

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	250 A
Speed	DC to 1 kHz
Package	SOT-227
Circuit configuration	Single switch no diode

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

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	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, $L = 10$ μ H, $R_g = 2.0$ Ω	400	
Gate to emitter voltage	V_{GE}		± 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

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				



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 = 1 mA		600	-	-	V
Emitter to collector breakdown voltage	V _{(BR)ECS} ⁽¹⁾	V _{GE} = 0 V, I _C = 1.0 A		18	-	-	
Collector to emitter voltage	V _{CE(on)}	I _C = 100 A	V _{GE} = 15 V	-	1.10	1.3	
		I _C = 200 A		-	1.33	1.66	
		I _C = 100 A, T _J = 125 °C		-	1.02	-	
		I _C = 200 A, T _J = 125 °C		-	1.32	-	
		I _C = 100 A, T _J = 150 °C		-	1.02	-	
		I _C = 200 A, T _J = 150 °C		-	1.33	-	
Gate threshold voltage	V _{GE(th)}	V _{CE} = V _{GE} , I _C = 250 μA		3.0	4.5	6.0	
		V _{CE} = V _{GE} , I _C = 250 μA, T _J = 125 °C		-	3.1	-	
Temperature coefficient of threshold voltage	ΔV _{GE(th)} /ΔT _J	V _{CE} = V _{GE} , I _C = 1 mA, 25 °C to 125 °C		-	-12	-	mV/°C
Collector to emitter leakage current	I _{CES}	V _{GE} = 0 V, V _{CE} = 600 V		-	20	1000	μA
		V _{GE} = 0 V, V _{CE} = 600 V, T _J = 125 °C		-	0.2	-	mA
		V _{GE} = 0 V, V _{CE} = 600 V, T _J = 150 °C		-	0.6	10	
Gate to emitter leakage current	I _{GES}	V _{GE} = ± 20 V		-	-	± 250	nA

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

SWITCHING CHARACTERISTICS (T _J = 25 °C unless otherwise specified)								
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNITS	
Total gate charge (turn-on)	Q _g	I _C = 100 A, V _{CC} = 600 V, V _{GE} = 15 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 °C I _C = 100 A V _{CC} = 480 V V _{GE} = 15 V R _g = 5.0 Ω L = 500 μH	Energy losses include tail and diode recovery. Diode used 60APH06	-	0.55	-	mJ	
Turn-off switching loss	E _{off}			-	25	-		
Total switching loss	E _{tot}			-	25.5	-		
Turn-on delay time	t _{d(on)}			-	267	-	ns	
Rise time	t _r			-	42	-		
Turn-off delay time	t _{d(off)}			-	310	-		
Fall time	t _f	-		450	-	mJ		
Turn-on switching loss	E _{on}	-		0.67	-			
Turn-off switching loss	E _{off}	-		43.0	-			
Total switching loss	E _{tot}	-		43.7	-	ns		
Turn-on delay time	t _{d(on)}	-		275	-			
Rise time	t _r	-		50	-			
Turn-off delay time	t _{d(off)}	-		350	-			
Fall time	t _f	-		700	-	nH		
Internal emitter inductance	L _E	Between lead and center of die contact			-	5.0	-	
Input capacitance	C _{ies}	V _{GE} = 0 V, V _{CC} = 30 V, f = 1.0 MHz		-	16 250	-	pF	
Output capacitance	C _{oes}			-	1040	-		
Reverse transfer capacitance	C _{res}			-	190	-		

