



# THE DATASHEET OF VS-GT90SA120U



## Insulated Gate Bipolar Transistor (Ultrafast IGBT), 106 A


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

- Trench IGBT technology
- Square RBSOA
- Positive  $V_{CE(on)}$  temperature coefficient
- 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**

PRIMARY CHARACTERISTICS	
$V_{CES}$	1200 V
$I_C$ DC	106 A at 90 °C
$V_{CE(on)}$ typical at 75 A, 25 °C	2.17 V
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit configuration	Single switch no 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	$I_C$	$T_C = 25$ °C	169	A
		$T_C = 90$ °C	106	
Pulsed collector current	$I_{CM}$	$T_J = 150$ °C, $t_p = 6$ ms, $V_{GE} = 15$ V	350	
Clamped inductive load current	$I_{LM}$		250	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Power dissipation	$P_D$	$T_C = 25$ °C	781	W
		$T_C = 90$ °C	375	
Isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ min	2500	V

ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CES)}$	$V_{GE} = 0$ V, $I_C = 4$ mA	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15$ V, $I_C = 75$ A	-	2.17	2.60	
		$V_{GE} = 15$ V, $I_C = 75$ A, $T_J = 125$ °C	-	2.44	-	
		$V_{GE} = 15$ V, $I_C = 75$ A, $T_J = 150$ °C	-	2.49	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$ , $I_C = 4$ mA	4.6	5.9	7.6	
		$V_{CE} = V_{GE}$ , $I_C = 4$ mA, $T_J = 125$ °C	-	4.63	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$ , $I_C = 4$ mA (25 °C to 125 °C)	-	-13	-	mV/°C
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0$ V, $V_{CE} = 1200$ V	-	0.9	100	$\mu$ A
		$V_{GE} = 0$ V, $V_{CE} = 1200$ V, $T_J = 125$ °C	-	750	-	mA
		$V_{GE} = 0$ V, $V_{CE} = 1200$ V, $T_J = 150$ °C	-	2.7	-	mA
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20$ 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)	$Q_g$	$I_C = 90\text{ A}, V_{CC} = 960\text{ V}, V_{GE} = 15\text{ V}$		-	307	-	nC				
Gate to emitter charge (turn-on)	$Q_{ge}$			-	33	-					
Gate to collector charge (turn-on)	$Q_{gc}$			-	160	-					
Turn-on switching loss	$E_{on}$	$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$		-	2.15	-	mJ				
Turn-off switching loss	$E_{off}$			-	2.59	-					
Total switching loss	$E_{tot}$			-	4.74	-					
Turn-on delay time	$t_{d(on)}$			$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$		-	36	-	ns		
Rise time	$t_r$					-	26	-			
Turn-off delay time	$t_{d(off)}$					-	116	-			
Fall time	$t_f$					-	82	-			
Turn-on switching loss	$E_{on}$					$I_C = 75\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$		-	2.23	-	mJ
Turn-off switching loss	$E_{off}$							-	3.87	-	
Total switching loss	$E_{tot}$							-	6.1	-	
Turn-on delay time	$t_{d(on)}$	$T_J = 150\text{ }^\circ\text{C}, I_C = 250, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 800\text{ V}, V_P = 1200\text{ V}, L = 500\text{ }\mu\text{H}$						-	34	-	ns
Rise time	$t_r$							-	27	-	
Turn-off delay time	$t_{d(off)}$							-	123	-	
Fall time	$t_f$			-	147			-			
Reverse bias safe operating area	RBSOA							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	-	150	$^\circ\text{C}$
Junction to case	$R_{thJC}$		-	-	0.16	$^\circ\text{C/W}$
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				

