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

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

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

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

ELECTRICAL SPECIFICATIONS (T_J = 25 °C unless otherwise specified)						
PARAMETER	**SYMBOL**	**TEST CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Collector to emitter breakdown voltage	$V_{BR(CES)}$	V_{GE} = 0 V, I_C = 250 μA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 100 A	-	2.4	2.8	
		V_{GE} = 15 V, I_C = 100 A, T_J = 125 °C	-	3	3.4	
		V_{GE} = 15 V, I_C = 100 A, T_J = 150°C	-	3.3	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 250 μA	3	3.9	5.0	
		V_{CE} = V_{GE}, I_C = 250 μA, T_J = 125 °C	-	2.5	-	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1 mA (25 °C to 125 °C)	-	- 10	-	mV/°C
Collector to emitter leakage current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	7	100	μA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	1.5	6.0	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 150 °C	-	6	10	
Forward voltage drop, diode	V_{FM}	I_C = 100 A, V_{GE} = 0 V	-	1.6	2.1	V
		I_C = 100 A, V_{GE} = 0 V, T_J = 125 °C	-	1.56	2.0	
		I_C = 100 A, V_{GE} = 0 V, T_J = 150 °C	-	1.53	-	
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 200	nA

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} = 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	-	
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 = 125 °C		-	0.52	-	mJ
Turn-off switching loss	E_{off}			-	1.24	-	
Total switching loss	E_{tot}			-	1.76	-	
Turn-on delay time	$t_{d(on)}$			-	240	-	ns
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	MIN.	TYP.	MAX.	UNITS
Maximum junction and storage temperature		T_J, T_{Stg}	- 40	-	150	°C
Junction to case	IGBT	R_{thJC}	-	-	0.20	°C/W
	Diode		-	-	0.33	
Case to sink thermal resistance, flat greased surface		R_{thCS}	-	0.1	-	
Mounting torque, on termianls and heatsink		T	-	-	1.3	Nm
Weight			-	30	-	g
Case style			SOT-227			

