

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


**SOT-227**

PRIMARY CHARACTERISTICS	
$V_{CES}$	600 V
$V_{CE(on)}$ (typical) at 200 A, 25 °C	1.33 V
$I_C$ at $T_C = 90$ °C <sup>(1)</sup>	250 A
Speed	DC to 1 kHz
Package	SOT-227
Circuit configuration	Single switch no diode

**Note**

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

**FEATURES**

- Standard: optimized for minimum saturation voltage and low speed
- Lowest conduction losses available
- Fully isolated package (2500  $V_{AC}$ )
- 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**
**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	$I_C$ <sup>(1)</sup>	$T_C = 25$ °C	400	A
		$T_C = 90$ °C	250	
Pulsed collector current	$I_{CM}$	Repetitive rating; $V_{GE} = 20$ V, pulse width limited by maximum junction temperature	400	
Clamped Inductive load current	$I_{LM}$	$V_{CC} = 80$ % ( $V_{CES}$ ), $V_{GE} = 20$ V, $L = 10$ $\mu$ H, $R_g = 2.0$ $\Omega$	400	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Power dissipation	$P_D$	$T_C = 25$ °C	961	W
		$T_C = 90$ °C	462	
Isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ min	2500	V

**Note**

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

THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		-40	-	150	°C
Thermal resistance junction to case	$R_{thJC}$		-	-	0.13	°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				



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$	600	-	-	V
Emitter to collector breakdown voltage	$V_{(BR)ECS}^{(1)}$	$V_{GE} = 0\text{ V}, I_C = 1.0\text{ A}$	18	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$I_C = 100\text{ A}$	-	1.10	1.3	
		$I_C = 200\text{ A}$	-	1.33	1.66	
		$I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.02	-	
		$I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.32	-	
		$I_C = 100\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	1.02	-	
		$I_C = 200\text{ A}, T_J = 150\text{ }^\circ\text{C}$	-	1.33	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	3.0	4.5	6.0	
		$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}, T_J = 125\text{ }^\circ\text{C}$	-	3.1	-	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 1\text{ mA}, 25\text{ }^\circ\text{C to } 125\text{ }^\circ\text{C}$	-	-12	-	mV/°C
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	20	1000	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.2	-	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	0.6	10	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 250$	nA

**Note**

(1) Pulse width  $\leq 80\text{ }\mu\text{s}$ ; duty factor  $\leq 0.1\text{ }\%$

<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)	$Q_g$	$I_C = 100\text{ A}, V_{CC} = 600\text{ V}, V_{GE} = 15\text{ V}$	-	770	1200	nC		
Gate-to-emitter charge (turn-on)	$Q_{ge}$		-	100	150			
Gate-to-collector charge (turn-on)	$Q_{gc}$		-	260	380			
Turn-on switching loss	$E_{on}$	$T_J = 25\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	0.55	-	mJ		
Turn-off switching loss	$E_{off}$		-	25	-			
Total switching loss	$E_{tot}$		-	25.5	-			
Turn-on delay time	$t_{d(on)}$		$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	267	-	ns	
Rise time	$t_r$			-	42	-		
Turn-off delay time	$t_{d(off)}$			-	310	-		
Fall time	$t_f$			-	450	-		
Turn-on switching loss	$E_{on}$			-	0.67	-		mJ
Turn-off switching loss	$E_{off}$			-	43.0	-		
Total switching loss	$E_{tot}$			-	43.7	-		
Turn-on delay time	$t_{d(on)}$	$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\text{ }\Omega$ $L = 500\text{ }\mu\text{H}$	-	275	-	ns		
Rise time	$t_r$		-	50	-			
Turn-off delay time	$t_{d(off)}$		-	350	-			
Fall time	$t_f$		-	700	-			
Internal emitter inductance	$L_E$	Between lead and center of die contact	-	5.0	-	nH		
Input capacitance	$C_{ies}$	$V_{GE} = 0\text{ V}, V_{CC} = 30\text{ V}, f = 1.0\text{ MHz}$	-	16 250	-	pF		
Output capacitance	$C_{oes}$		-	1040	-			
Reverse transfer capacitance	$C_{res}$		-	190	-			

