

Insulated Gate Bipolar Transistor (Warp 2 Speed IGBT), 90 A


SOT-227

FEATURES

- NPT warp 2 speed IGBT technology with positive temperature coefficient
- Square RBSOA
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- Fully isolated package
- Very low internal inductance (≤ 5 nH typical)
- Industry standard outline
- UL approved file E78996 
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

PRODUCT SUMMARY

V_{CES}	600 V
I_C DC	90 A at 90 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	2.40 V
I_F DC	108 A at 90 °C
Package	SOT-227
Circuit	Single Switch Diode

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	$T_C = 25\text{ °C}$	147	A
		$T_C = 90\text{ °C}$	90	
Pulsed collector current	I_{CM}		300	
Clamped inductive load current	I_{LM}		300	
Diode continuous forward current	I_F	$T_C = 25\text{ °C}$	180	
		$T_C = 90\text{ °C}$	108	
Gate-to-emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	$T_C = 25\text{ °C}$	625	W
		$T_C = 90\text{ °C}$	300	
Power dissipation, diode	P_D	$T_C = 25\text{ °C}$	379	
		$T_C = 90\text{ °C}$	182	
Isolation voltage	V_{ISOL}	Any terminal to case, $t = 1$ min	2500	V

**ELECTRICAL SPECIFICATIONS** ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CE)}$	$V_{GE} = 0\text{ V}$, $I_C = 250\text{ }\mu\text{A}$	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$	-	2.4	2.8	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	3	3.4	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	3.3	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	3	3.9	5.0	
		$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.5	-	
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 $125\text{ }^{\circ}\text{C}$)	-	-10	-	mV/ $^{\circ}\text{C}$
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$	-	7	100	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.5	6.0	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	6	10	
Forward voltage drop, diode	V_{FM}	$I_C = 100\text{ A}$, $V_{GE} = 0\text{ V}$	-	1.6	2.1	V
		$I_C = 100\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.56	2.0	
		$I_C = 100\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	1.53	-	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 200	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 = 100 A, V _{CC} = 480 V, V _{GE} = 15 V		-	460	690	nC	
Gate to emitter charge (turn-on)	Q _{ge}			-	160	250		
Gate to collector charge (turn-on)	Q _{gc}			-	70	130		
Turn-on switching loss	E _{on}	I _C = 100 A, V _{CC} = 360 V, V _{GE} = 15 V, R _g = 5 Ω, L = 500 μH, T _J = 25 °C	Energy losses include tail and diode recovery. Diode used 60APH06	-	0.39	-	mJ	
Turn-off switching loss	E _{off}			-	1.10	-		
Total switching loss	E _{tot}			-	1.49	-		
Turn-on delay time	t _{d(on)}			-	245	-	ns	
Rise time	t _r			-	53	-		
Turn-off delay time	t _{d(off)}			-	240	-		
Fall time	t _f			-	63	-	mJ	
Turn-on switching loss	E _{on}			-	0.52	-		
Turn-off switching loss	E _{off}			-	1.24	-		
Total switching loss	E _{tot}	I _C = 100 A, V _{CC} = 360 V, V _{GE} = 15 V, R _g = 5 Ω, L = 500 μH, T _J = 125 °C		-	1.76	-	ns	
Turn-on delay time	t _{d(on)}			-	240	-		
Rise time	t _r			-	54	-		
Turn-off delay time	t _{d(off)}			-	250	-		
Fall time	t _f				-	80	-	
Reverse bias safe operating area	RBSOA	T _J = 150 °C, I _C = 300 A, R _g = 22 Ω, V _{GE} = 15 V to 0 V, V _{CC} = 400 V, V _P = 600 V, L = 500 μH		Fullsquare				
Diode reverse recovery time	t _{rr}	I _F = 50 A, dI _F /dt = 200 A/μs, V _R = 200 V		-	95	-	ns	
Diode peak reverse current	I _{rr}			-	10	-	A	
Diode recovery charge	Q _{rr}			-	480	-	nC	
Diode reverse recovery time	t _{rr}	I _F = 50 A, dI _F /dt = 200 A/μs, V _R = 200 V, T _J = 125 °C		-	144	-	ns	
Diode peak reverse current	I _{rr}			-	16	-	A	
Diode recovery charge	Q _{rr}			-	1136	-	nC	