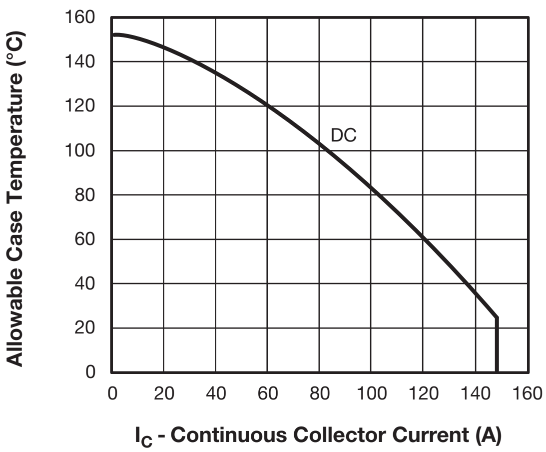


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

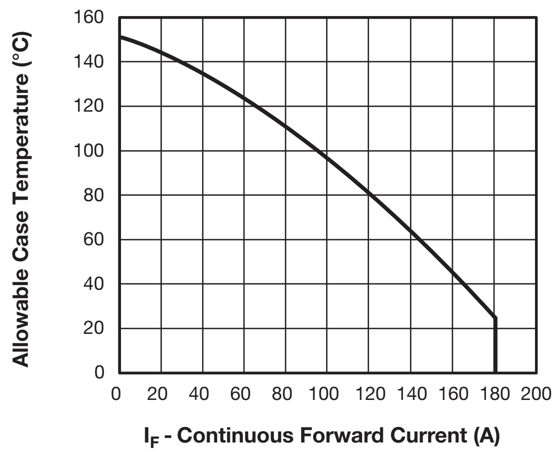


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

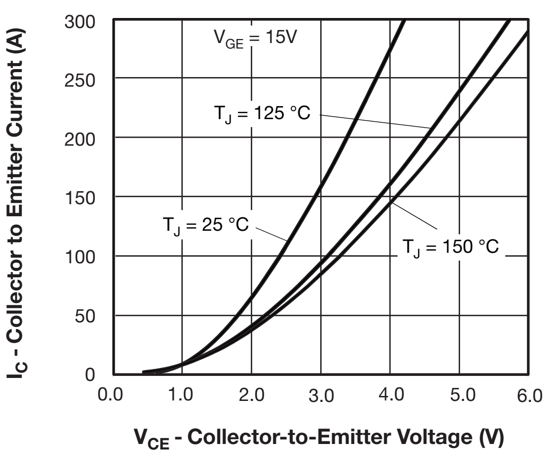


Fig. 2 - Typical Collector to Emitter Voltage (V)

