

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_{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


**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	A
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



SWITCHING CHARACTERISTICS ($T_J = 25\text{ }^\circ\text{C}$ 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}	$T_J = 25\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\ \Omega$ $L = 500\ \mu\text{H}$	-	1.61	-	mJ	
Turn-off switching loss	E_{off}		-	6.65	-		
Total switching loss	E_{tot}		-	8.26	-		
Turn-on delay time	$t_{d(on)}$		-	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}		$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\ \Omega$ $L = 500\ \mu\text{H}$	-	2.03	-	mJ
Turn-off switching loss	E_{off}	-		9.65	-		
Total switching loss	E_{tot}	-		11.68	-		
Turn-on delay time	$t_{d(on)}$	$T_J = 125\text{ }^\circ\text{C}$ $I_C = 100\text{ A}$ $V_{CC} = 480\text{ V}$ $V_{GE} = 15\text{ V}$ $R_g = 5.0\ \Omega$ $L = 500\ \mu\text{H}$		-	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	$T_J = 175\text{ }^\circ\text{C}, I_C = 250\text{ A}, R_g = 5.0\ \Omega,$ $V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 400\text{ V},$ $V_p = 600\text{ V}$	Fullsquare				

THERMAL AND MECHANICAL SPECIFICATIONS						
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				