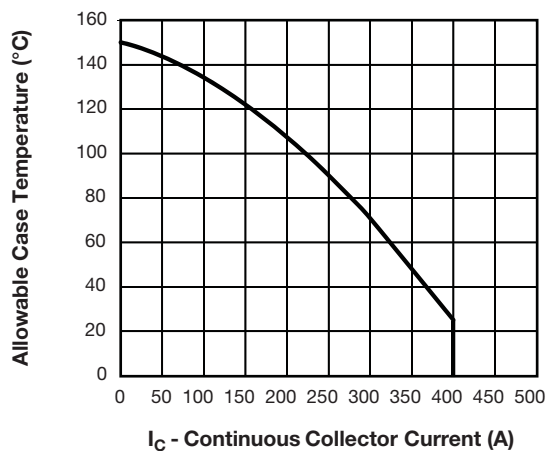


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

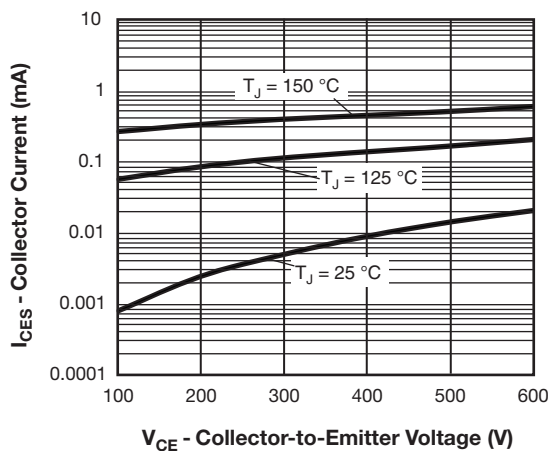


Fig. 4 - Typical IGBT Zero Gate Voltage Collector Current

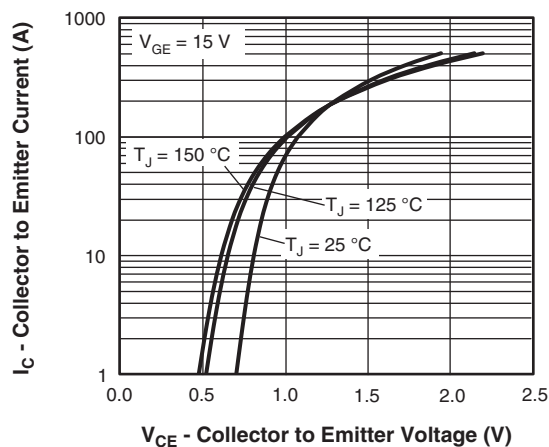


Fig. 2 - Typical Collector to Emitter Current Output Characteristics

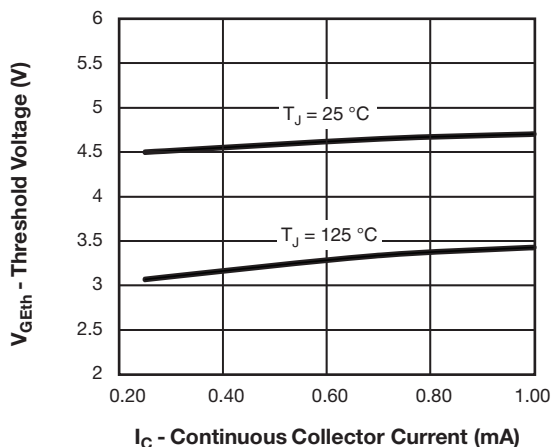


Fig. 5 - Typical IGBT Threshold Voltage

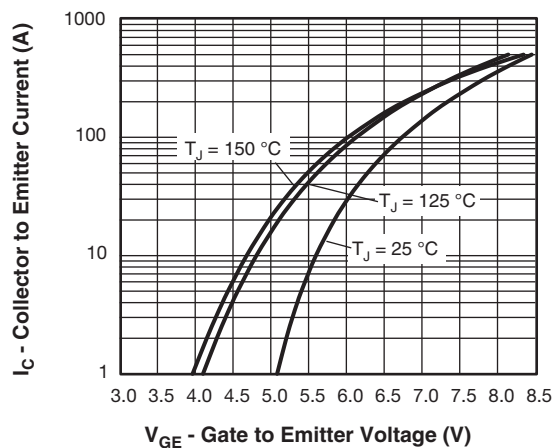
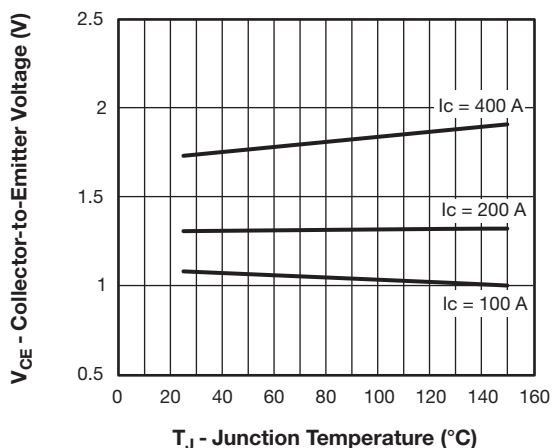


