Insulated Gate Bipolar Transistor (Trench IGBT), 140 A

SOT-227

FEATURES

- Trench IGBT technology with positive temperature coefficient
- Square RBSOA
- 3 µs short circuit capability
- FRED Pt® antiparallel diodes with ultrasoft reverse recovery
- T_J maximum = 175 °C
- 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

Pb-free

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
- Lower conduction losses and switching losses
- Low EMI, requires less snubbing

PRODUCT SUMMARY	
V_{CES}	600 V
I_C DC	140 A at 90 °C (1)
$V_{CE(on)}$ typical at 100 A, 25 °C	1.72 V
I_F DC	71 A at 90 °C
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit	Single switch diode

Note

(1) Maximum collector current admitted is 100 A, to do not exceed the maximum temperature of terminals

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		600	V
Continuous collector current	I_C (1)	T_C = 25 °C	200	A
		T_C = 90 °C	140	
Pulsed collector current	I_{CM}		350	
Clamped inductive load current	I_{LM}		350	
Diode continuous forward current	I_F	T_C = 25 °C	104	
		T_C = 90 °C	71	
Gate-to-emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	T_C = 25 °C	652	W
		T_C = 90 °C	370	
Power dissipation, diode	P_D	T_C = 25 °C	238	
		T_C = 90 °C	135	
Isolation voltage	V_{ISOL}	Any terminal to case, t = 1 min	2500	V

Note

(1) Maximum collector current admitted is 100 A, to do not exceed the maximum temperature of terminals

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	-	1.7	2.0	
		V_{GE} = 15 V, I_C = 100 A, T_J = 125 °C	-	2.0	2.2	
		V_{GE} = 15 V, I_C = 100 A, T_J = 175°C	-	2.15	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 250 µA	3.5	4.6	6.5	
		V_{CE} = V_{GE}, I_C = 250 µA, T_J = 125 °C	-	2.65	-	
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)	-	-16.8	-	mV/°C
Collector to emitter leakage current	I_{CES}	V_{GE} = 0 V, V_{CE} = 600 V	-	0.6	100	µA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	0.15	3	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 175 °C	-	8	-	
Forward voltage drop, diode	V_{FM}	I_F = 40 A, V_{GE} = 0 V	-	1.74	2.2	V
		I_F = 40 A, V_{GE} = 0 V, T_J = 125 °C	-	1.35	1.74	
		I_F = 40 A, V_{GE} = 0 V, T_J = 150 °C	-	1.2	-	
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**
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	-	0.43	-	mJ
Turn-off switching loss	E_{off}			-	1.50	-	
Total switching loss	E_{tot}			-	1.93	-	
Turn-on delay time	$t_{d(on)}$			-	130	-	ns
Rise time	t_r			-	50	-	
Turn-off delay time	$t_{d(off)}$			-	127	-	
Fall time	t_f			-	82	-	
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		-	0.43	-	mJ
Turn-off switching loss	E_{off}			-	2.12	-	
Total switching loss	E_{tot}			-	2.55	-	
Turn-on delay time	$t_{d(on)}$			-	130	-	ns
Rise time	t_r			-	52	-	
Turn-off delay time	$t_{d(off)}$			-	130	-	
Fall time	t_f			-	100	-	
Reverse bias safe operating area	RBSOA	T_J = 175 °C, I_C = 350 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		-	72	-	ns
Diode reverse recovery current	I_{rr}			-	5.5	-	A
Diode recovery charge	Q_{rr}			-	200	-	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}			-	13	-	A
Diode recovery charge	Q_{rr}			-	930	-	nC
Short circuit safe operating area	SCSOA	T_J = 175 °C, R_g = 22 Ω, V_{GE} = 15 V to 0 V, V_{CC} = 400 V, V_P = 600 V		3			µs

THERMAL AND MECHANICAL SPECIFICATIONS							
PARAMETER		SYMBOL		MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range		T_J, T_{Stg}		-40	-	175	°C
Junction to case	IGBT	R_{thJC}		-	-	0.23	°C/W
	Diode			-	-	0.63	
Case to heatsink		R_{thCS}	Flat, greased surface	-	0.1	-	
Weight				-	30	-	g
Mounting torque				-	-	1.3	Nm
Case style		SOT-227					

