

## "Low Side Chopper" IGBT SOT-227 (Warp 2 Speed IGBT), 70 A



SOT-227

### FEATURES

- NPT warp 2 speed IGBT technology with positive temperature coefficient
- Square RBSOA
- Low  $V_{CE(on)}$
- FRED Pt<sup>®</sup> hyperfast rectifier
- Fully isolated package
- Very low internal inductance ( $\leq 5$  nH typical)
- Industry standard outline
- UL approved file E78996
- Compliant to RoHS Directive 2002/95/EC


**RoHS**  
COMPLIANT

PRODUCT SUMMARY	
$V_{CES}$	600 V
$I_C$ DC	70 A at 88 °C
$V_{CE(on)}$ typical at 70 A, 25 °C	2.23 V
$I_F$ DC	70 A at 86 °C

### BENEFITS

- Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
- Easy to assemble and parallel
- Direct mounting to heatsink
- Plug-in compatible with other SOT-227 packages
- Higher switching frequency up to 150 kHz
- Lower conduction losses and switching losses
- Low EMI, requires less snubbing

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		600	V
Continuous collector current	$I_C$	$T_C = 25\text{ °C}$	111	A
		$T_C = 80\text{ °C}$	76	
Pulsed collector current	$I_{CM}$		120	
Clamped inductive load current	$I_{LM}$		120	
Diode continuous forward current	$I_F$	$T_C = 25\text{ °C}$	113	
		$T_C = 80\text{ °C}$	75	
Peak diode forward current	$I_{FM}$		200	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Power dissipation, IGBT	$P_D$	$T_C = 25\text{ °C}$	447	W
		$T_C = 80\text{ °C}$	250	
Power dissipation, diode	$P_D$	$T_C = 25\text{ °C}$	236	
		$T_C = 80\text{ °C}$	132	
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1$ min	2500	V



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
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	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 35\text{ A}$	-	1.69	1.88	V
		$V_{GE} = 15\text{ V}, I_C = 70\text{ A}$	-	2.23	2.44	
		$V_{GE} = 15\text{ V}, I_C = 35\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.07	2.31	
		$V_{GE} = 15\text{ V}, I_C = 70\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.89	3.21	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 500\text{ }\mu\text{A}$	3	3.9	5	
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 $125\text{ }^\circ\text{C}$ )	-	- 9	-	mV/ $^\circ\text{C}$
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	1	100	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.07	2.0	mA
Diode reverse breakdown voltage	$V_{BR}$	$I_R = 1\text{ mA}$	600	-	-	V
Diode forward voltage drop	$V_{FM}$	$I_C = 35\text{ A}, V_{GE} = 0\text{ V}$	-	1.8	2.33	V
		$I_C = 70\text{ A}, V_{GE} = 0\text{ V}$	-	2.13	2.71	
		$I_C = 35\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.35	1.81	
		$I_C = 70\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.7	2.32	
Diode reverse leakage current	$I_{RM}$	$V_R = V_R$ rated	-	0.1	50	$\mu\text{A}$
		$T_J = 125\text{ }^\circ\text{C}, V_R = V_R$ rated	-	0.01	3	mA
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	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)	$Q_g$	$I_C = 50\text{ A}, V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V}$	-	320	-	nC	
Gate to emitter charge (turn-on)	$Q_{ge}$		-	42	-		
Gate to collector charge (turn-on)	$Q_{gc}$		-	110	-		
Turn-on switching loss	$E_{on}$	$I_C = 70\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$  Energy losses include tail and diode recovery (see fig. 18)	-	1.15	-	mJ	
Turn-off switching loss	$E_{off}$		-	1.16	-		
Total switching loss	$E_{tot}$		-	2.31	-		
Turn-on switching loss	$E_{on}$		-	1.27	-		
Turn-off switching loss	$E_{off}$		-	1.28	-		
Total switching loss	$E_{tot}$		-	2.55	-		
Turn-on delay time	$t_{d(on)}$		$I_C = 70\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	208	-	ns
Rise time	$t_r$			-	69	-	
Turn-off delay time	$t_{d(off)}$			-	208	-	
Fall time	$t_f$			-	100	-	
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 120\text{ A}, R_g = 22\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, V_{CC} = 400\text{ V}, V_P = 600\text{ V}$	Fullsquare				
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}$	-	59	93	ns	
Diode peak reverse current	$I_{rr}$		-	4	6	A	
Diode recovery charge	$Q_{rr}$		-	118	279	nC	
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 200\text{ A}/\mu\text{s}, V_R = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	130	159	ns	
Diode peak reverse current	$I_{rr}$		-	11	13	A	
Diode recovery charge	$Q_{rr}$		-	715	995	nC	



THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Maximum junction and storage temperature range	$T_J, T_{Stg}$	- 40	-	150	°C
Thermal resistance, junction to case	IGBT Diode $R_{thJC}$	-	-	0.28	°C/W
		-	-	0.53	
Thermal resistance, case to sink per module	$R_{thCS}$	-	0.05	-	
Mounting torque, 6-32 or M3 screw		-	-	1.3	Nm
Weight		-	30	-	g

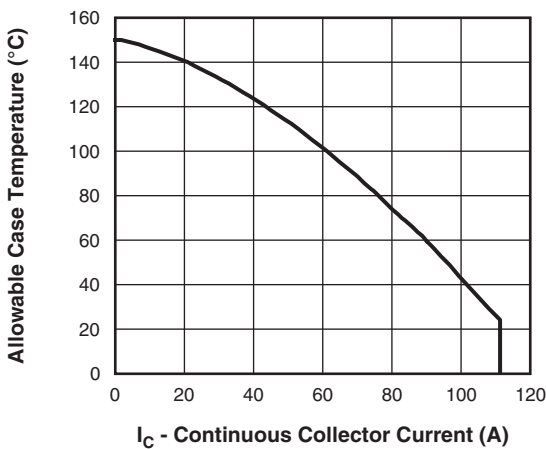


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

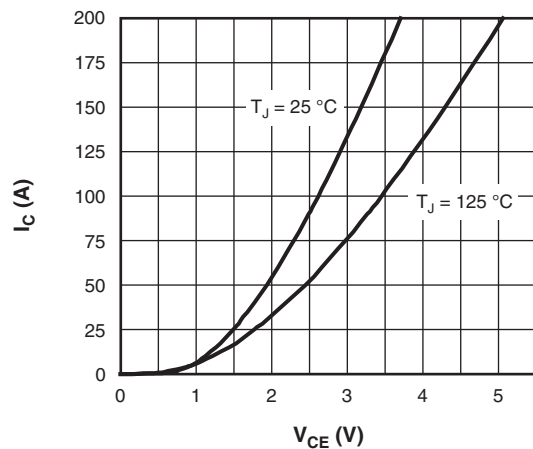


Fig. 3 - Typical IGBT Collector Current Characteristics

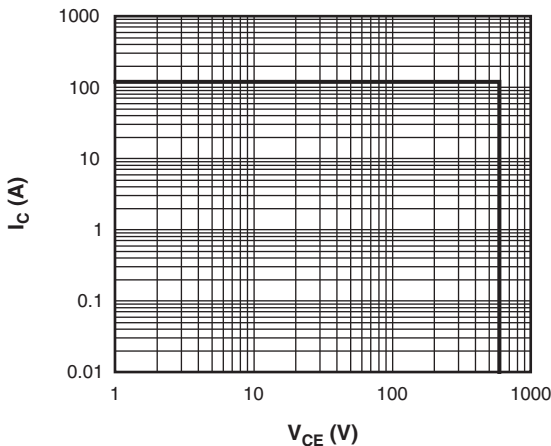


Fig. 2 - IGBT Reverse Bias SOA  
 $T_J = 150^\circ\text{C}, V_{GE} = 15\text{V}$