Fig. 3 - Typical IGBT Transfer Characteristics


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

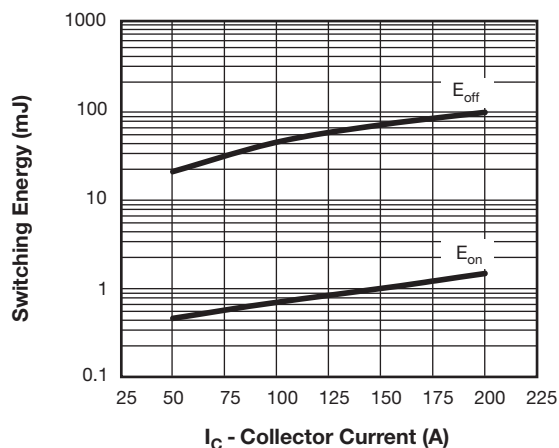


Fig. 7 - Typical IGBT Energy Losses vs. I_C , $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 5\text{ }\Omega$, Diode used: 60APH06

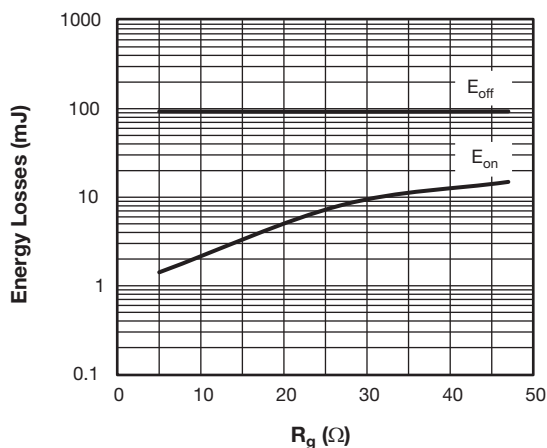


Fig. 9 - Typical IGBT Energy Losses vs. R_g , $T_J = 125^\circ\text{C}$, $I_C = 200\text{ A}$, $V_{CC} = 480\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, Diode used: 60APH06

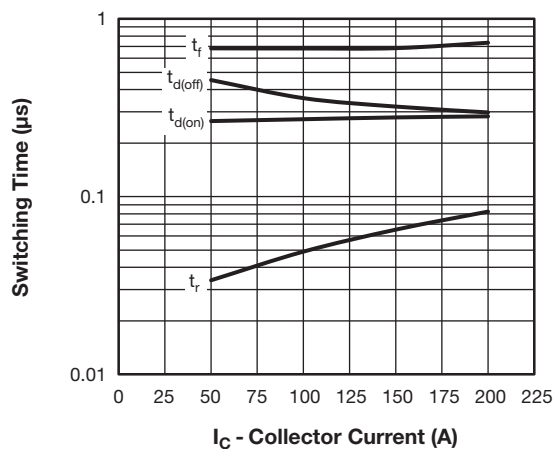


Fig. 8 - Typical IGBT Switching Time vs. I_C , $T_J = 125^\circ\text{C}$, $V_{CC} = 480\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, $R_g = 5\text{ }\Omega$, Diode used: 60APH06

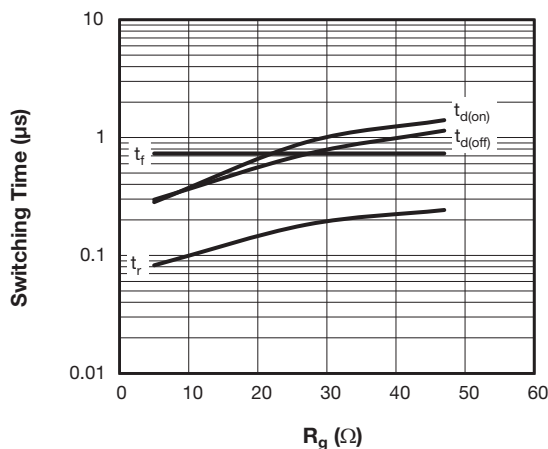


Fig. 10 - Typical IGBT Switching Time vs. R_g , $T_J = 125^\circ\text{C}$, $I_C = 200\text{ A}$, $V_{CC} = 480\text{ V}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$, Diode used: 60APH06