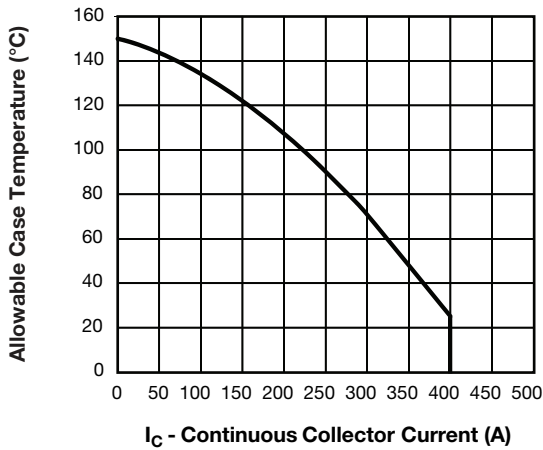


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

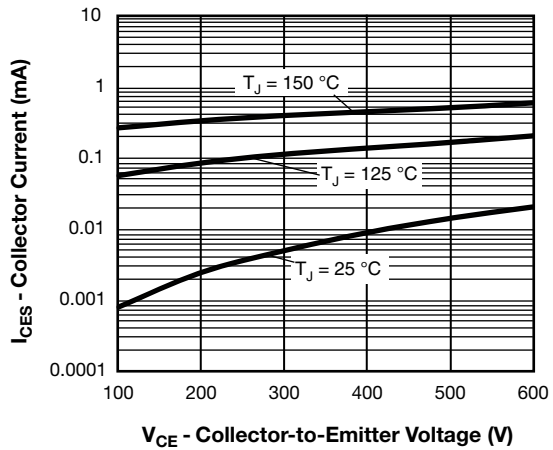


Fig. 4 - Typical IGBT Zero Gate Voltage Collector Current

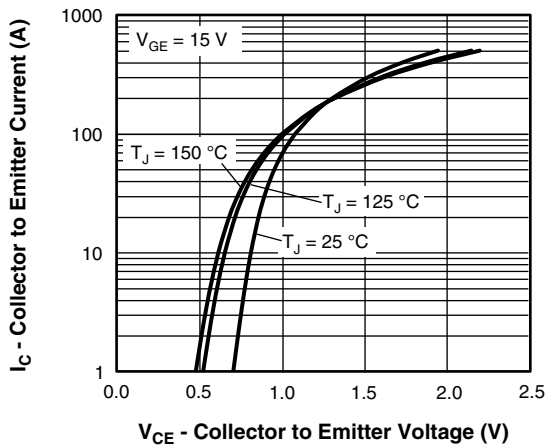


Fig. 2 - Typical Collector to Emitter Current Output Characteristics

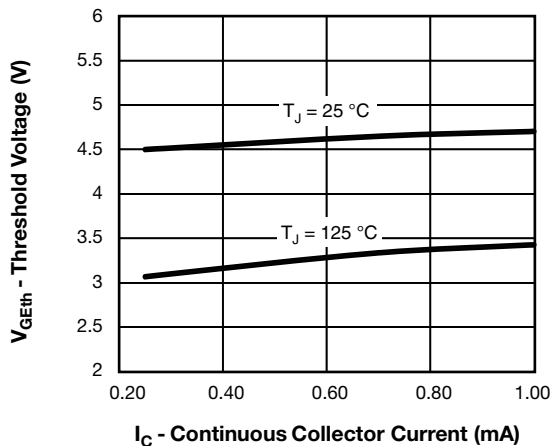


Fig. 5 - Typical IGBT Threshold Voltage

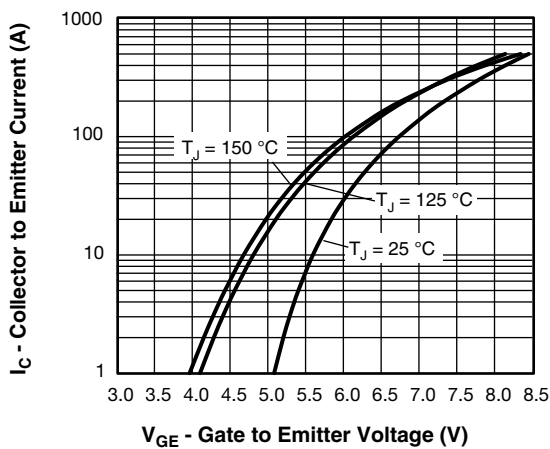


Fig. 3 - Typical IGBT Transfer Characteristics

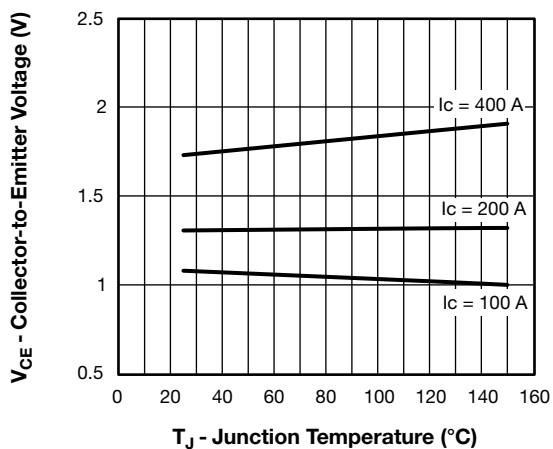


Fig. 6 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature,  $V_{GE} = 15\text{ V}$

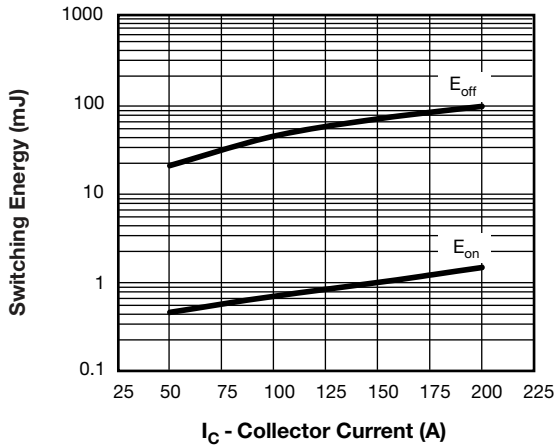


Fig. 7 - Typical IGBT Energy Losses vs.  $I_C$ ,  $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$ ,  $R_g = 5\ \Omega$ , Diode used: 60APH06