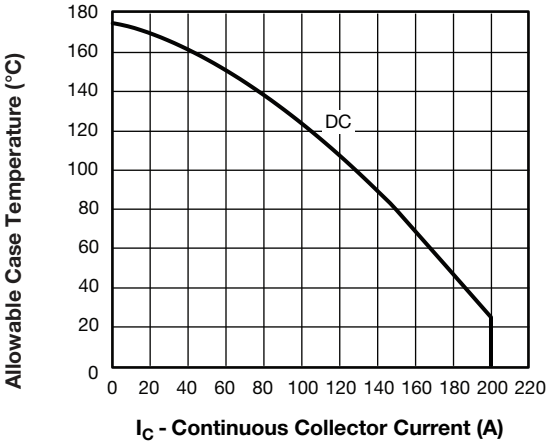


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

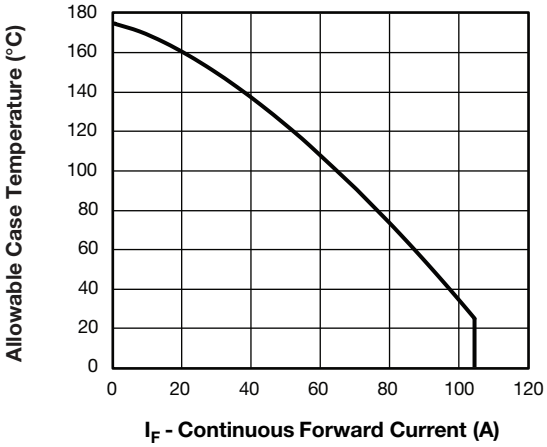


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

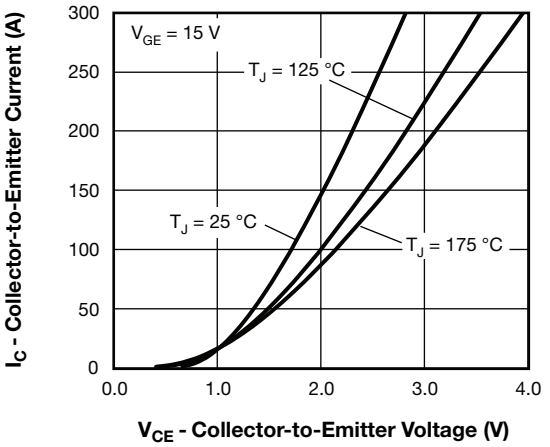


Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

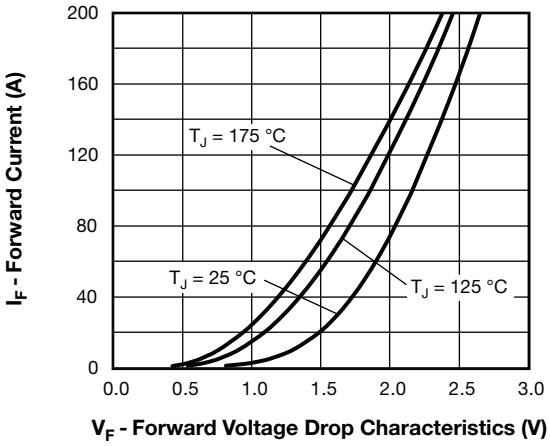


Fig. 4 - Typical Diode Forward Voltage Drop Characteristics

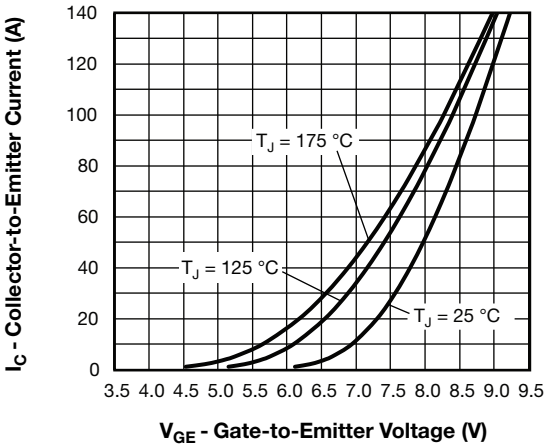


Fig. 5 - Typical IGBT Transfer Characteristics

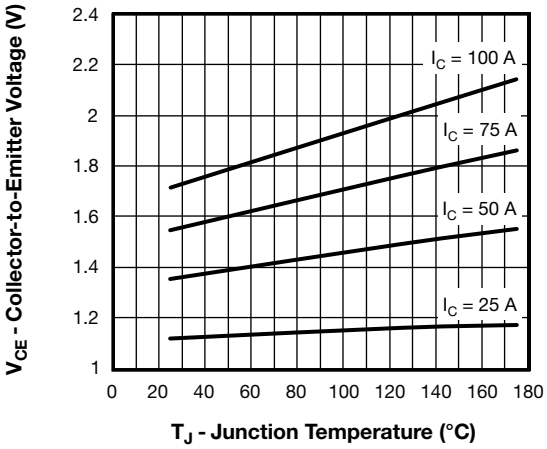