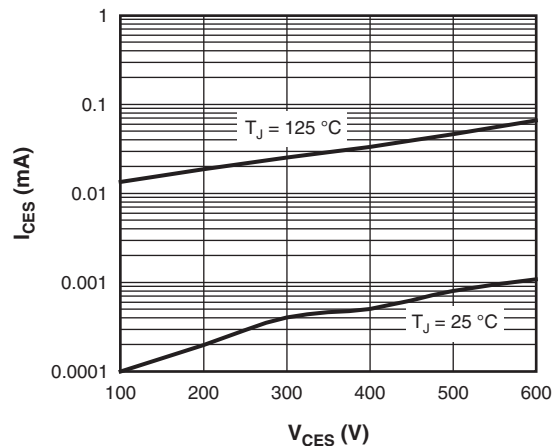


Fig. 4 - Typical IGBT Zero Gate Voltage Collector Current

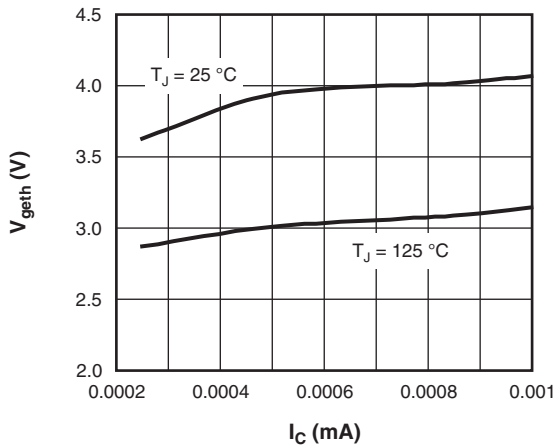


Fig. 5 - Typical IGBT Threshold Voltage

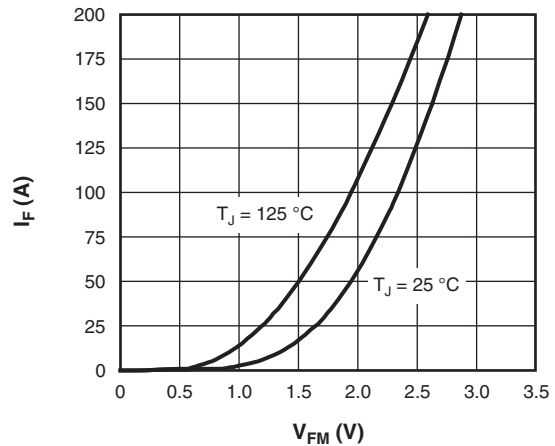


Fig. 8 - Typical Diode Forward Characteristics

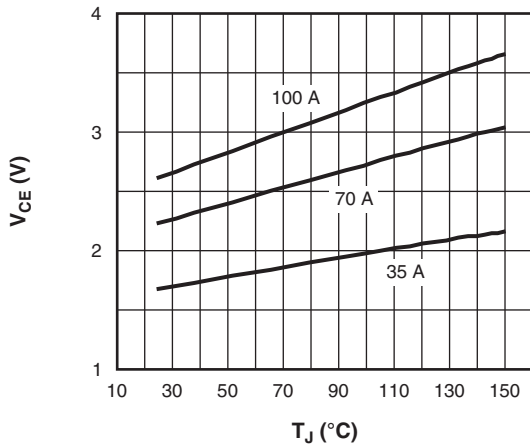


Fig. 6 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature,  $V_{GE} = 15\text{ V}$

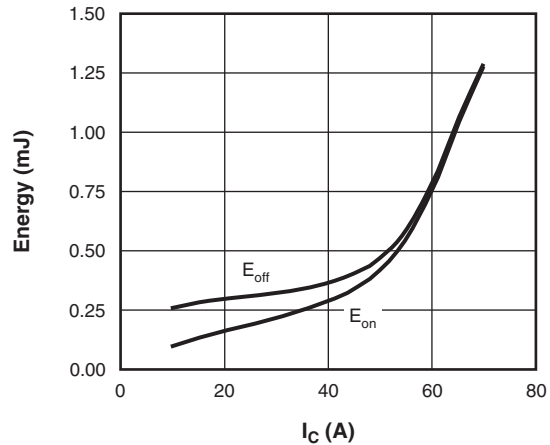


Fig. 9 - Typical IGBT Energy Loss vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 360\text{ V}$ ,  
 $R_g = 5\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$