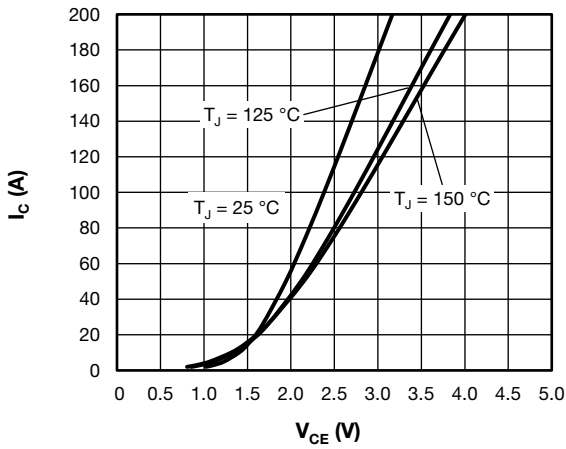


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

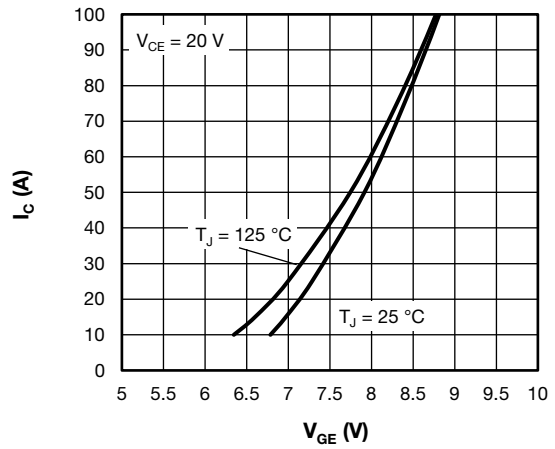


Fig. 4 - Typical Trench IGBT Transfer Characteristics

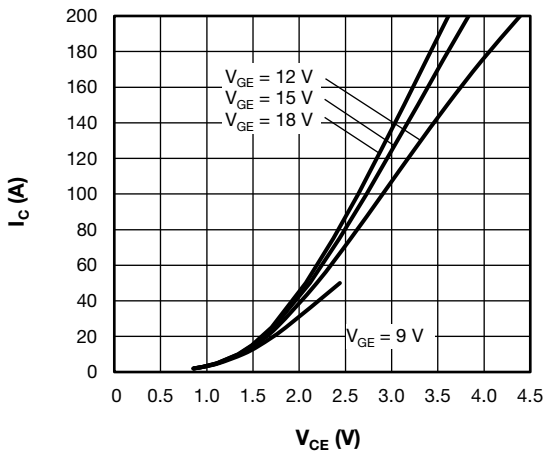


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ }^\circ\text{C}$

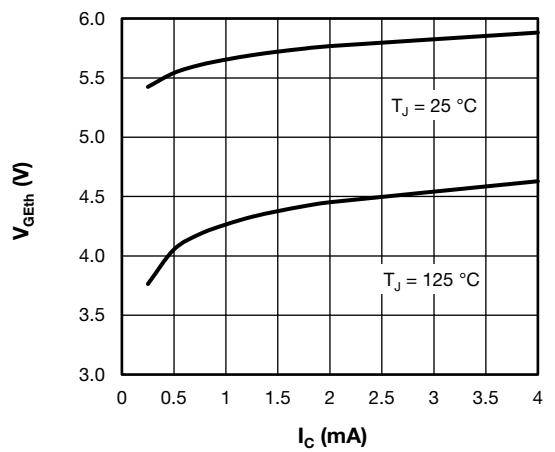


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

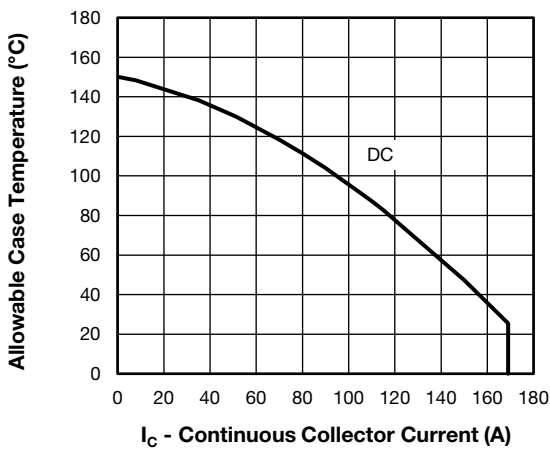


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

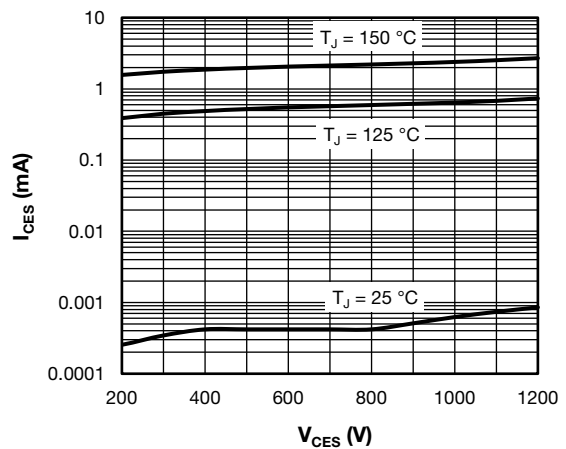