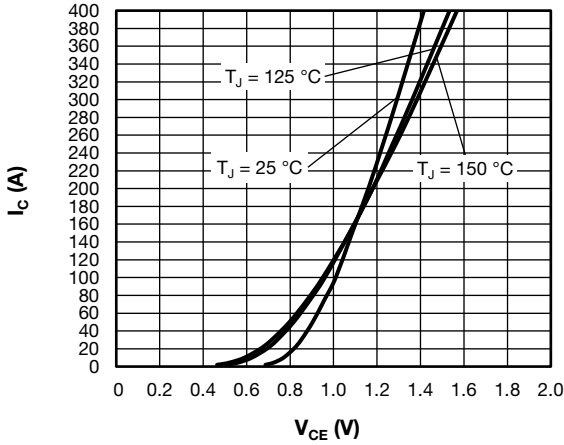


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

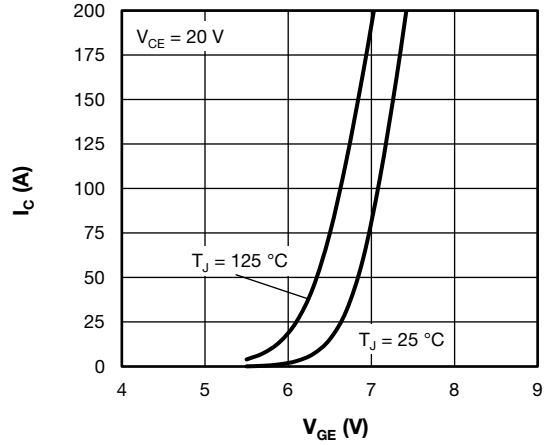


Fig. 4 - Typical Trench IGBT Transfer Characteristics

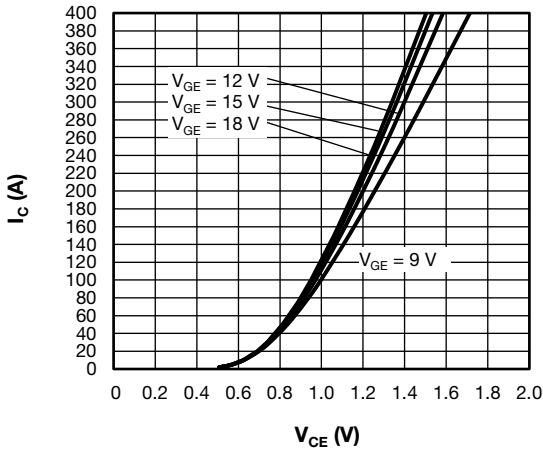


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ °C}$

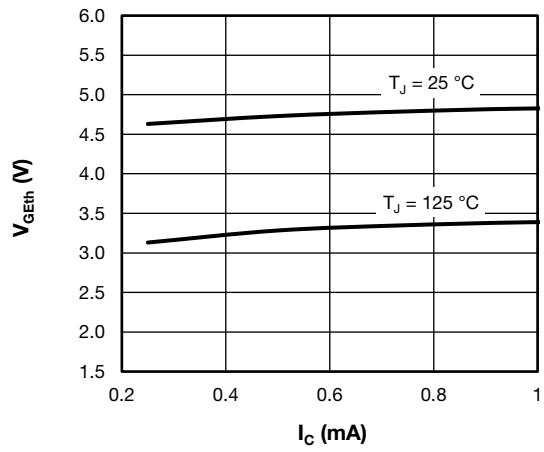


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

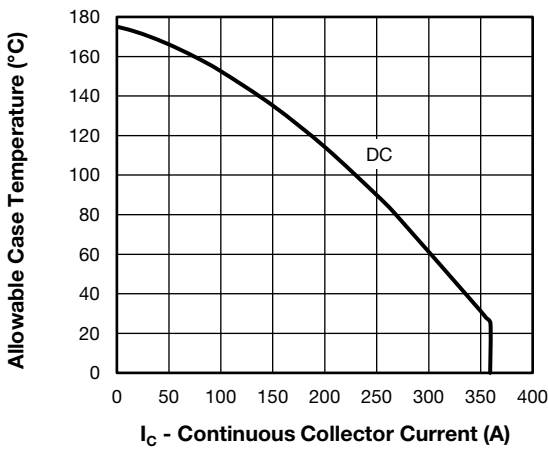


Fig. 3 - Typical Trench IGBT Continuous Collector Current vs. Case Temperature

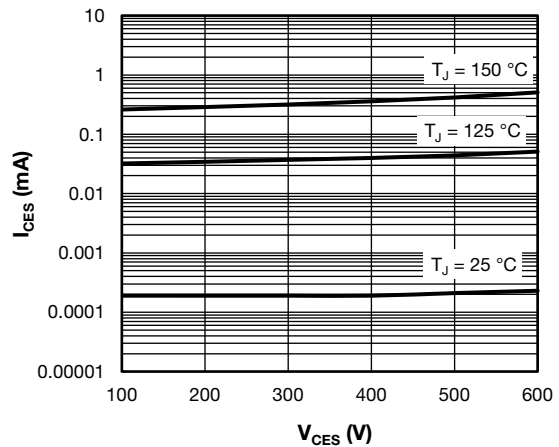


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

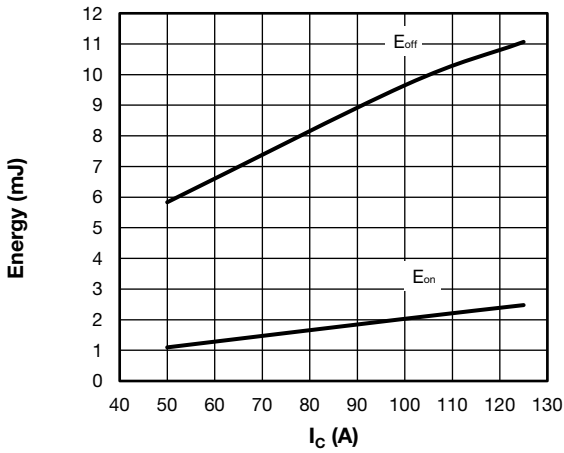


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $R_g = 5\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

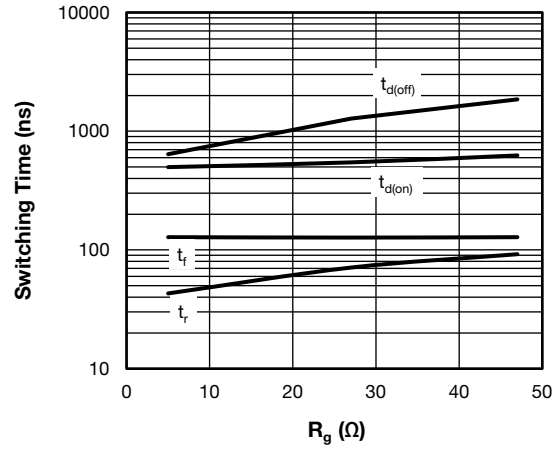


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
 $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