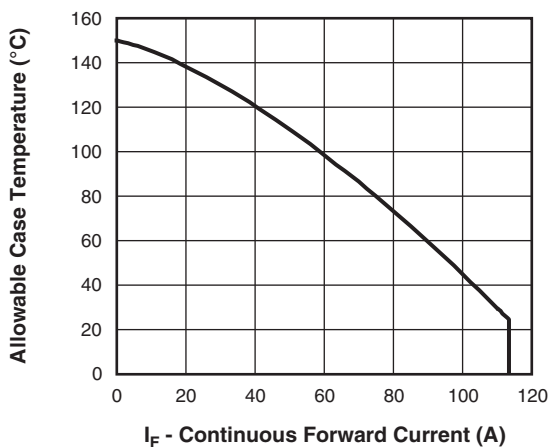


Fig. 7 - Maximum DC Forward Current vs. Case Temperature

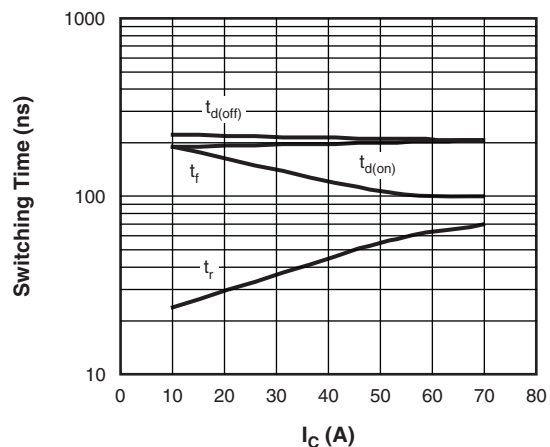


Fig. 10 - Typical IGBT Switching Time vs.  $I_C$   
 $T_J = 125\text{ °C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $V_{CC} = 360\text{ V}$ ,  
 $R_g = 5\text{ }\Omega$ ,  $V_{GE} = 15\text{ V}$

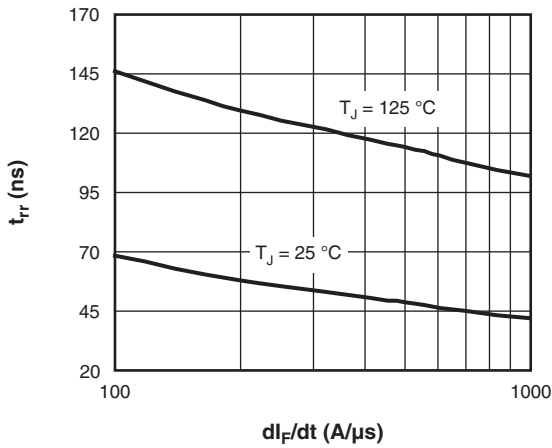


Fig. 11 - Typical  $t_{rr}$  Diode vs.  $dI_F/dt$   
 $V_R = 200\text{ V}$ ,  $I_F = 50\text{ A}$

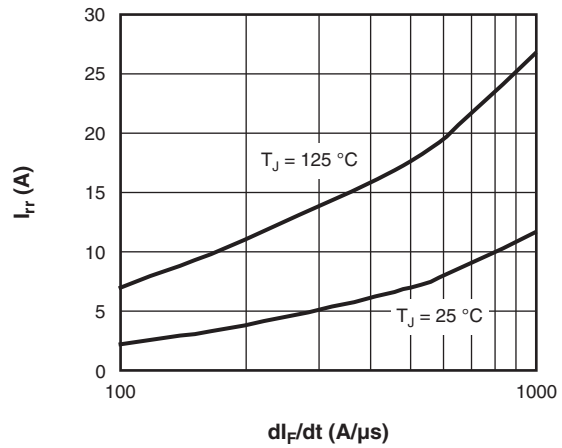


Fig. 12 - Typical  $I_{rr}$  Diode vs.  $dI_F/dt$   
 $V_{RR} = 200\text{ V}$ ,  $I_F = 50\text{ A}$

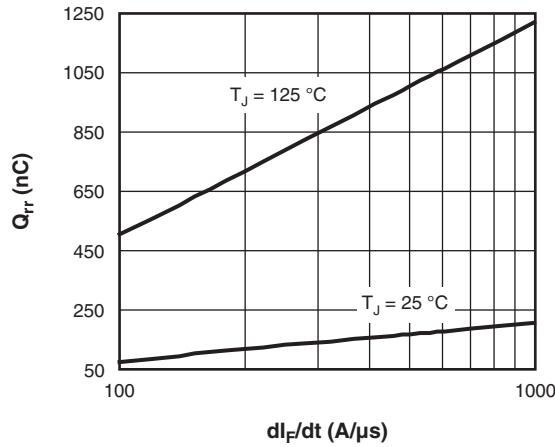


Fig. 13 - Typical  $Q_{rr}$  Diode vs.  $dI_F/dt$   
 $V_R = 200\text{ V}$ ,  $I_F = 50\text{ A}$