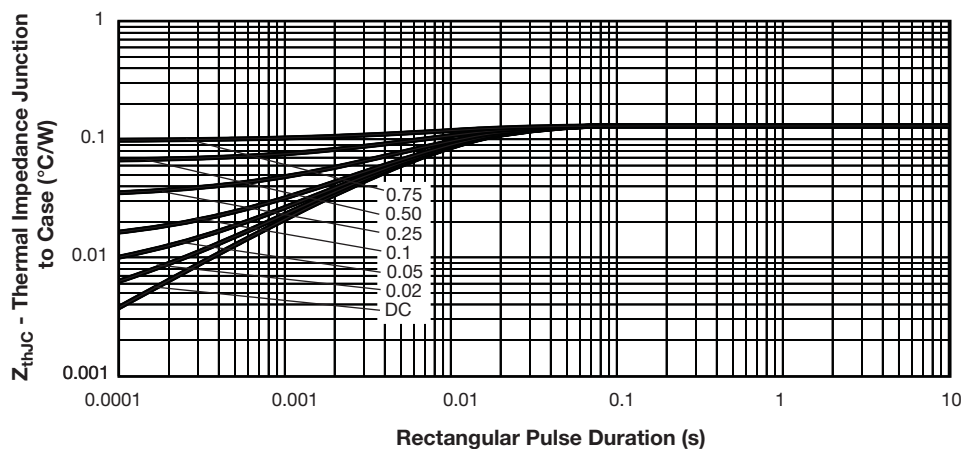


Fig. 11 - Maximum Thermal Impedance Z_{thJC} Characteristics

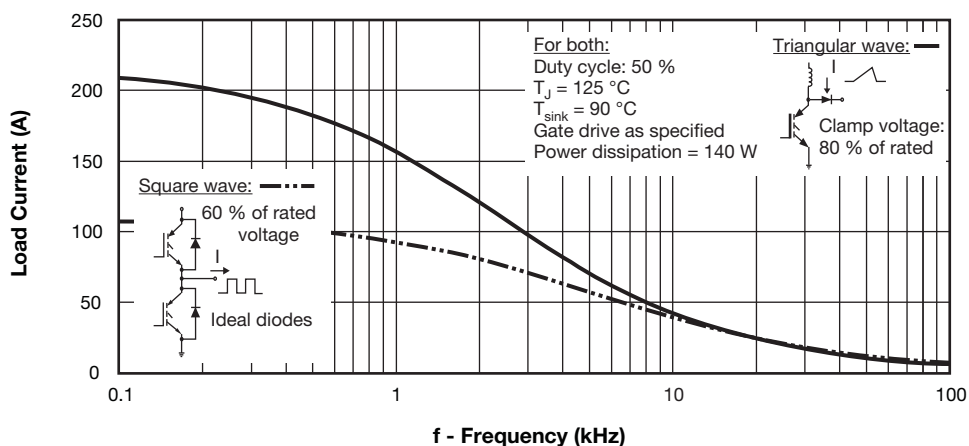


Fig. 12 - Typical Load Current vs. Frequency (Load Current = I_{RMS} of Fundamental)