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, V_{GE} = 15 V

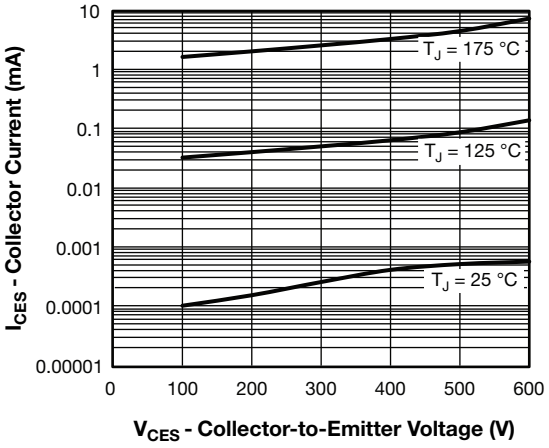


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

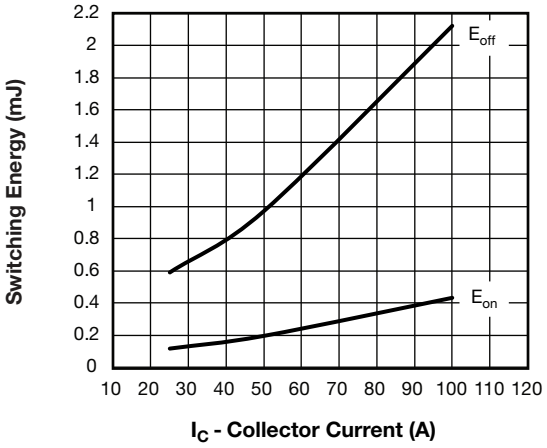


Fig. 9 - Typical IGBT Energy Losses vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

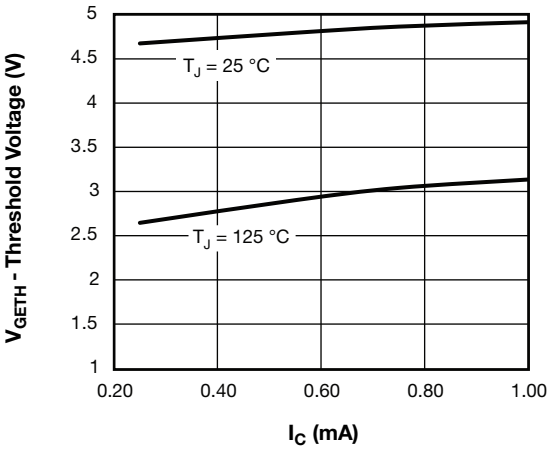


Fig. 7 - Typical IGBT Threshold Voltage

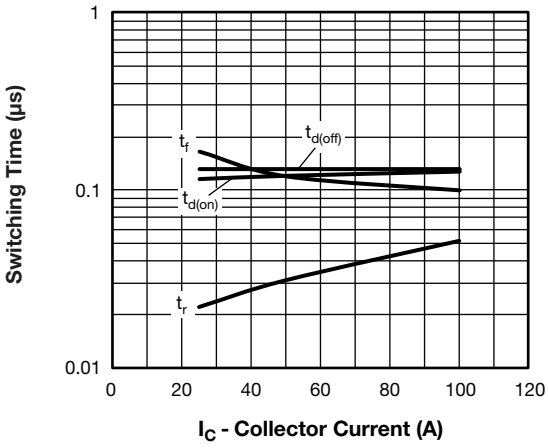


Fig. 10 - Typical IGBT Switching Time vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