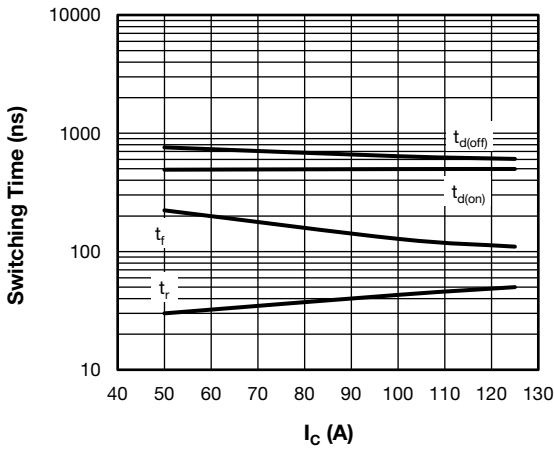


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $R_g = 5\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

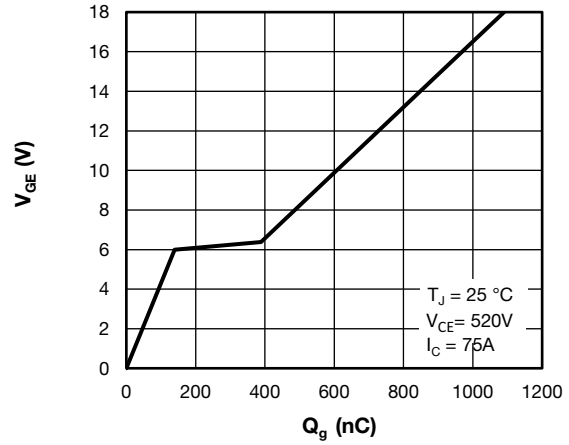


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage
 $T_J = 25^\circ\text{C}$
 $V_{CE} = 520\text{ V}$
 $I_C = 75\text{ A}$

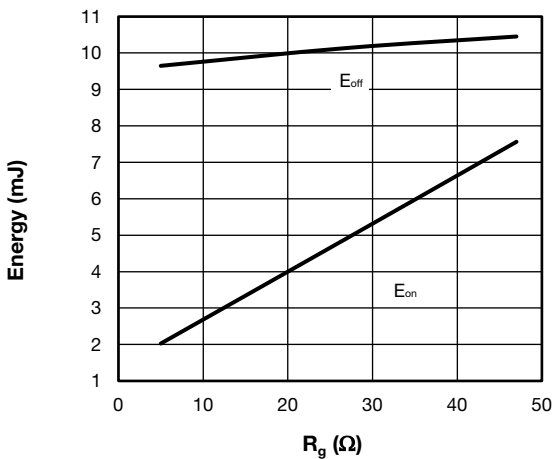


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
 $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

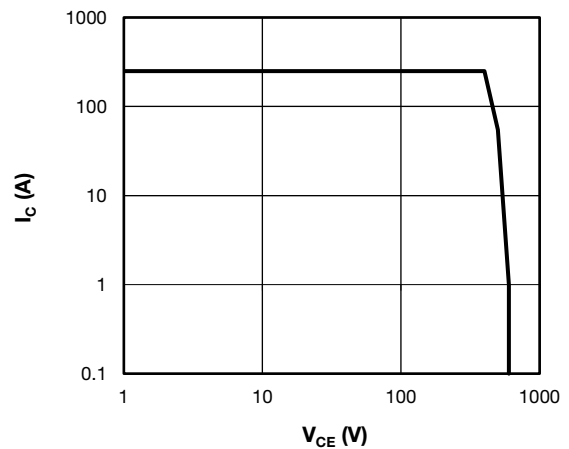


Fig. 12 - Typical Trench IGBT Reverse BIAS SOA
 $T_J = 175^\circ\text{C}$, $I_C = 250\text{ A}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V}/0\text{ V}$,
 $V_{CC} = 400\text{ V}$, $V_p = 600\text{ V}$