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

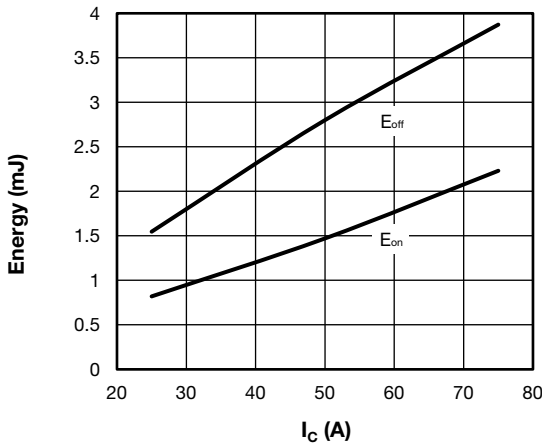


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

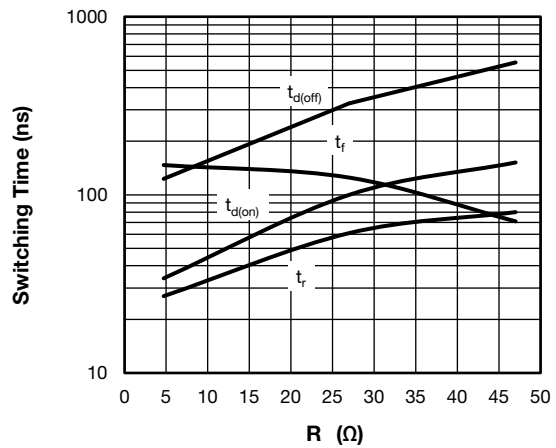


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 75\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

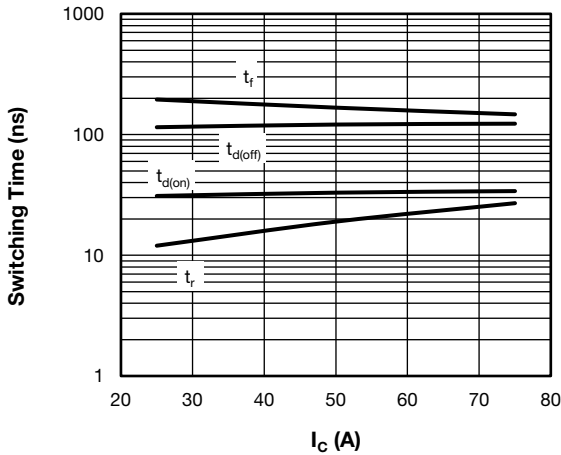


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

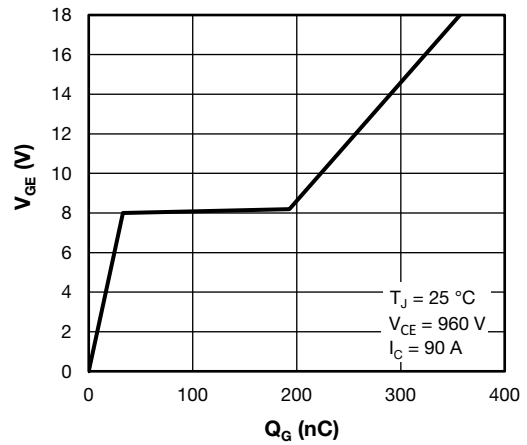


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage  
 $T_J = 25\text{ }^\circ\text{C}$   
 $V_{CE} = 960\text{ V}$   
 $I_C = 90\text{ A}$