THERMAL AND MECHANICAL SPECIFICATIONS

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	T_J, T_{Stg}		-40	-	150	°C
Junction to case	R_{thJC}		-	-	0.20	°C/W
			-	-	0.33	
Case to heatsink	R_{thCS}	Flat, greased surface	-	0.1	-	
Weight			-	30	-	g
Mounting torque			-	-	1.3	Nm
Case style	SOT-227					

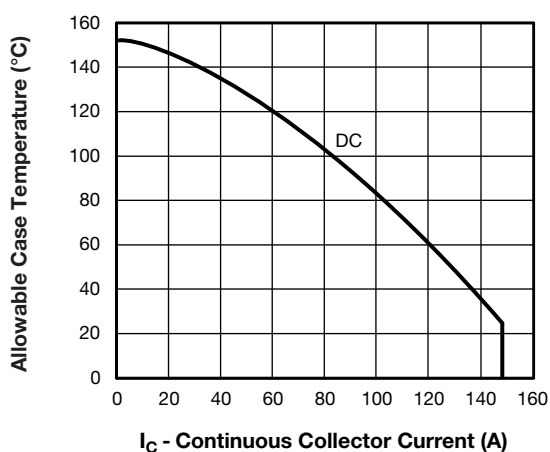


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

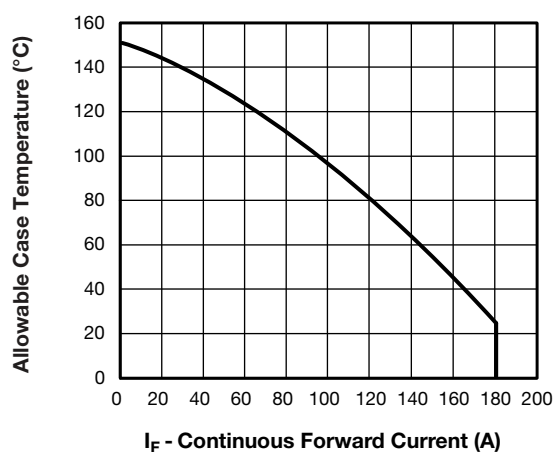


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

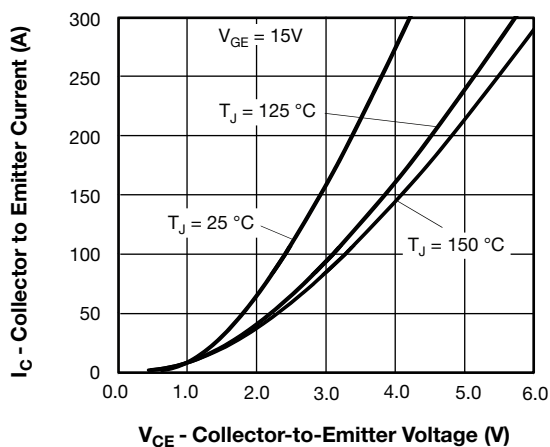


Fig. 2 - Typical Collector to Emitter Voltage (V)

