

## Insulated Gate Bipolar Transistor Ultralow $V_{CE(on)}$ , 250 A


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

- Standard: optimized for minimum saturation voltage and low speed
- Lowest conduction losses available
- Fully isolated package (2500 V<sub>AC</sub>)
- Very low internal inductance (5 nH typical)
- Industry standard outline
- Designed and qualified for industrial level
- 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	
$V_{CES}$	600 V
$V_{CE(on)}$ (typical) at 200 A, 25 °C	1.16 V
$I_C$ at $T_C = 90$ °C	250 A
Speed	DC to 1 kHz
Package	SOT-227
Circuit configuration	Single switch no diode

**BENEFITS**

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

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		600	V
Continuous collector current	$I_C$	$T_C = 25$ °C	359	A
		$T_C = 90$ °C	250	
Pulsed collector current	$I_{CM}$	$T_C = 175$ °C, $t_p = 6$ ms, $V_{GE} = 15$ V	945	
Clamped Inductive load current	$I_{LM}$		250	
Gate to emitter voltage	$V_{GE}$		± 20	V
Power dissipation	$P_D$	$T_C = 25$ °C	750	W
		$T_C = 90$ °C	425	
Isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ min	2500	V

ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0$ V, $I_C = 0.4$ mA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$I_C = 100$ A	-	1.01	1.16	
		$I_C = 200$ A	-	1.16	-	
		$I_C = 100$ A, $T_J = 125$ °C	-	0.96	-	
		$I_C = 200$ A, $T_J = 125$ °C	-	1.18	-	
		$I_C = 100$ A, $T_J = 150$ °C	-	0.95	-	
		$I_C = 200$ A, $T_J = 150$ °C	-	1.18	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$ , $I_C = 2$ mA	3.8	4.9	6.3	
		$V_{CE} = V_{GE}$ , $I_C = 2$ mA, $T_J = 125$ °C	-	3.5	-	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$ , $I_C = 2$ mA, 25 °C to 125 °C	-	-14	-	mV/°C
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0$ V, $V_{CE} = 600$ V	-	0.2	100	µA
		$V_{GE} = 0$ V, $V_{CE} = 600$ V, $T_J = 125$ °C	-	51	-	
		$V_{GE} = 0$ V, $V_{CE} = 600$ V, $T_J = 150$ °C	-	508	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20$ V	-	-	± 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)	$Q_g$	$I_C = 75\text{ A}, V_{CC} = 520\text{ V}, V_{GE} = 15\text{ V}$	-	909	-	nC	
Gate-to-emitter charge (turn-on)	$Q_{ge}$		-	139	-		
Gate-to-collector charge (turn-on)	$Q_{gc}$		-	249	-		
Turn-on switching loss	$E_{on}$	$T_J = 25\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	1.61	-	mJ	
Turn-off switching loss	$E_{off}$		-	6.65	-		
Total switching loss	$E_{tot}$		-	8.26	-		
Turn-on delay time	$t_{d(on)}$		$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	469	-	ns
Rise time	$t_r$			-	36	-	
Turn-off delay time	$t_{d(off)}$			-	539	-	
Fall time	$t_f$			-	109	-	
Turn-on switching loss	$E_{on}$			-	2.03	-	
Turn-off switching loss	$E_{off}$		-	9.65	-	mJ	
Total switching loss	$E_{tot}$		-	11.68	-		
Turn-on delay time	$t_{d(on)}$	$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	498	-	ns	
Rise time	$t_r$		-	43	-		
Turn-off delay time	$t_{d(off)}$		-	640	-		
Fall time	$t_f$		-	128	-		
Internal emitter inductance	$L_E$	Between lead and center of die contact	-	5.0	-	nH	
Input capacitance	$C_{ies}$	$V_{GE} = 0\text{ V}, V_{CC} = 25\text{ V}, f = 1.0\text{ MHz}$	-	24 200	-	pF	
Output capacitance	$C_{oes}$		-	300	-		
Reverse transfer capacitance	$C_{res}$		-	84	-		
Reverse bias safe operating area	RBSOA	$T_J = 175\text{ }^\circ\text{C}, I_C = 250\text{ A}, R_g = 5.0\text{ }\Omega,$ $V_{GE} = 15\text{ V to }0\text{ V}, V_{CC} = 400\text{ V},$ $V_p = 600\text{ V}$	Fullsquare				