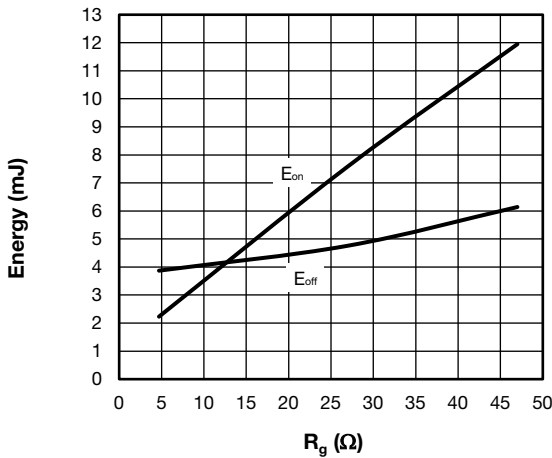


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$   
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 75\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

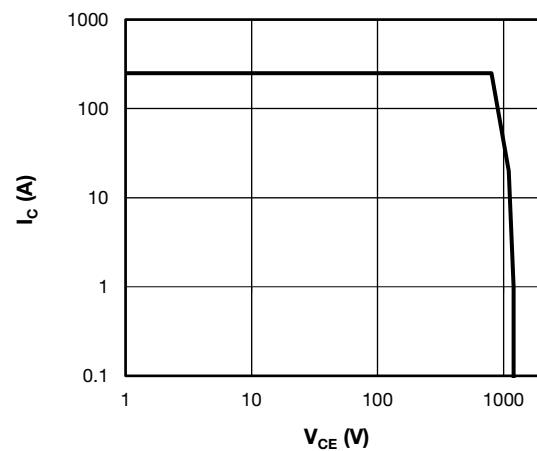


Fig. 12 - Trench IGBT Reverse BIAS SOA  
 $T_J = 150\text{ }^\circ\text{C}$ ,  $I_C = 250\text{ A}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/0\text{ V}$ ,  $V_{CC} = 800\text{ V}$ ,  $V_p = 1200\text{ V}$

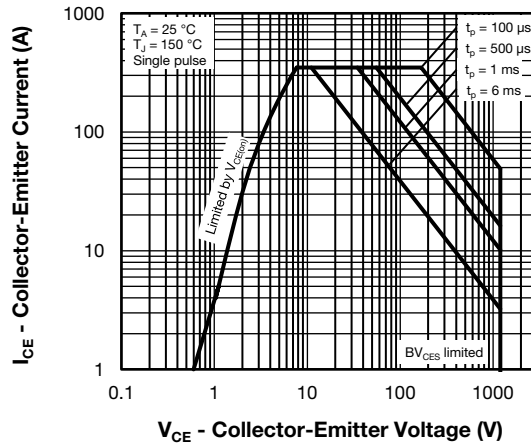


Fig. 13 - Trench IGBT Safe Operating Area

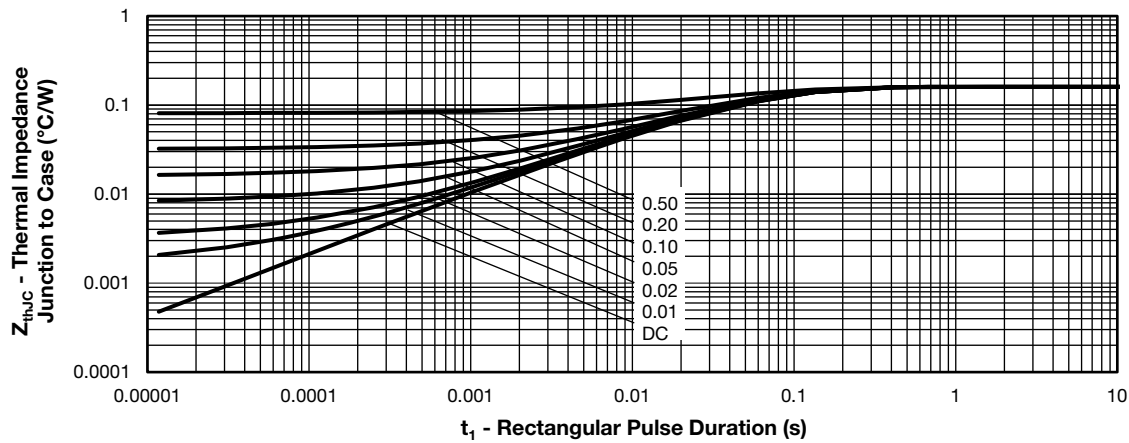
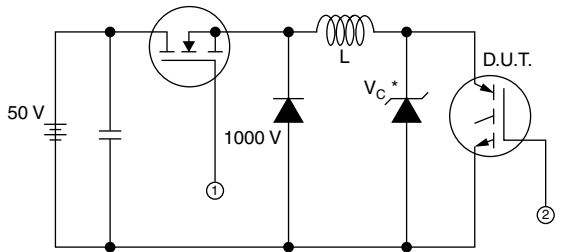