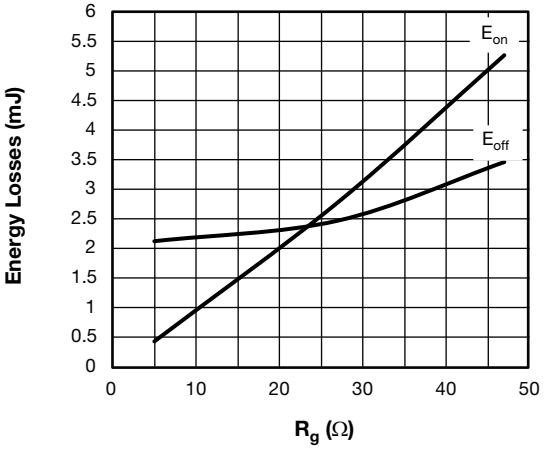


Fig. 11 - Typical IGBT Energy Loss vs. R_g
T_J = 125 °C, I_C = 100 A, L = 500 µH,
V_{CC} = 360 V, V_{GE} = 15 V, Diode used: 60APH06

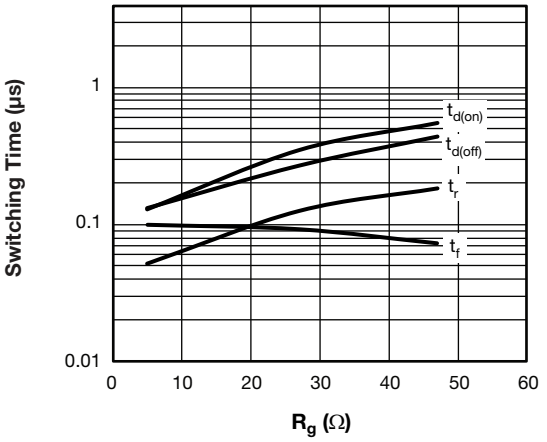


Fig. 12 - Typical IGBT Switching Time vs. R_g
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
I_C = 100 A, V_{GE} = 15 V, Diode used: 60APH06