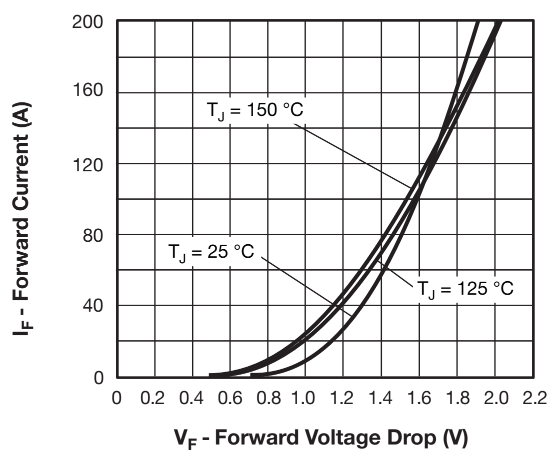


Fig. 4 - Typical Forward Voltage Drop Characteristics

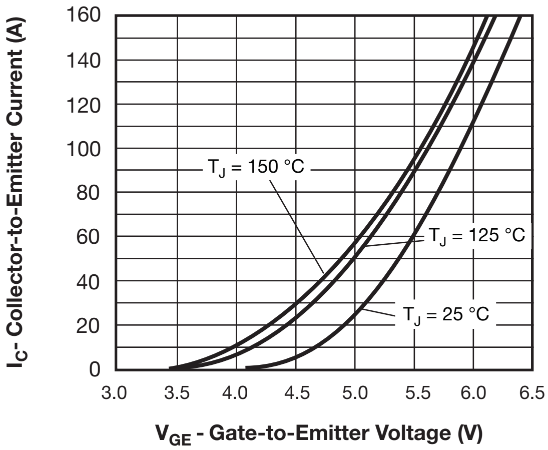


Fig. 5 - Typical IGBT Transfer Characteristics

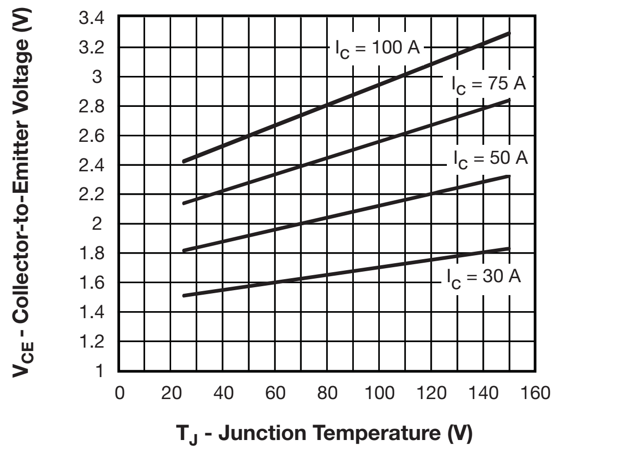


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, V_{GE} = 15 V

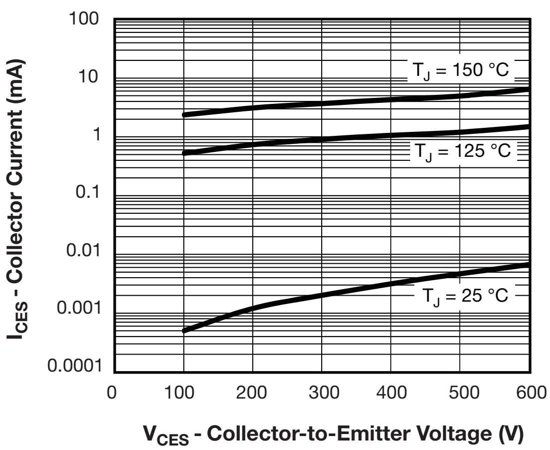


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

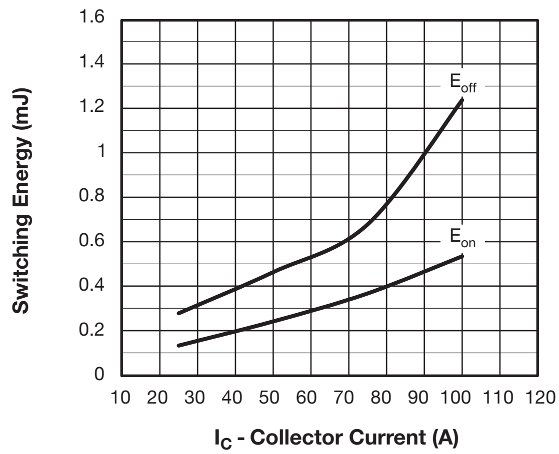