Fig. 14 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics



\* 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  $I_d$

Fig. 15 - Clamped Inductive Load Test Circuit

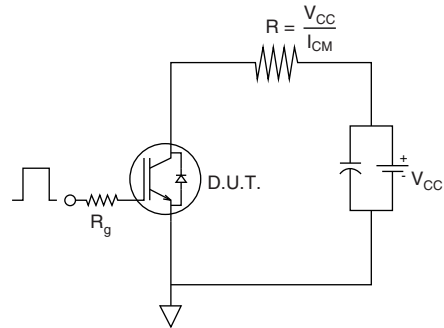


Fig. 16 - Pulsed Collector Current Test Circuit

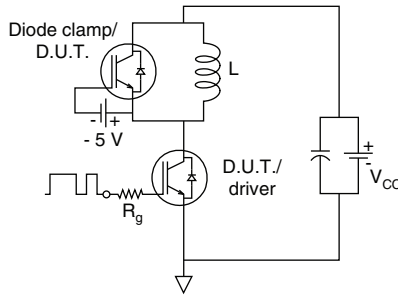


Fig. 17 - Switching Loss Test Circuit

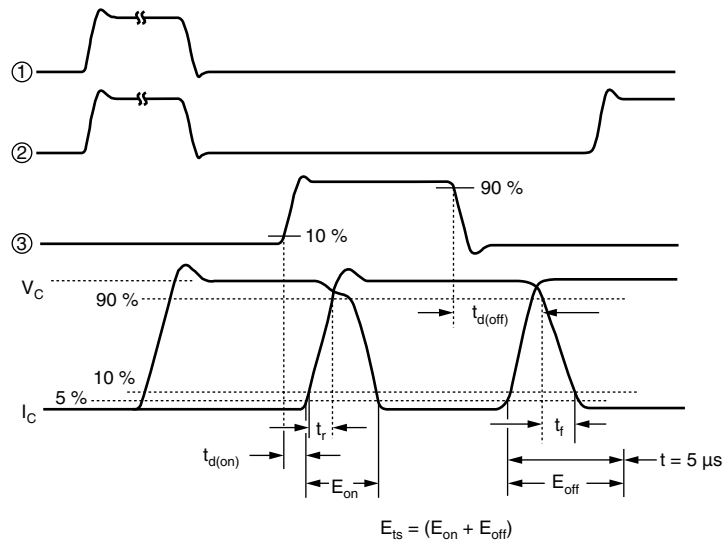
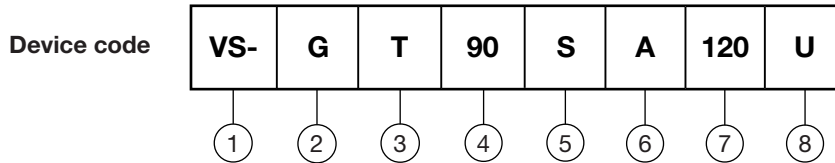


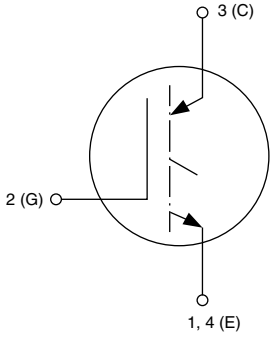
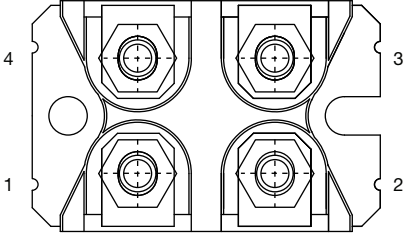
Fig. 18 - Switching Loss Waveforms Test Circuit