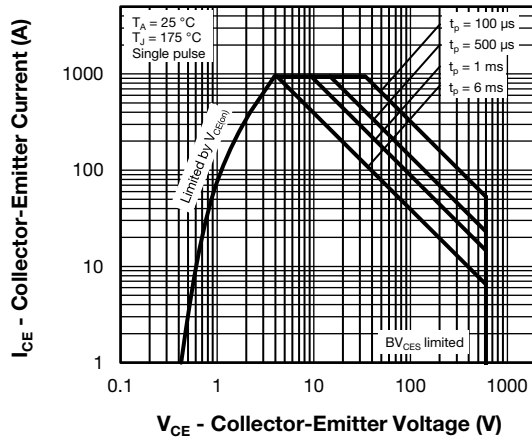


Fig. 13 - Typical Trench IGBT Safe Operating Area

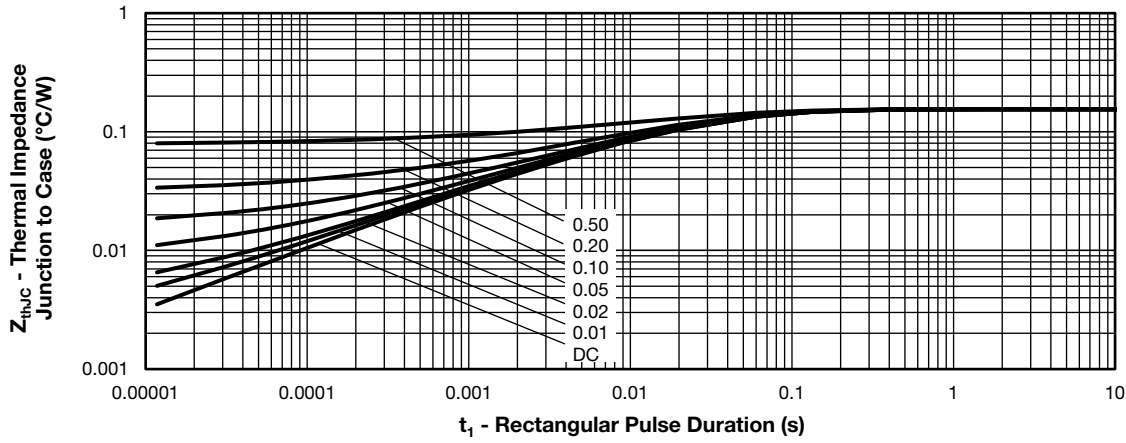
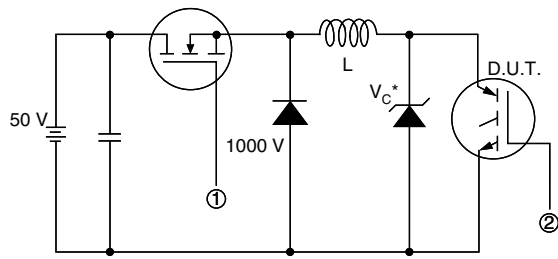


Fig. 14 - Maximum Thermal Impedance Z_{thJC} Characteristics



* Driver same type as D.U.T.; $V_C = 80\%$ of $V_{CE}(\text{max})$

Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain rated I_d

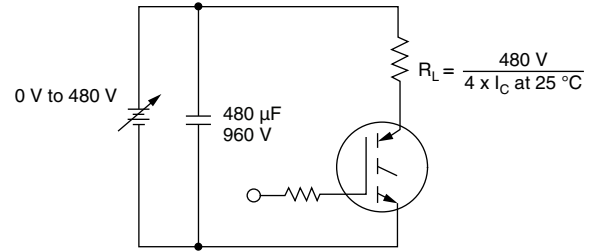
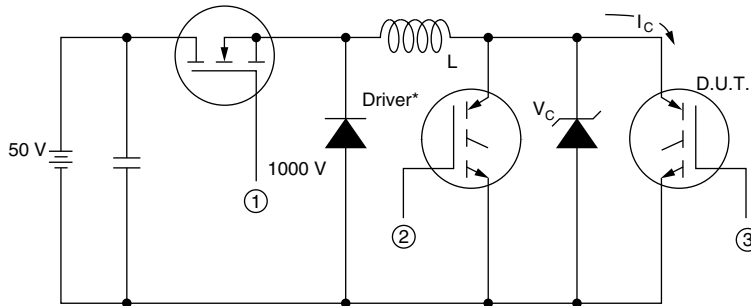