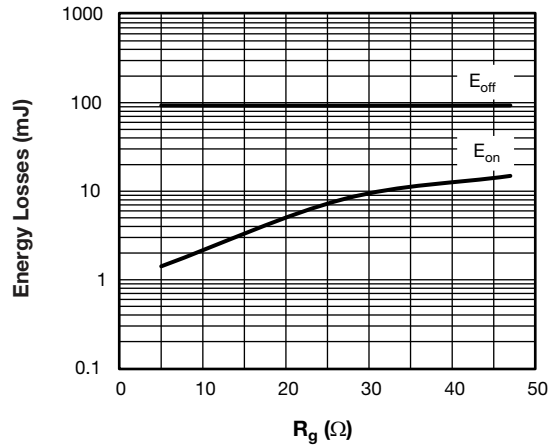


Fig. 9 - Typical IGBT Energy Losses vs.  $R_g$ ,  $T_J = 125^\circ\text{C}$ ,  $I_C = 200\text{ A}$ ,  $V_{CC} = 480\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$ , Diode used: 60APH06

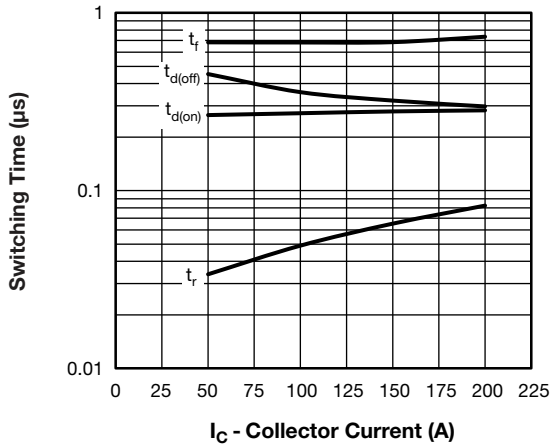


Fig. 8 - Typical IGBT Switching Time vs.  $I_C$ ,  $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 480\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$ ,  $R_g = 5\ \Omega$ , Diode used: 60APH06

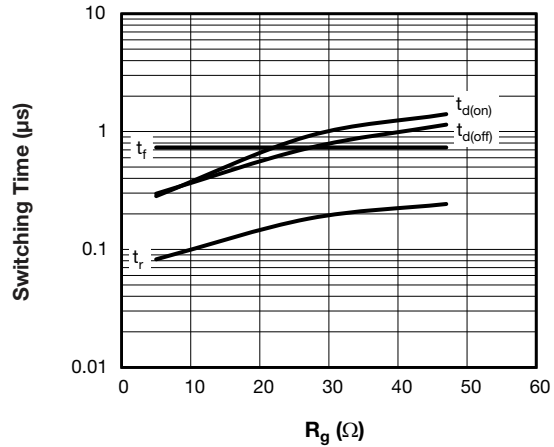


Fig. 10 - Typical IGBT Switching Time vs.  $R_g$ ,  $T_J = 125^\circ\text{C}$ ,  $I_C = 200\text{ A}$ ,  $V_{CC} = 480\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$ , Diode used: 60APH06