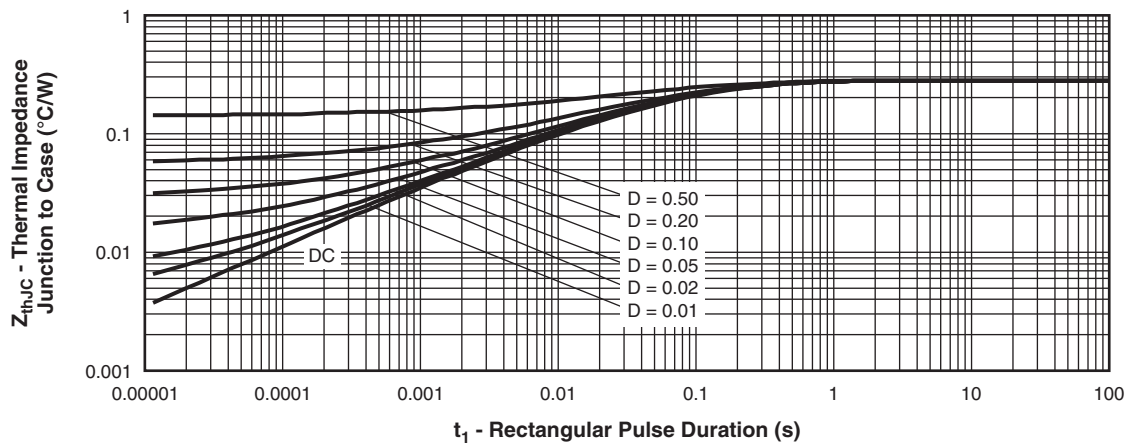


Fig. 14 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (IGBT)

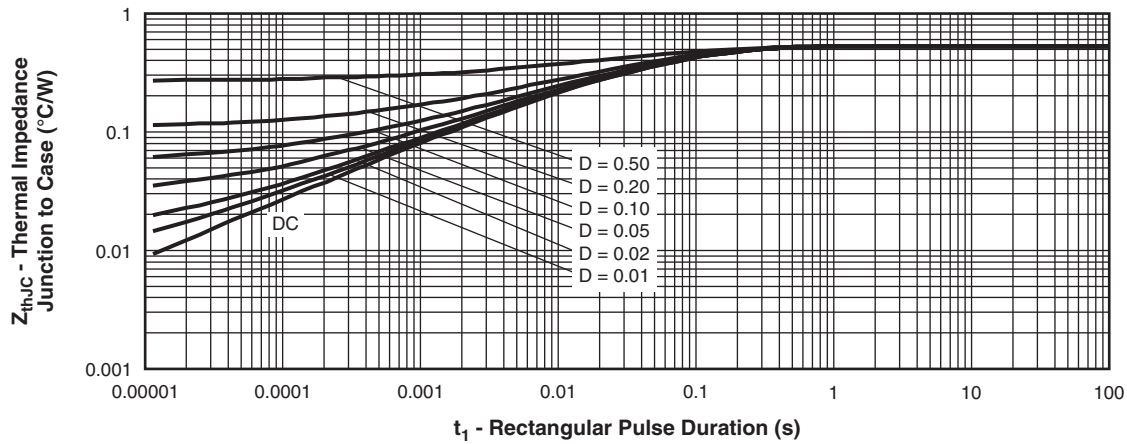


Fig. 15 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (DIODE)