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		-40	-	175	$^\circ\text{C}$
Thermal resistance junction to case	$R_{thJC}$		-	-	0.2	$^\circ\text{C/W}$
Thermal resistance 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				

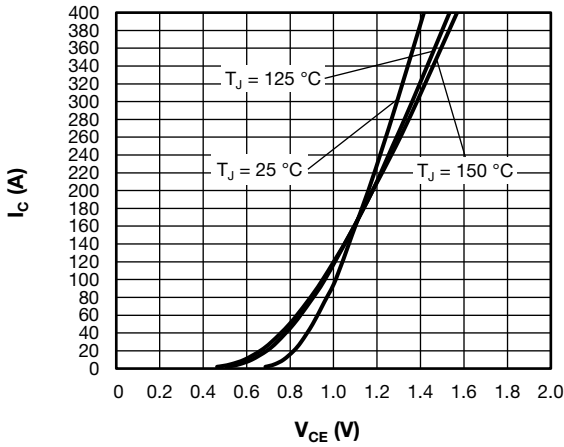


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

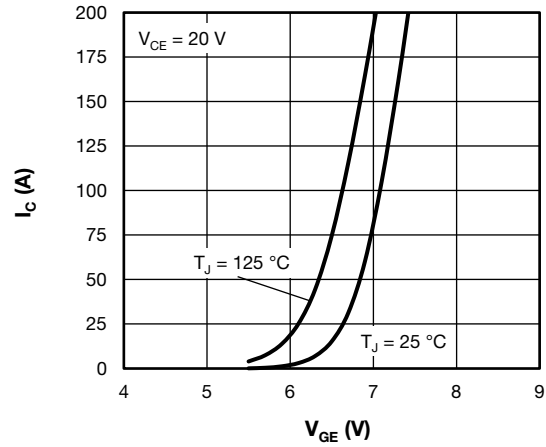


Fig. 4 - Typical Trench IGBT Transfer Characteristics

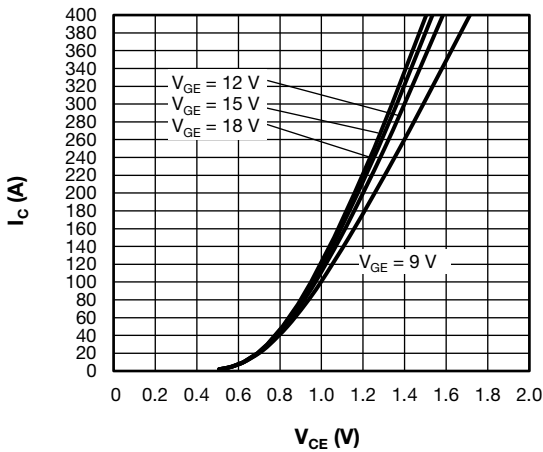


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$

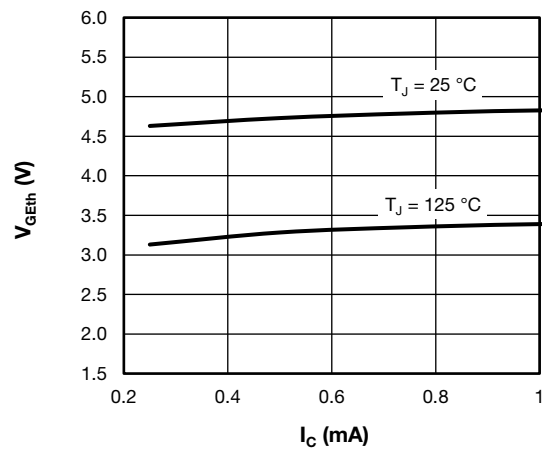


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