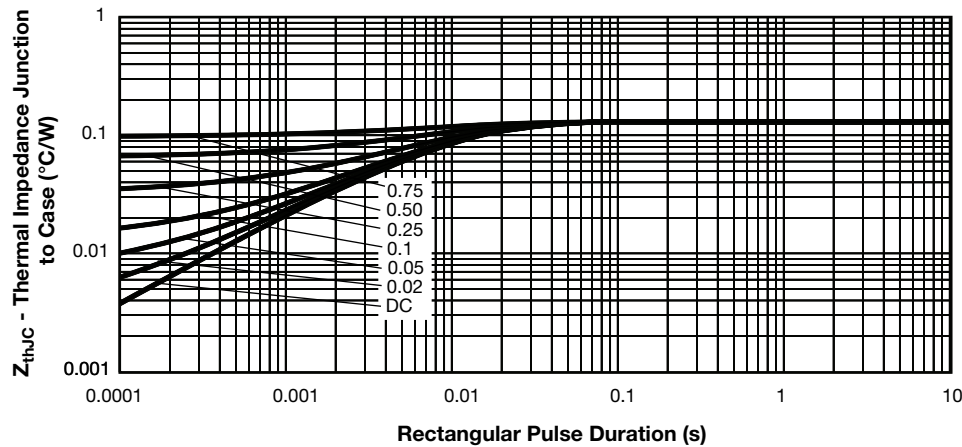


Fig. 11 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics

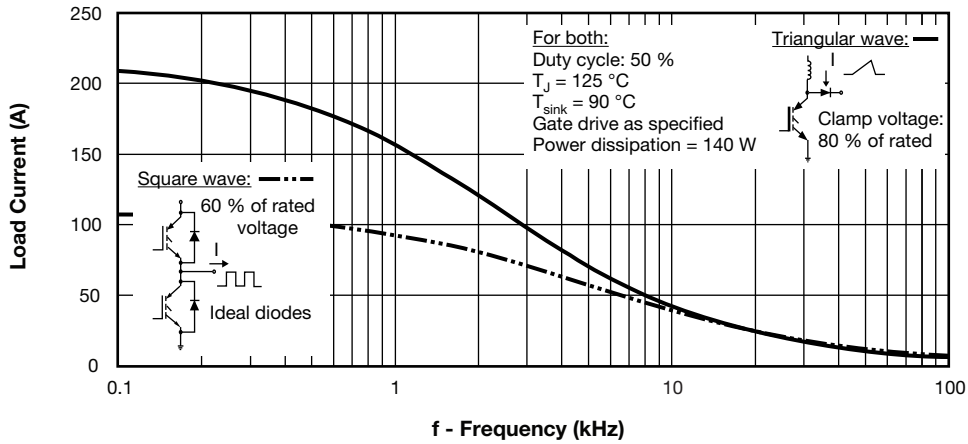


Fig. 12 - Typical Load Current vs. Frequency (Load Current =  $I_{RMS}$  of Fundamental)