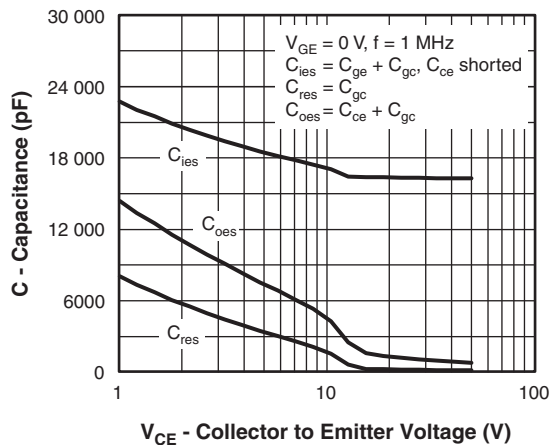


Fig. 13 - Typical Capacitance vs. Collector to Emitter Voltage

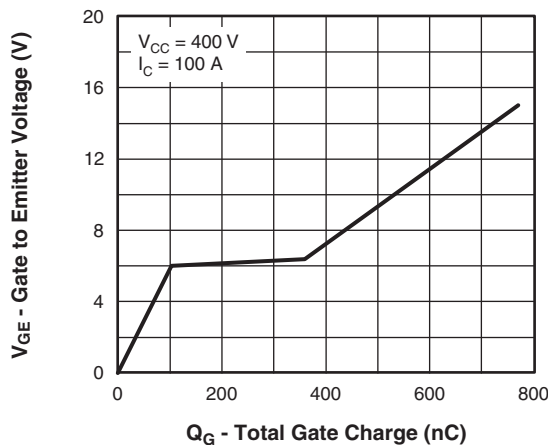


Fig. 14 - Typical Gate Charge vs. Gate to Emitter Voltage

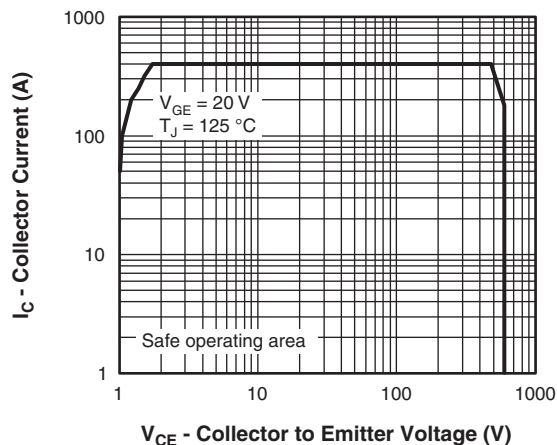
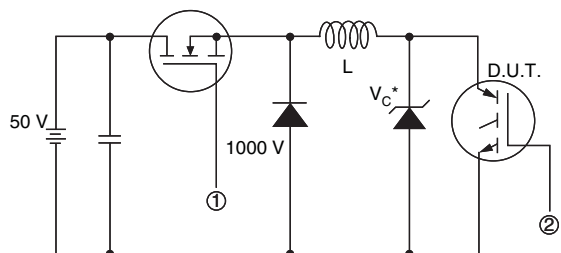


Fig. 15 - Turn-Off SOA



* 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

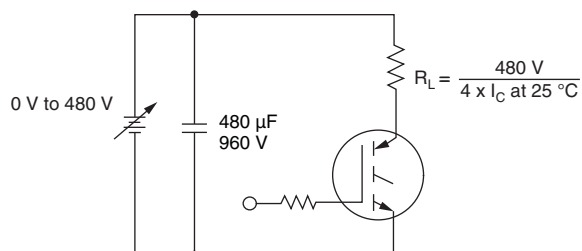
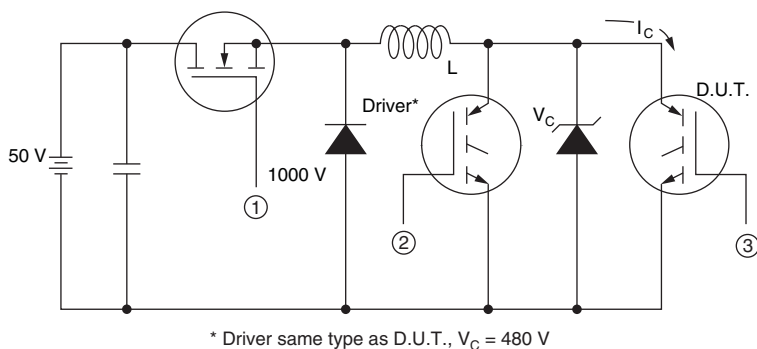