**ORDERING INFORMATION TABLE**



- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - T = Trench IGBT
- 4** - Current rating (90 = 90 A)
- 5** - Circuit configuration (S = single switch no diode)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (120 = 1200 V)
- 8** - Speed/type (U = ultrafast IGBT)

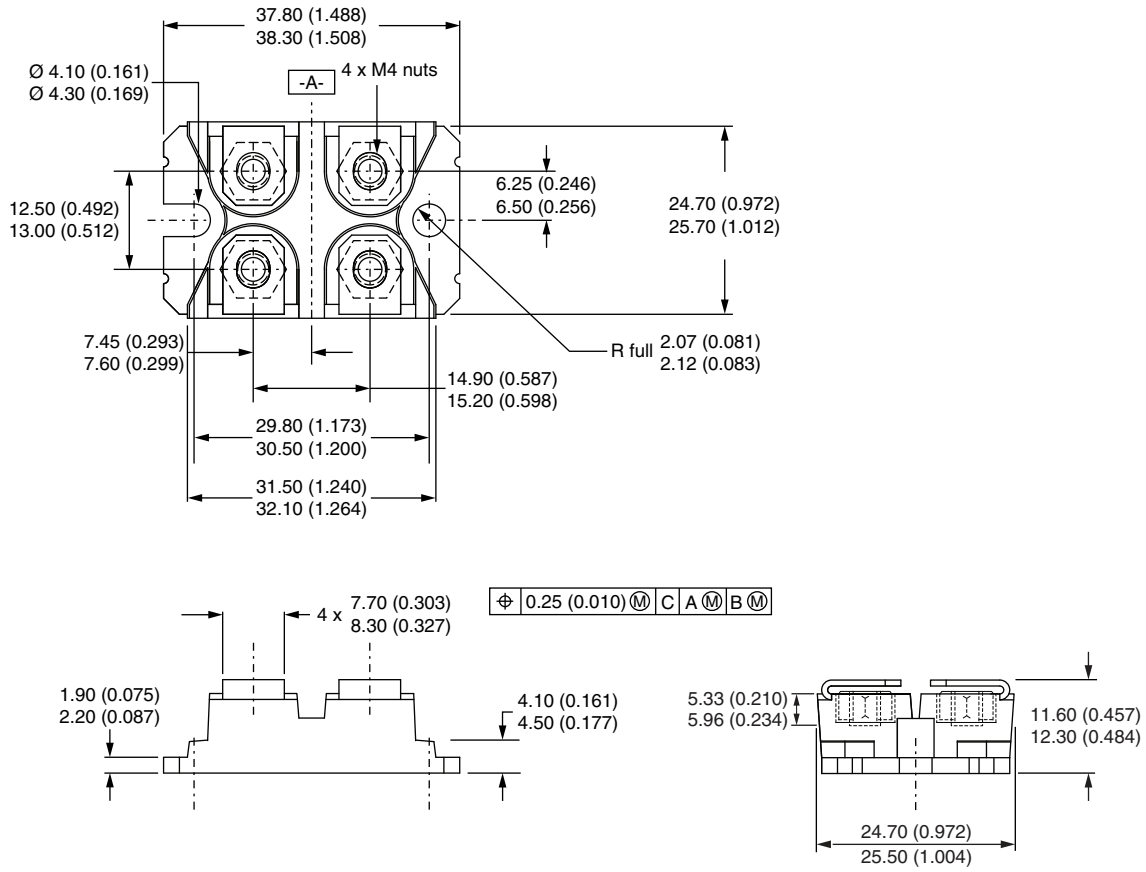
<b>CIRCUIT CONFIGURATION</b>		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch no diode	S	 <div style="display: inline-block; vertical-align: top; margin-left: 20px;"> <p>Lead Assignment</p>  </div>

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 2

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter



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