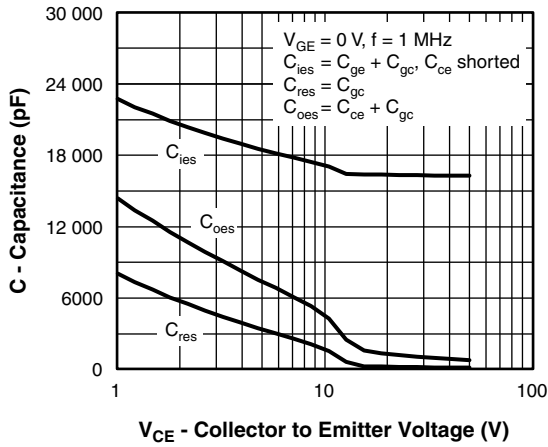


Fig. 13 - Typical Capacitance vs. Collector to Emitter Voltage

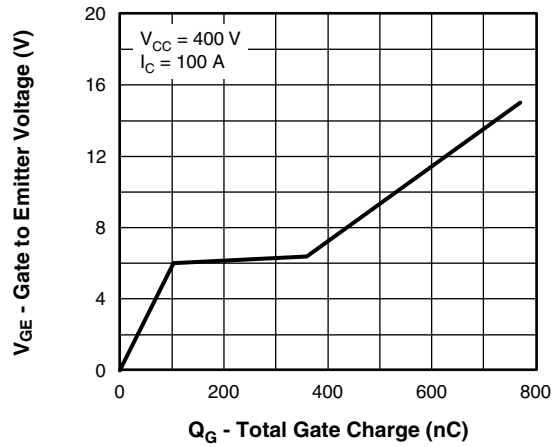


Fig. 14 - Typical Gate Charge vs. Gate to Emitter Voltage

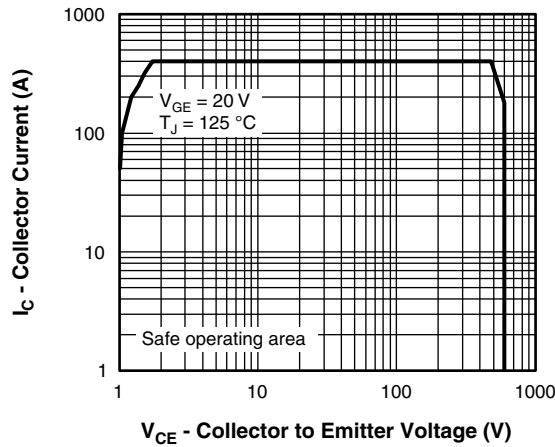
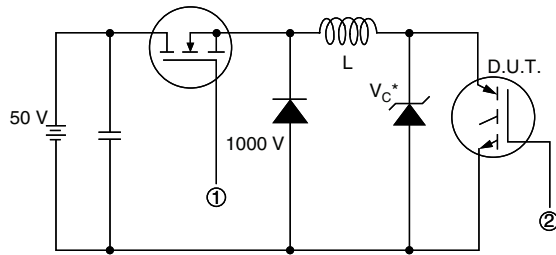


Fig. 15 - Turn-Off SOA



\* 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. 16a - Clamped Inductive Load Test Circuit

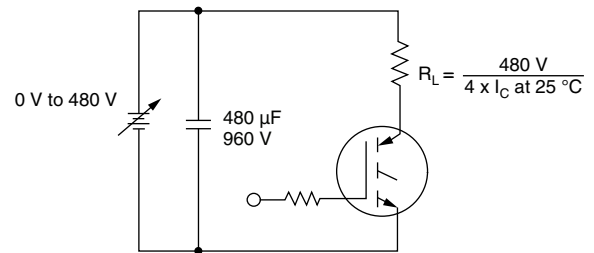
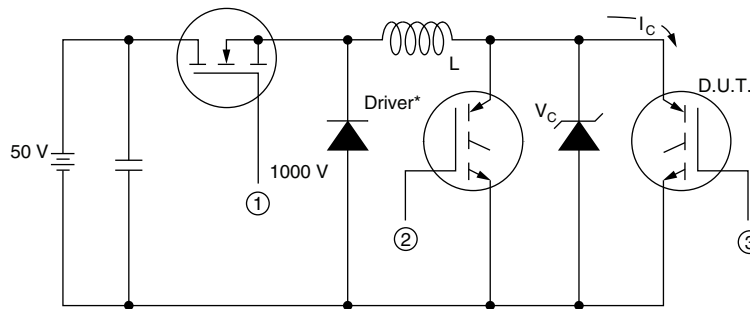


