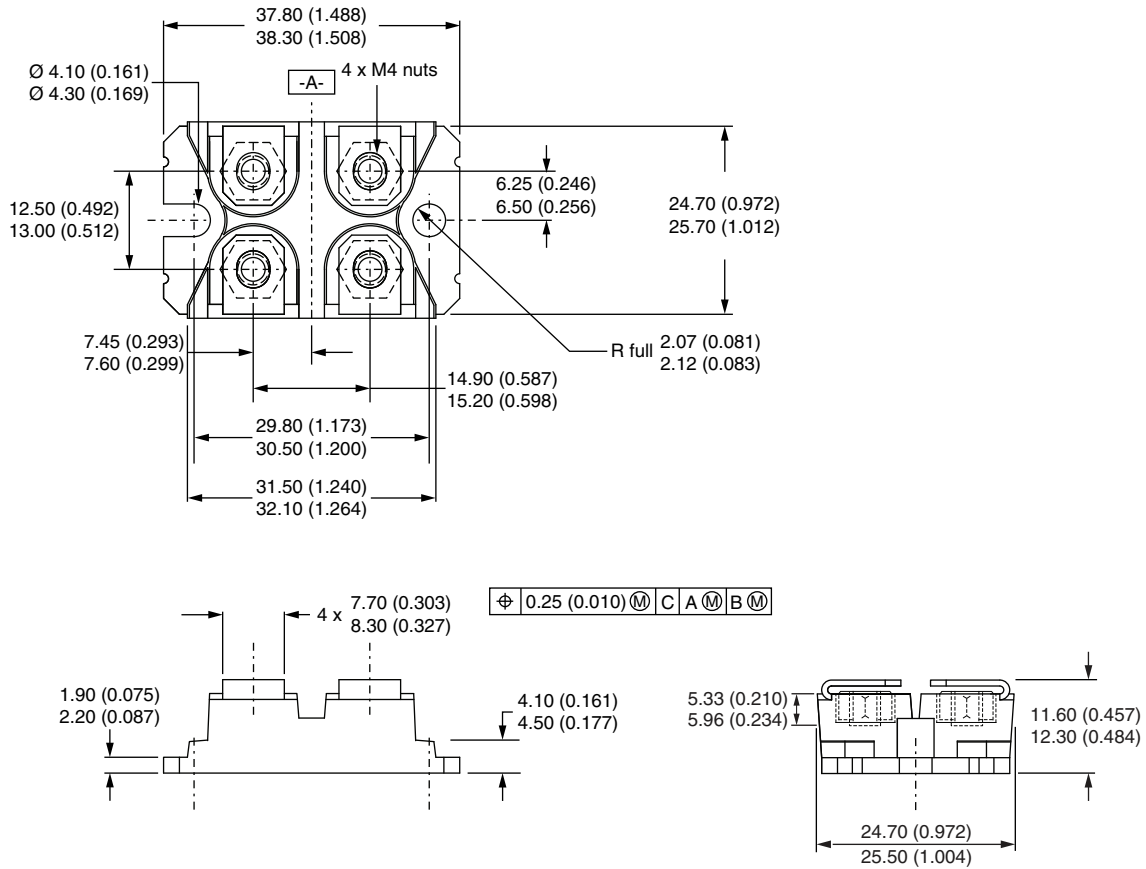
**PACKAGING INFORMATION**





## SOT-227 Generation 2

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter



## Disclaimer

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