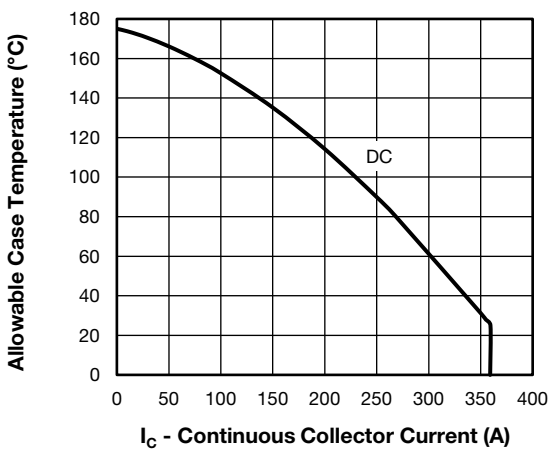


Fig. 3 - Typical Trench IGBT  
Continuous Collector Current vs. Case Temperature

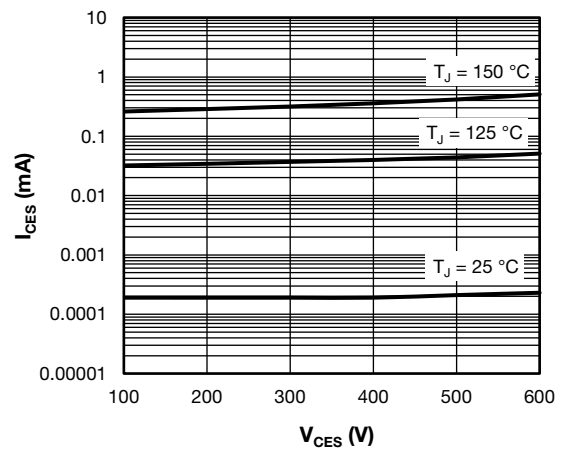


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

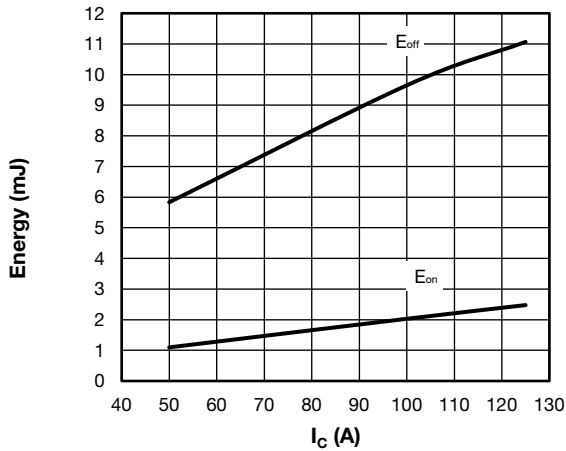


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $R_g = 5\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

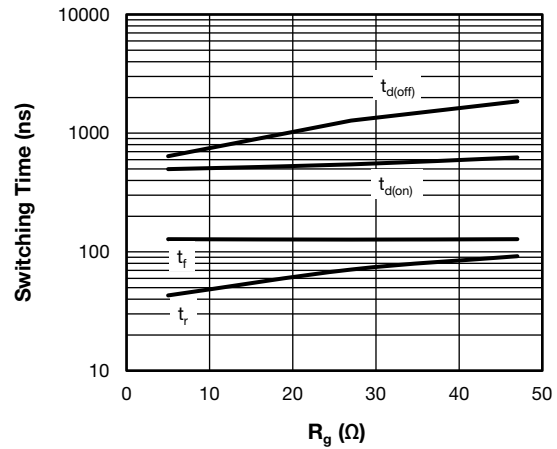


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

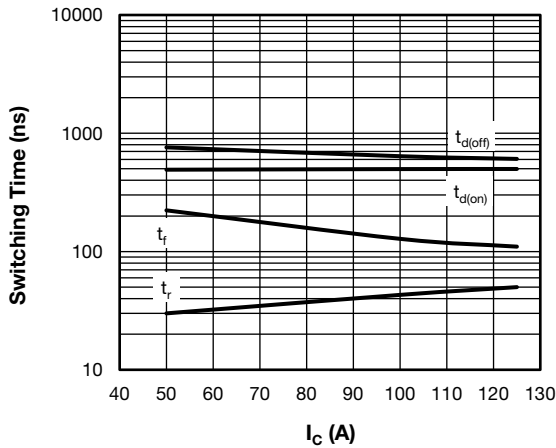


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $R_g = 5\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