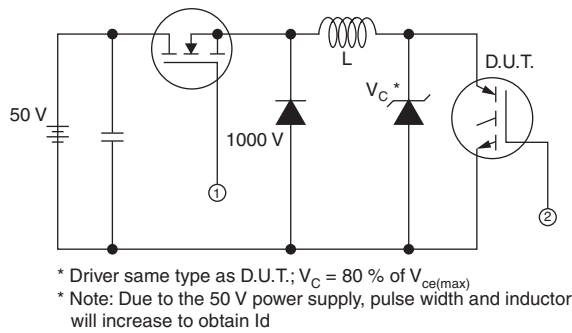


Fig. 16 - Clamped Inductive Load Test Circuit

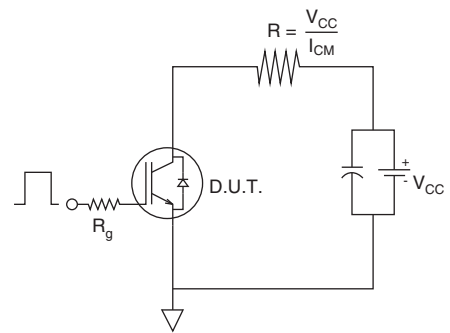


Fig. 17 - Pulsed Collector Current Test Circuit

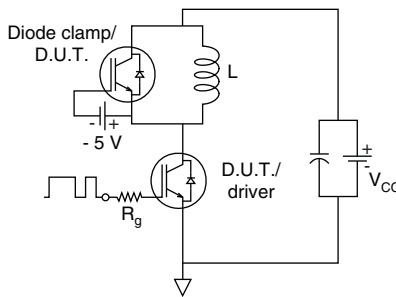


Fig. 18 - Switching Loss Test Circuit

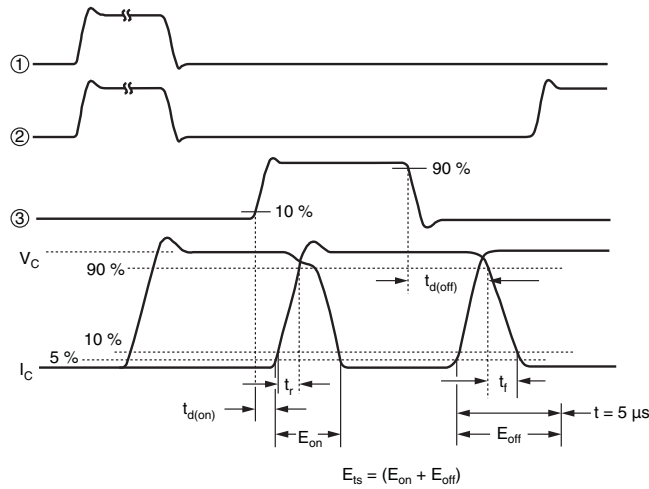


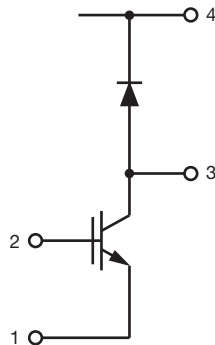
Fig. 19 - Switching Loss Waveforms Test Circuit

**ORDERING INFORMATION TABLE**

Device code	<b>VS-</b>	<b>G</b>	<b>B</b>	<b>70</b>	<b>L</b>	<b>A</b>	<b>60</b>	<b>U</b>	<b>F</b>
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

- 1** - Vishay Semiconductors product
- 2** - Insulated Gate Bipolar Transistor (IGBT)
- 3** - B = IGBT Generation 5
- 4** - Current rating (70 = 70 A)
- 5** - Circuit configuration (L = Low Side Chopper)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (60 = 600 V)
- 8** - Speed/type (U = Ultrafast IGBT)
- 9** - F = F/W FRED Pt® diode

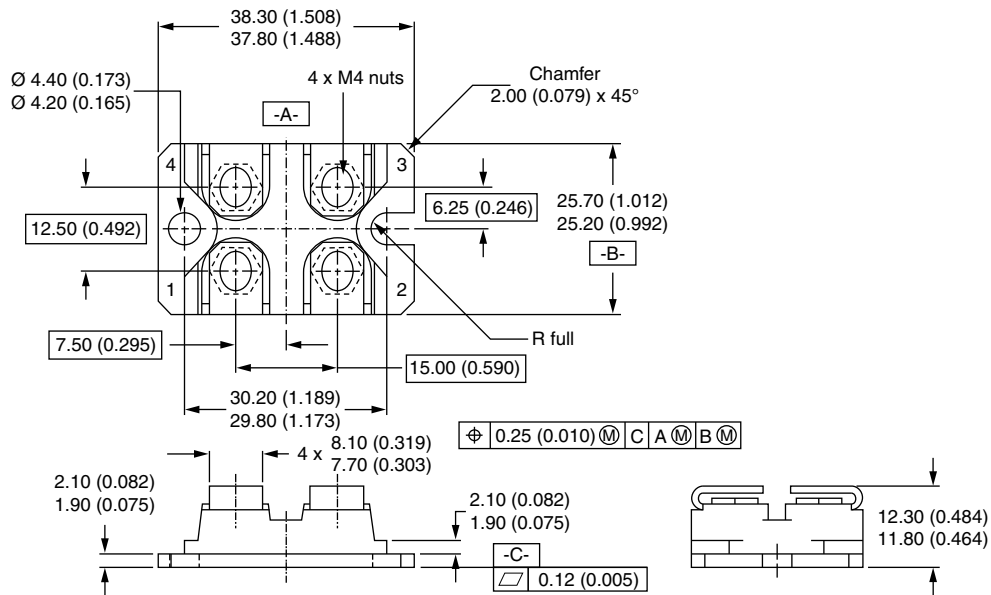
**CIRCUIT CONFIGURATION**



LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95036">http://www.vishay.com/doc?95036</a>
Packaging information	<a href="http://www.vishay.com/doc?95037">http://www.vishay.com/doc?95037</a>

## SOT-227

**DIMENSIONS** in millimeters (inches)



**Notes**

- Dimensioning and tolerancing per ANSI Y14.5M-1982
- Controlling dimension: millimeter





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