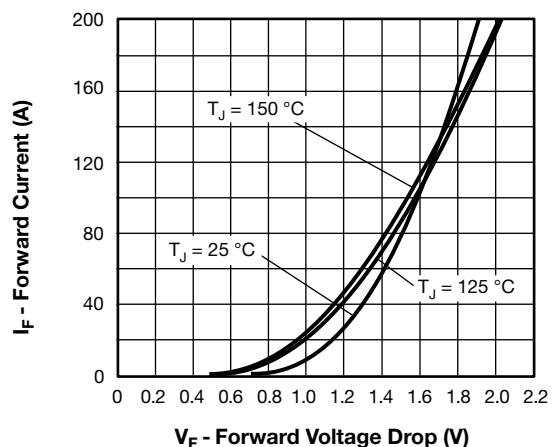


Fig. 4 - Typical Forward Voltage Drop Characteristics

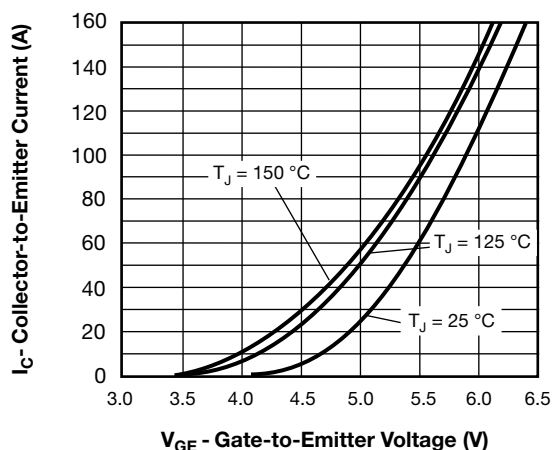


Fig. 5 - Typical IGBT Transfer Characteristics

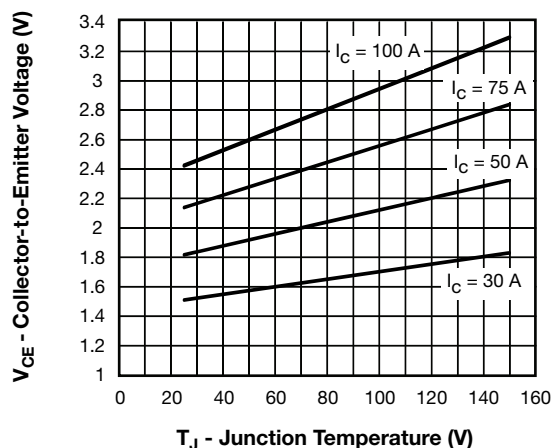
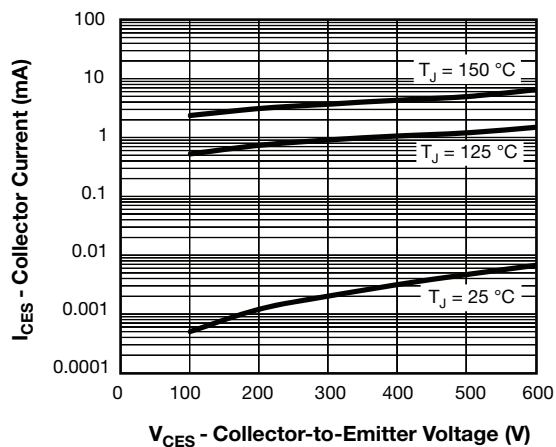

Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE} = 15\text{ V}$


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

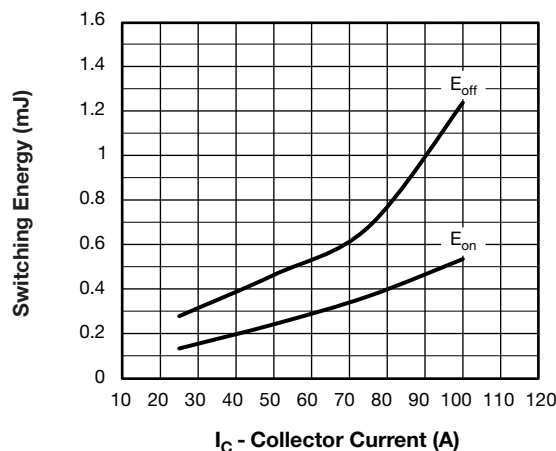
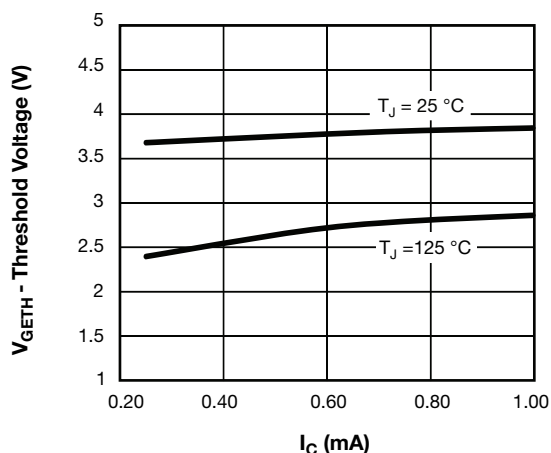
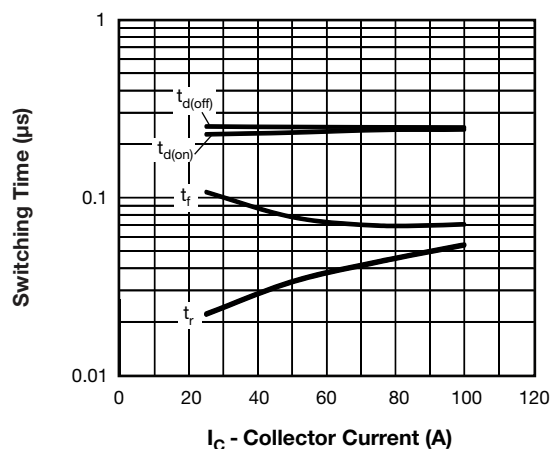