Fig. 9 - Typical IGBT Energy Losses vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

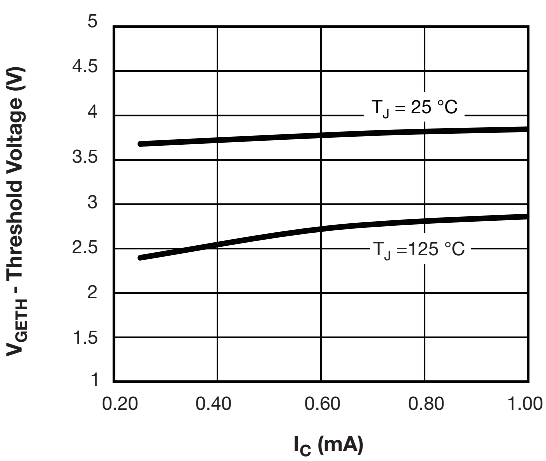


Fig. 7 - Typical IGBT Threshold Voltage

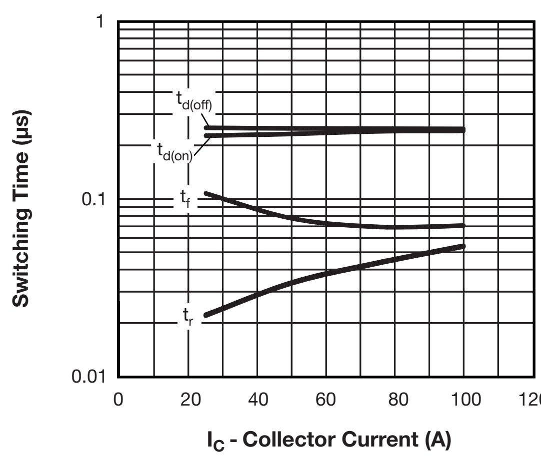


Fig. 10 - Typical IGBT Switching Time vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

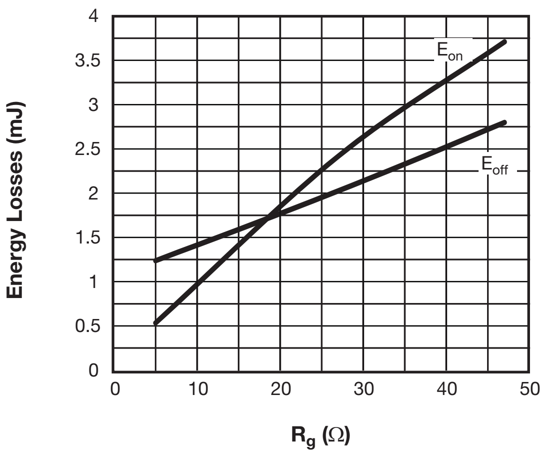


Fig. 11 - Typical IGBT Energy Loss vs. R_g
T_J = 125 °C, I_C = 100 A, L = 500 µH,
V_{CC} = 360 V, V_{GE} = 15 V, Diode used: 60APH06