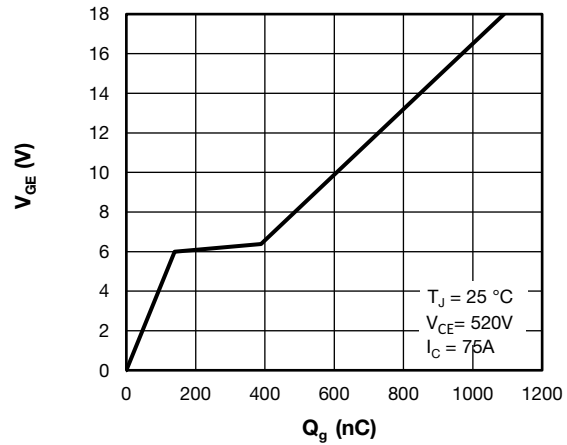


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage  
 $T_J = 25^\circ\text{C}$   
 $V_{CE} = 520\text{ V}$   
 $I_C = 75\text{ A}$

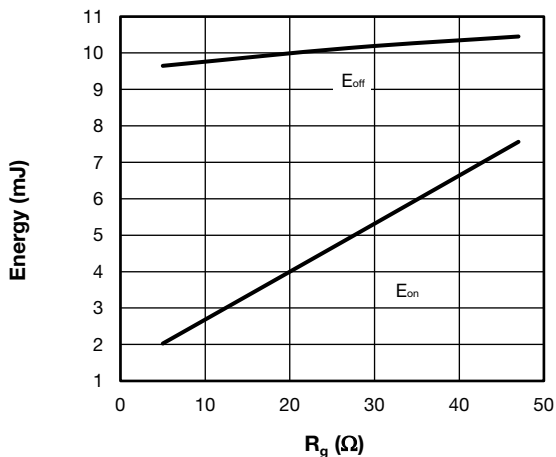


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $I_C = 100\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

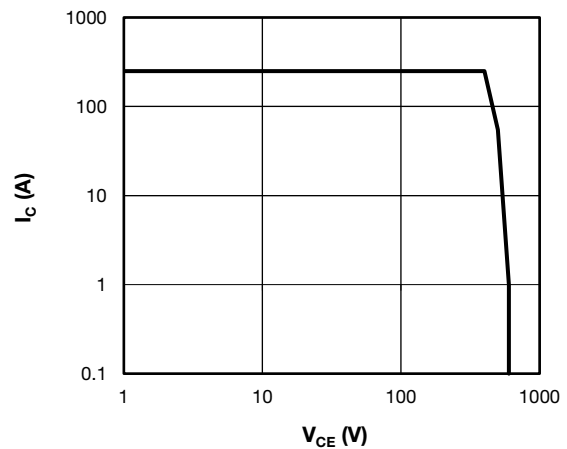


Fig. 12 - Typical Trench IGBT Reverse BIAS SOA  
 $T_J = 175^\circ\text{C}$ ,  $I_C = 250\text{ A}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/0\text{ V}$ ,  
 $V_{CC} = 400\text{ V}$ ,  $V_p = 600\text{ V}$