Fig. 9 - Typical IGBT Energy Losses vs. I_C
 $T_J = 125\text{ °C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06


Fig. 7 - Typical IGBT Threshold Voltage


Fig. 10 - Typical IGBT Switching Time vs. I_C
 $T_J = 125\text{ °C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

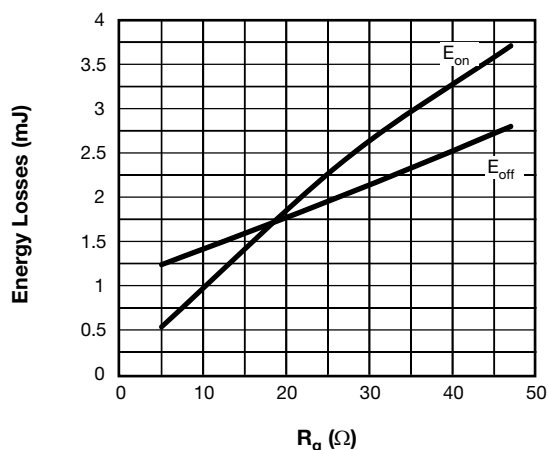


Fig. 11 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125^\circ\text{C}$, $I_C = 100\text{ A}$, $L = 500\text{ }\mu\text{H}$,
 $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

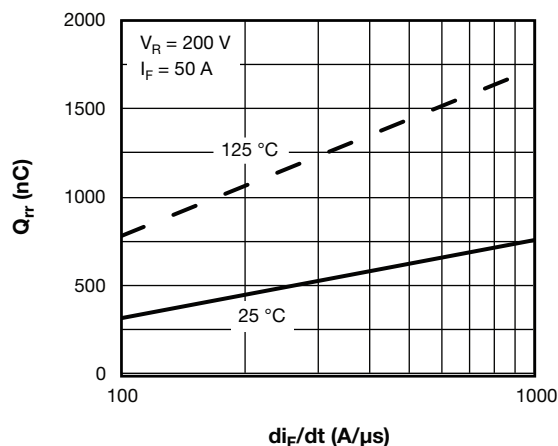


Fig. 14 - Typical Stored Charge vs. dI_F/dt of Diode

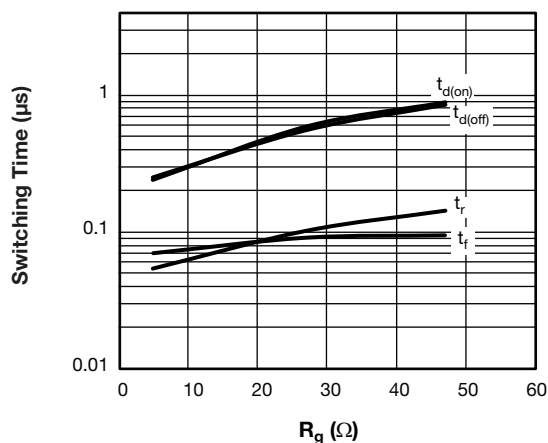


Fig. 12 - Typical IGBT Switching Time vs. R_g
 $T_J = 125^\circ\text{C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