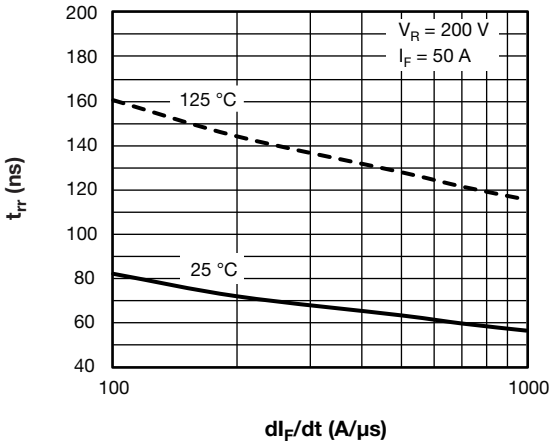


Fig. 13 - Typical Reverse RecoveryTime vs. dI_F/dt of Diode

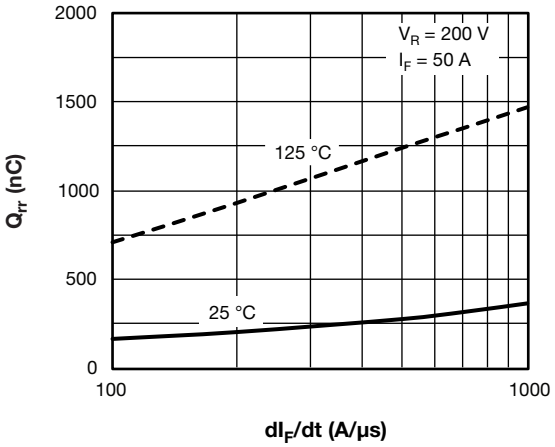


Fig. 14 - Typical Stored Charge vs. dI_F/dt of Diode

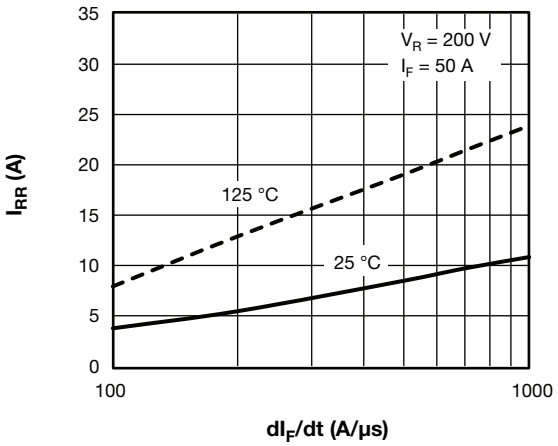


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode

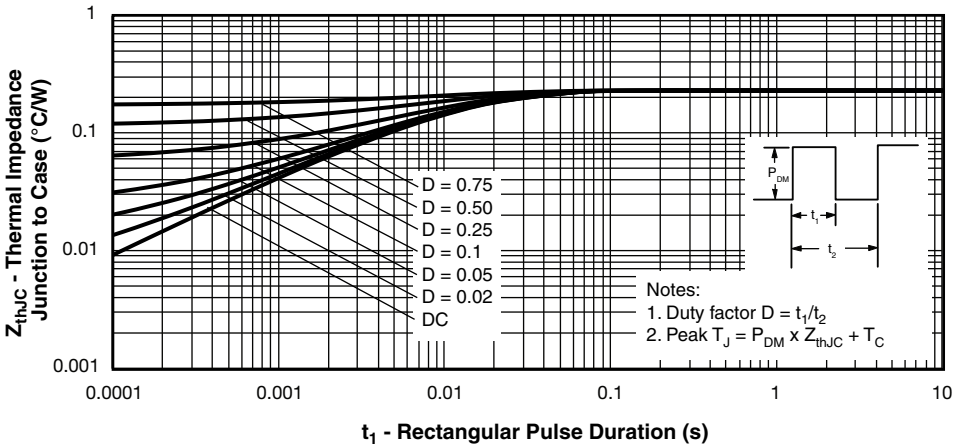


Fig. 16 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

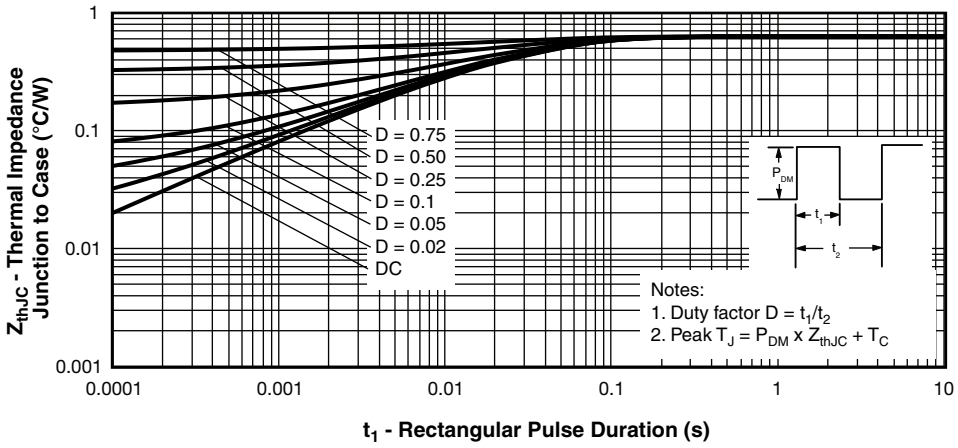


Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

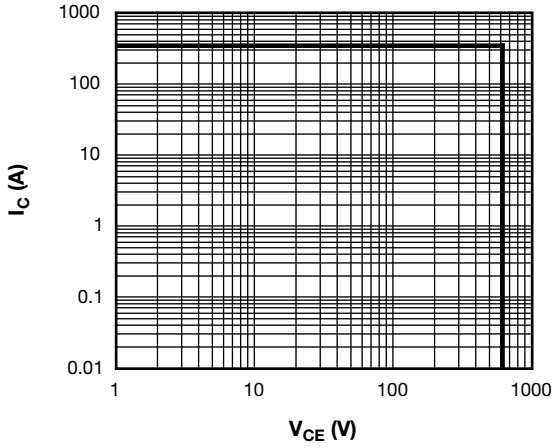
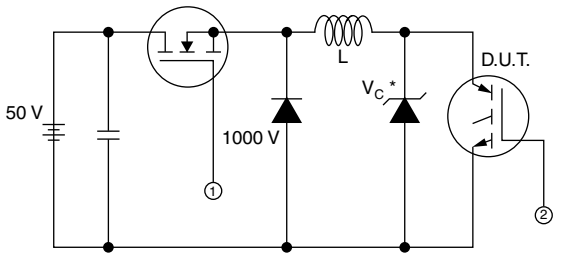
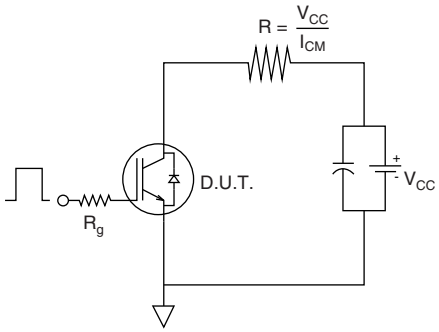