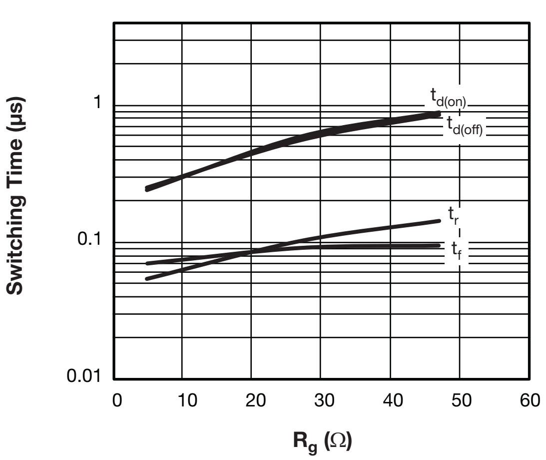


Fig. 12 - Typical IGBT Switching Time vs. R_g
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
I_C = 100 A, V_{GE} = 15 V, Diode used: 60APH06

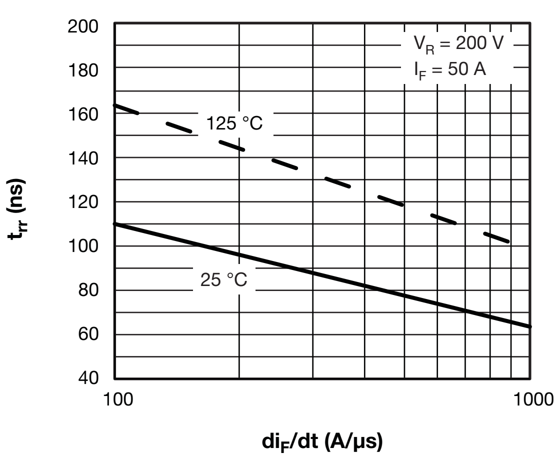


Fig. 13 - Typical Reverse RecoveryTime vs. dI_F/dt, of Diode

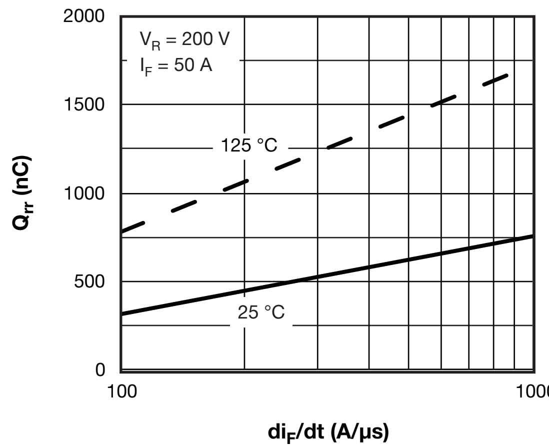


Fig. 14 - Typical Stored Charge vs. dI_F/dt of Diode

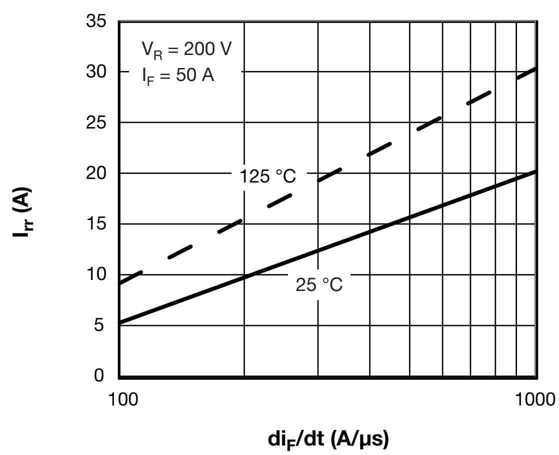


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode

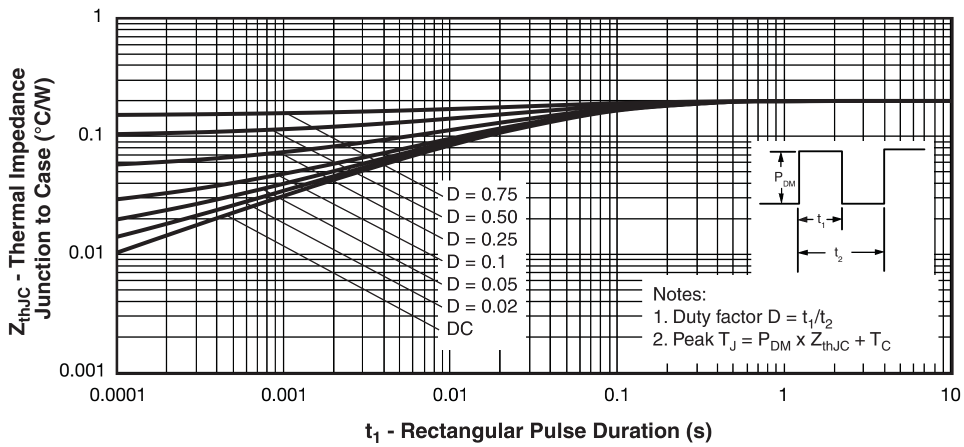


Fig. 16 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

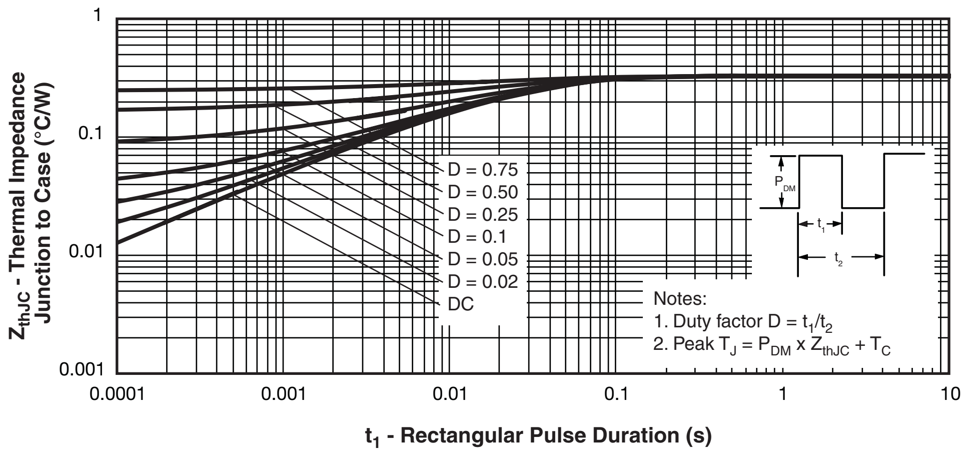


Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

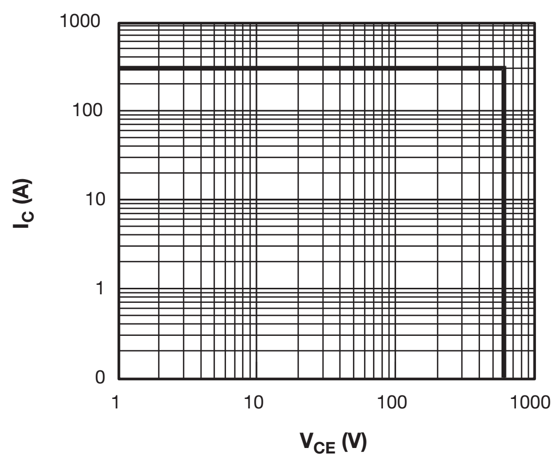
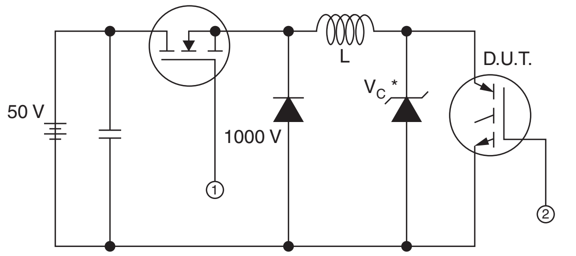
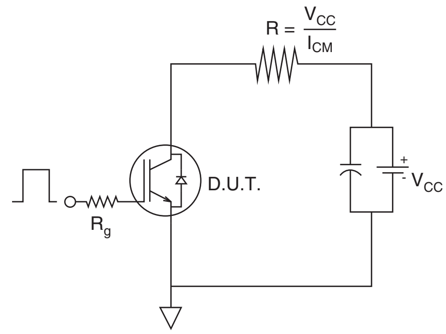


Fig. 18 - IGBT Reverse BIAS SOA, T_J = 150 °C, V_{GE} = 15 V

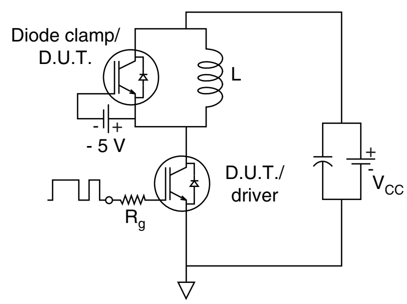


* Driver same type as D.U.T.; V_C = 80 % of $V_{ce(max)}$
* Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain Id

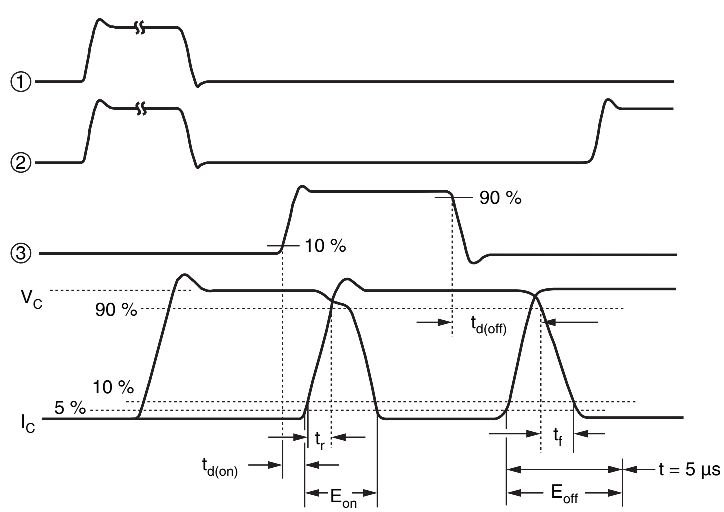
19a - Clamped Inductive Load Test Circuit



19b - Pulsed Collector Current Test Circuit



20a - Switching Loss Test Circuit



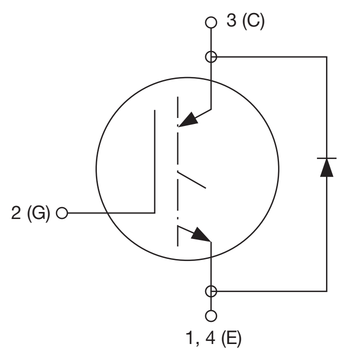
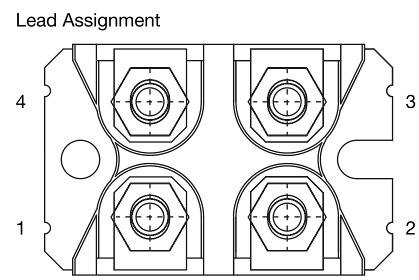
$E_{ts} = (E_{on} + E_{off})$