Fig. 15 - Clamped Inductive Load Test Circuit

Fig. 16 - Pulsed Collector Current Test Circuit



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

Fig. 17 - Switching Lost Test Circuit

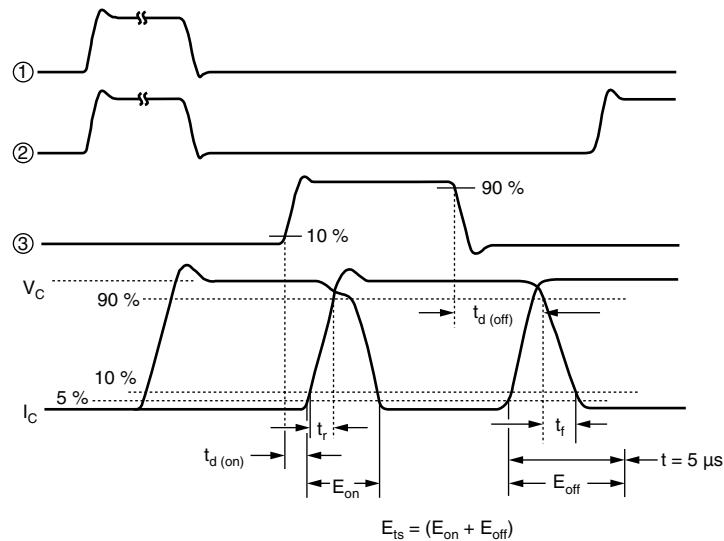


Fig. 18 - Switching Loss Waveforms

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)

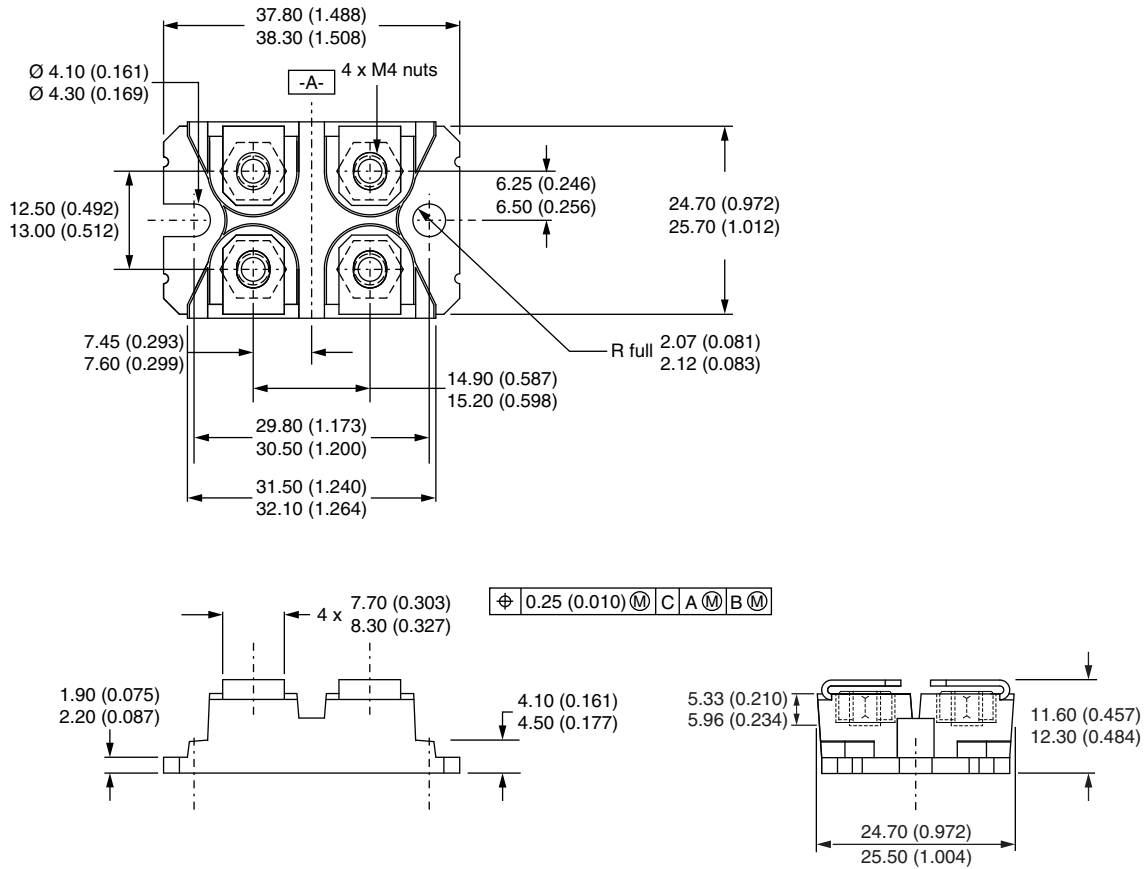
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch, no diode	S	

LINKS TO RELATED DOCUMENTS	
Dimensions	www.vishay.com/doc?95423
Packaging information	www.vishay.com/doc?95425



SOT-227 Generation 2

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter



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