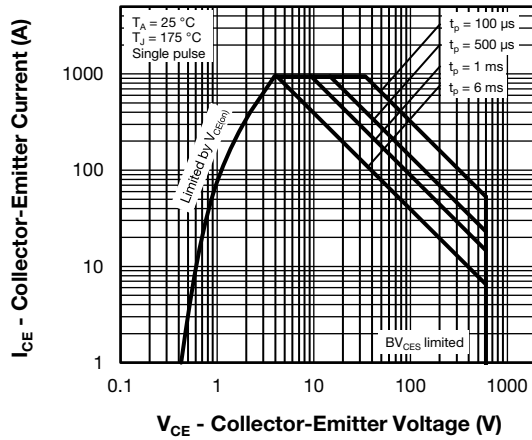


Fig. 13 - Typical Trench IGBT Safe Operating Area

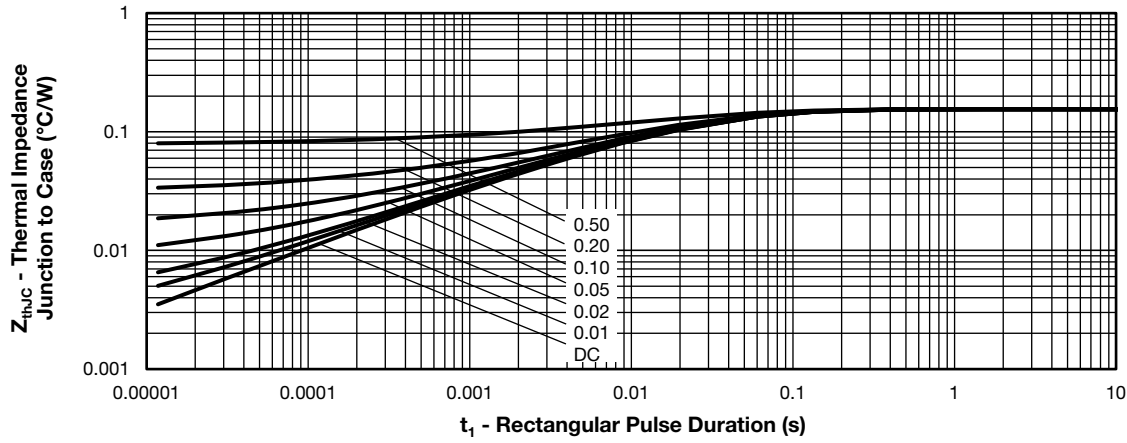
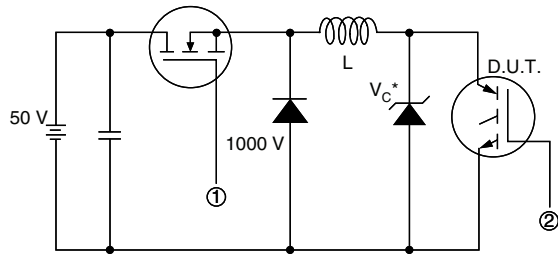


Fig. 14 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics



\* 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 rated  $I_d$

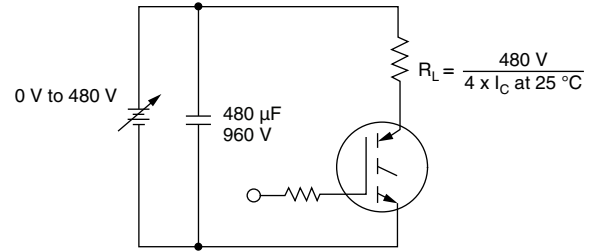
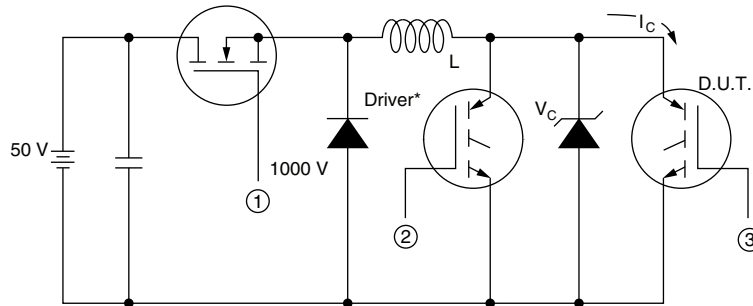