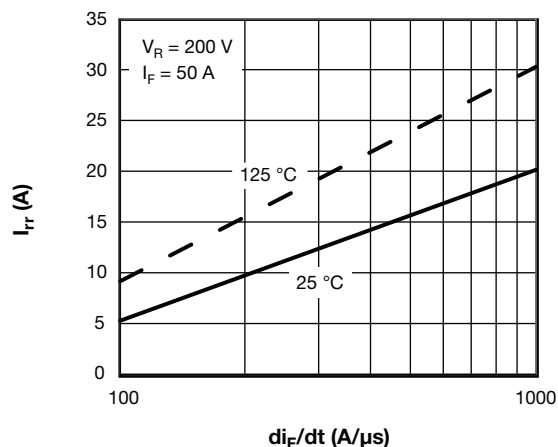


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode

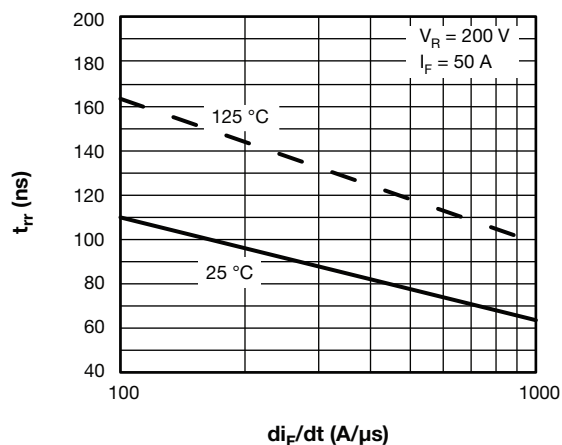
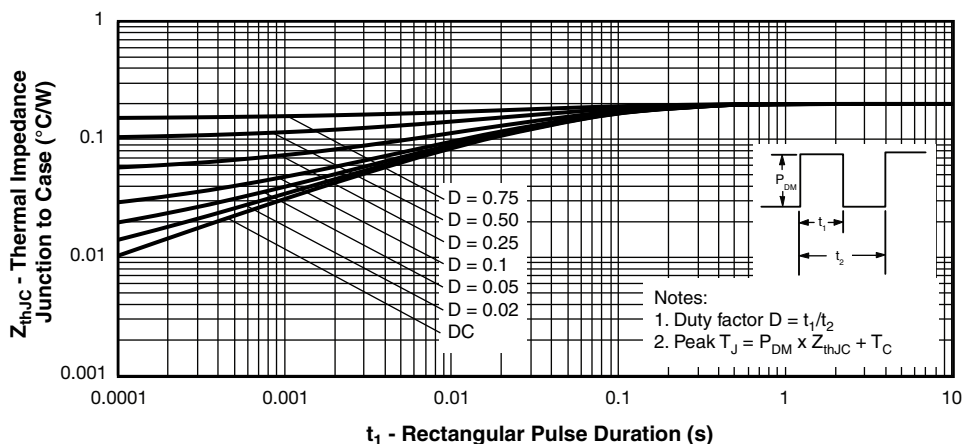
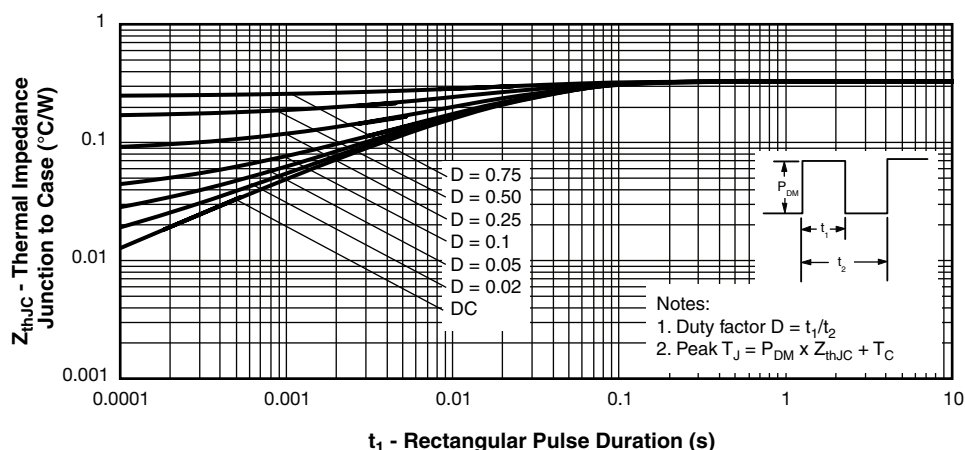
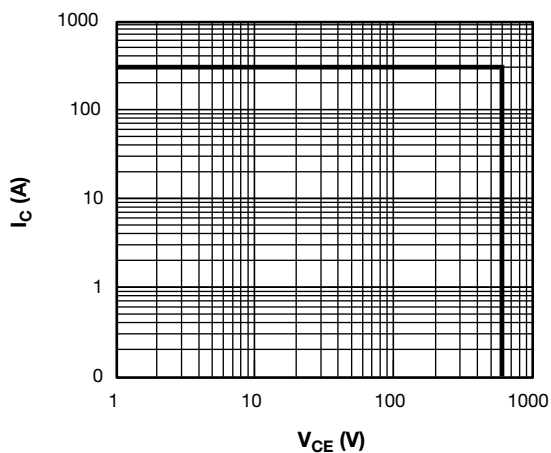
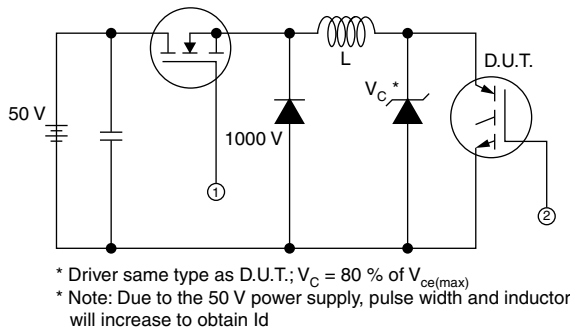
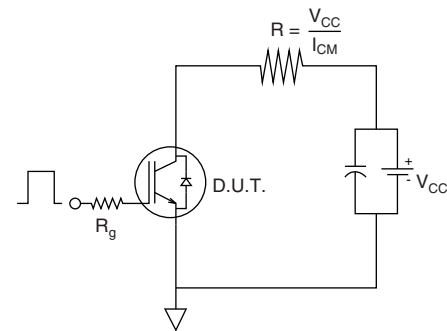