Fig. 16b - Pulsed Collector Current Test Circuit



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

Fig. 17a - Switching Lost Test Circuit

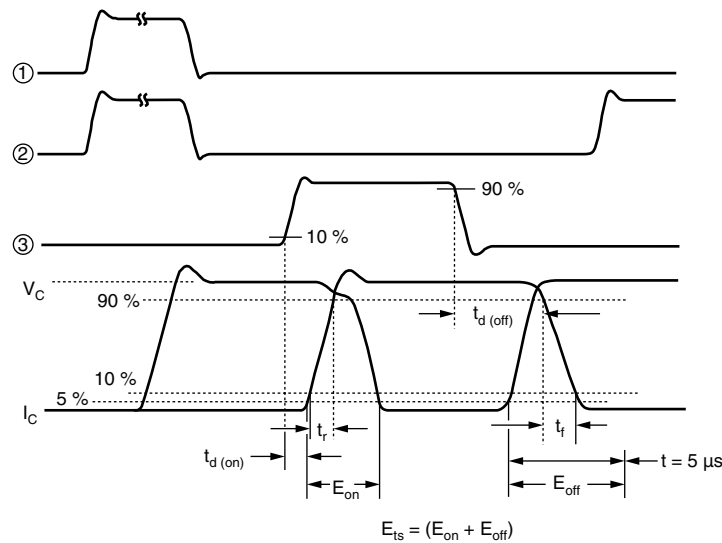


Fig. 17b - Switching Loss Waveforms



**ORDERING INFORMATION TABLE**

Device code	<b>VS-</b>	<b>G</b>	<b>A</b>	<b>250</b>	<b>S</b>	<b>A</b>	<b>60</b>	<b>S</b>
	①	②	③	④	⑤	⑥	⑦	⑧

- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - Gen 4, 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)

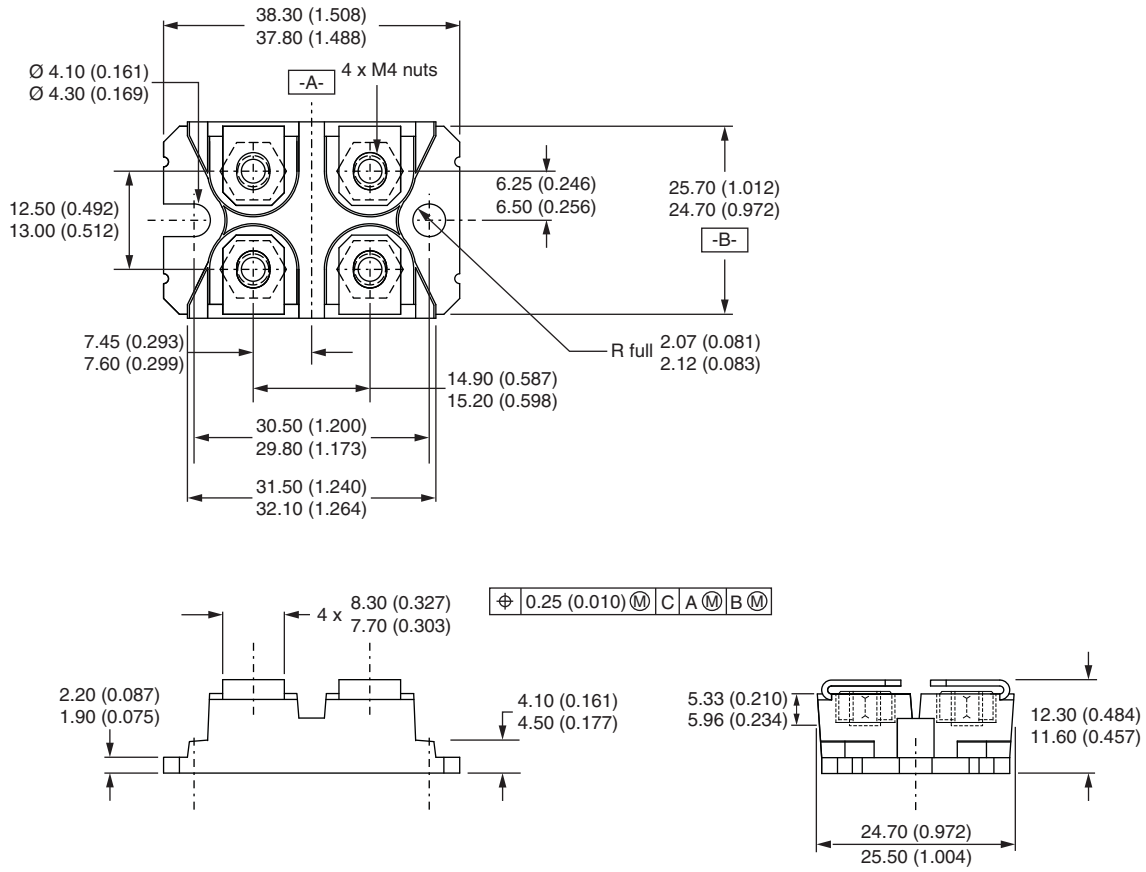
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch, no diode	S	 

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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