Fig. 16 - Pulsed Collector Current Test Circuit

Fig. 15 - Clamped Inductive Load Test Circuit



\* Driver same type as D.U.T.,  $V_C = 480$  V

Fig. 17 - Switching Lost Test Circuit

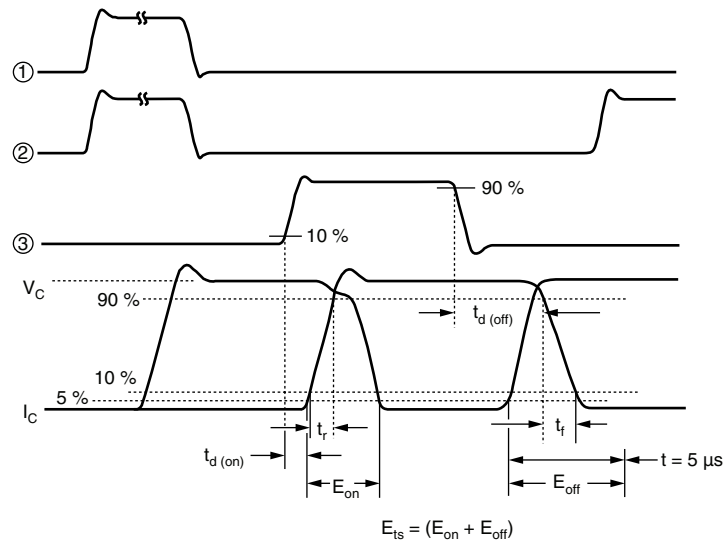


Fig. 18 - Switching Loss Waveforms

## ORDERING INFORMATION TABLE

Device code	VS-	G	T	250	S	A	60	S
	1	2	3	4	5	6	7	8

1	-	Vishay Semiconductors product
2	-	Insulated gate bipolar transistor (IGBT)
3	-	Trench IGBT silicon
4	-	Current rating (250 = 250 A)
5	-	Circuit configuration (S = single switch no diode)
6	-	Package indicator (A = SOT-227)
7	-	Voltage rating (60 = 600 V)
8	-	Speed/type (S = standard speed)

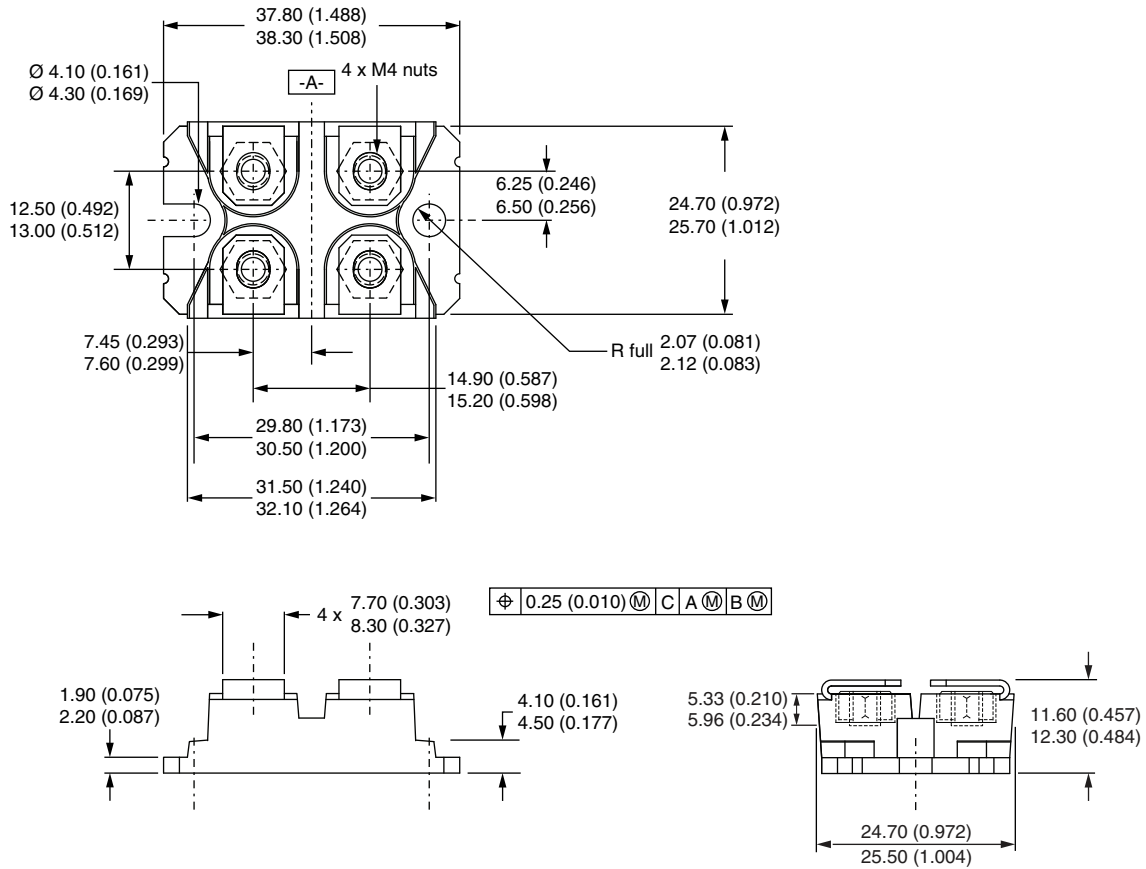
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch, no diode	S	 

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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