Fig. 13 - Typical Reverse Recovery Time vs. dI_F/dt , of Diode

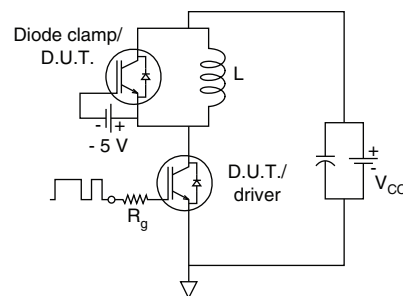

Fig. 16 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

Fig. 18 - IGBT Reverse BIAS SOA, $T_J = 150^{\circ}C$, $V_{GE} = 15V$



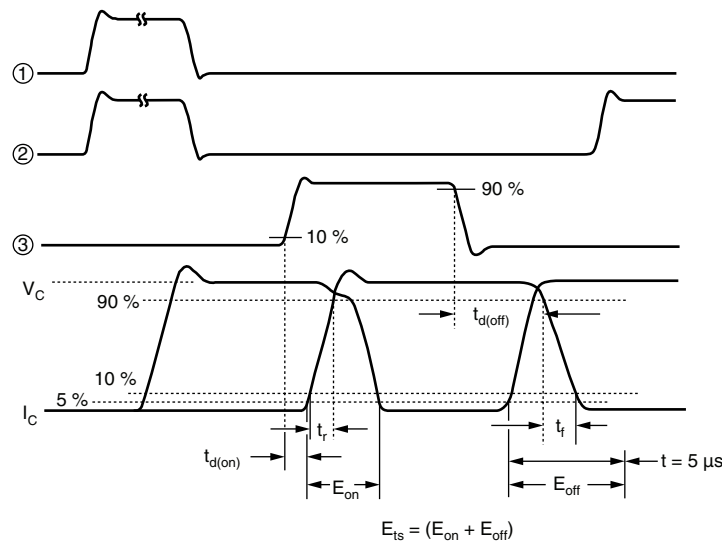
19a - Clamped Inductive Load Test Circuit



19b - Pulsed Collector Current Test Circuit



20a - Switching Loss Test Circuit

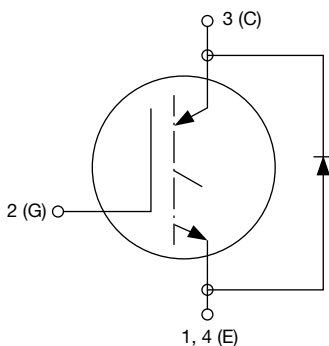
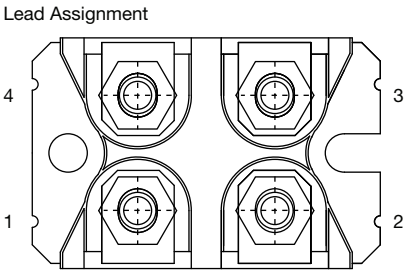