Fig. 16a - Clamped Inductive Load Test Circuit

Fig. 16b - Pulsed Collector Current Test Circuit



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

Fig. 17a - Switching Lost Test Circuit

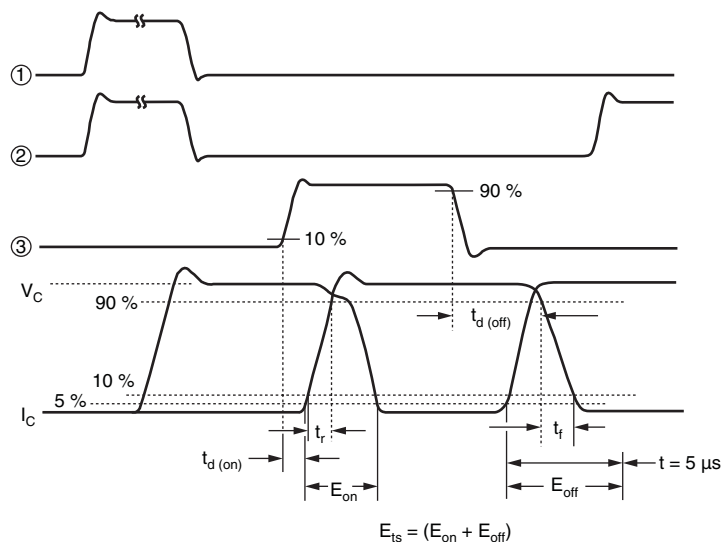


Fig. 17b - Switching Loss Waveforms



ORDERING INFORMATION TABLE

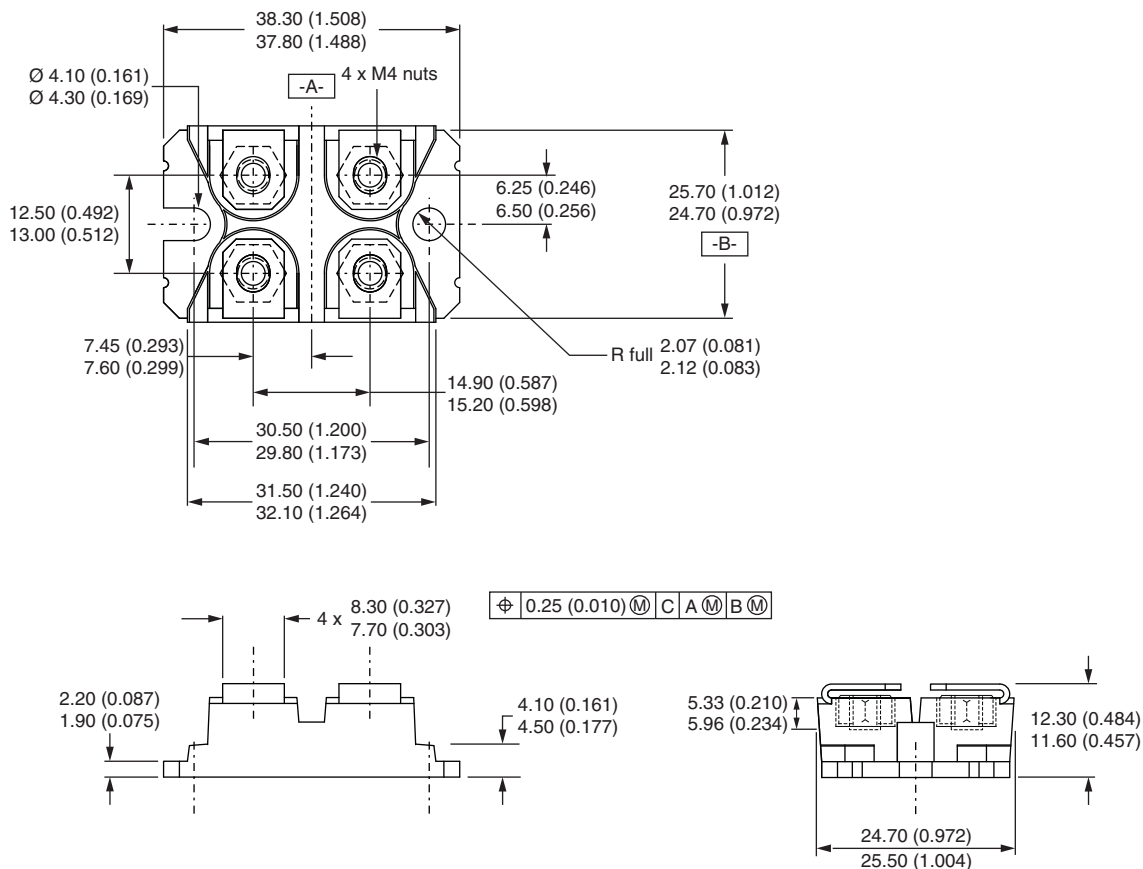
Device code	VS-	G	A	250	S	A	60	S
	1	2	3	4	5	6	7	8
1	Vishay Semiconductors product							
2	Insulated gate bipolar transistor (IGBT)							
3	Gen 4, IGBT silicon							
4	Current rating (250 = 250 A)							
5	Circuit configuration (S = single switch no diode)							
6	Package indicator (A = SOT-227)							
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	 Lead Assignment

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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