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

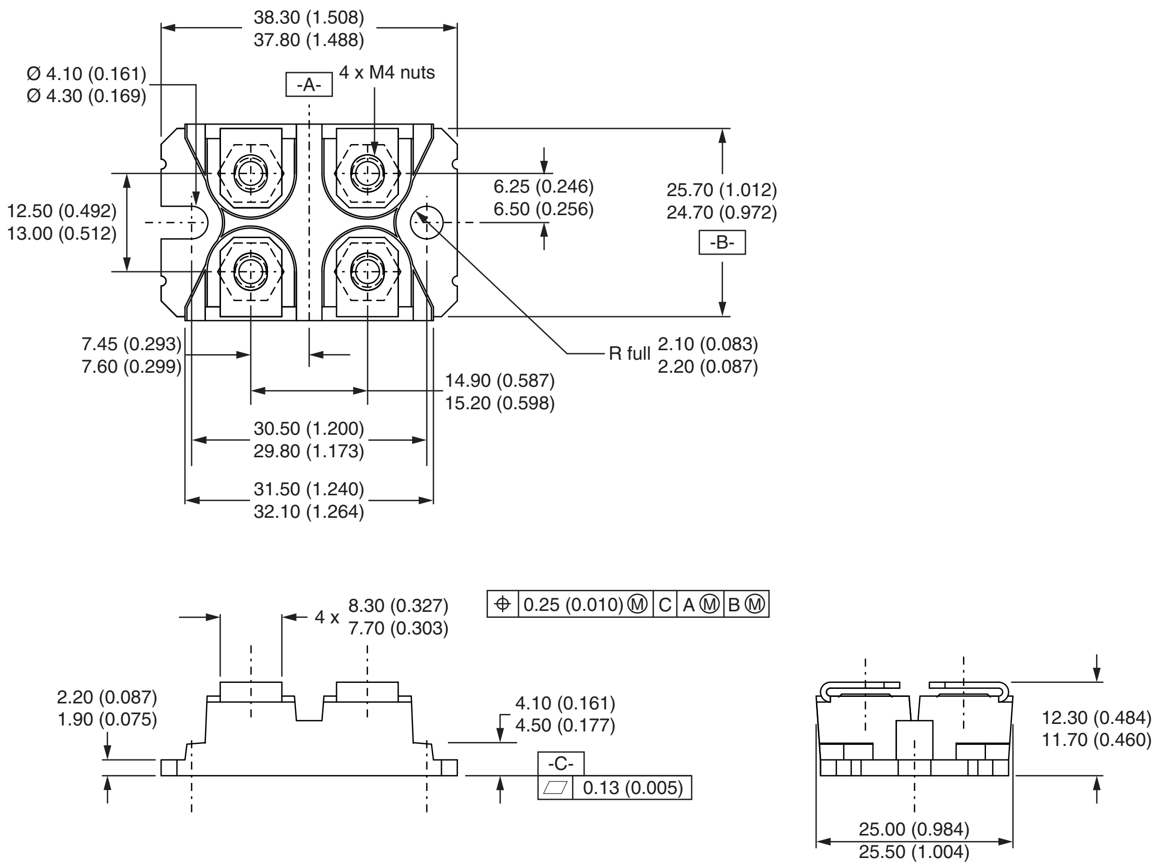
1 - Vishay Semiconductors product
2 - Insulated Gate Bipolar Transistor (IGBT)
3 - B = IGBT Generation 5
4 - Current rating (90 = 90 A)
5 - Circuit configuration (D = Single switch with antiparallel diode)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (60 = 600 V)
8 - Speed/type (U = Ultrafast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