20b - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

Device code	VS-	G	B	90	D	A	60	U
	1	2	3	4	5	6	7	8

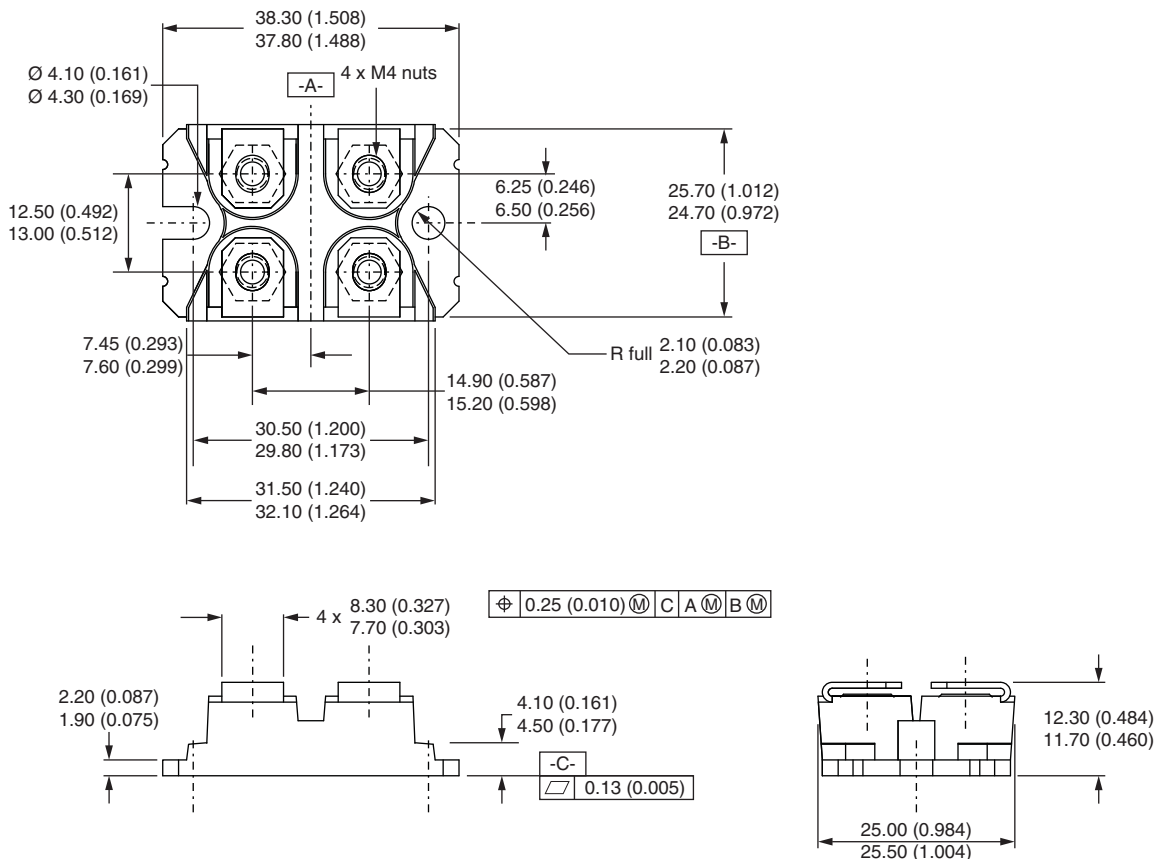
- 1** - Vishay Semiconductors product
- 2** - Insulated Gate Bipolar Transistor (IGBT)
- 3** - B = IGBT Generation 5
- 4** - Current rating (90 = 90 A)
- 5** - Circuit configuration (D = Single switch with antiparallel diode)
- 6** - Package indicator (A = SOT-227)
- 7** - Voltage rating (60 = 600 V)
- 8** - Speed/type (U = Ultrafast IGBT)

CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch diode	D	 

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

SOT-227 Generation II

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter



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