Fig. 18 - IGBT Reverse BIAS SOA, T_J = 175 °C, V_{GE} = 15 V

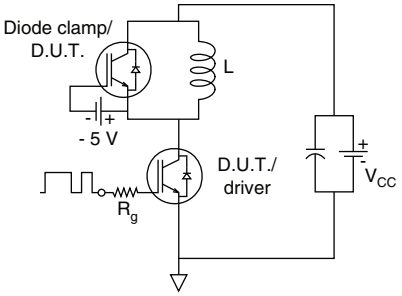


* Driver same type as D.U.T.; V_C = 80 % of $V_{ce(max)}$
* Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain Id

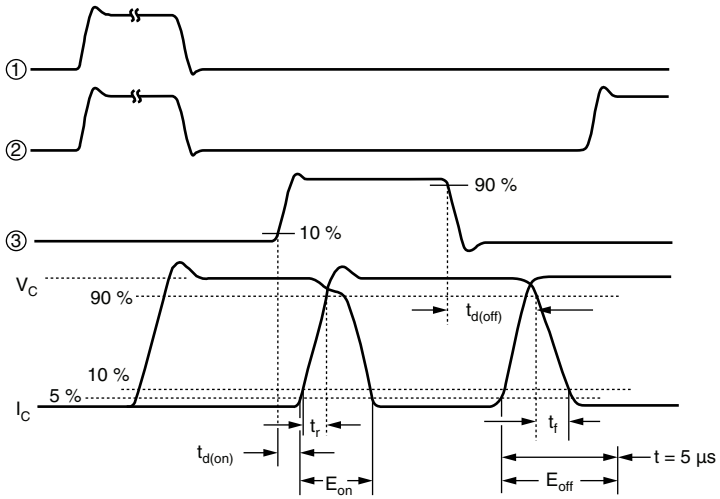
19a - Clamped Inductive Load Test Circuit



19b - Pulsed Collector Current Test Circuit



20a - Switching Loss Test Circuit



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

20b - Switching Loss Waveforms Test Circuit

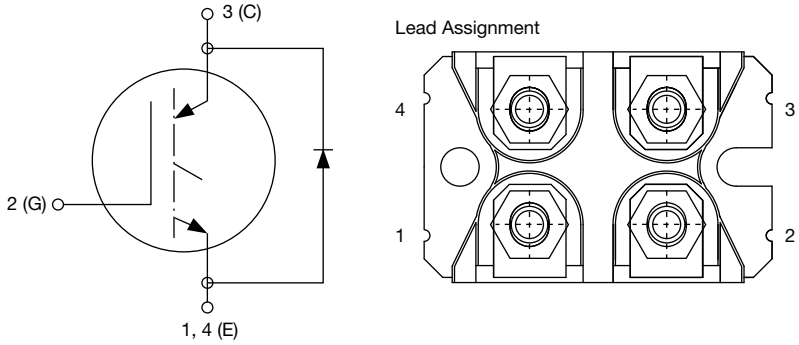
ORDERING INFORMATION TABLE

Device code

VS-	G	T	140	D	A	60	U
1	2	3	4	5	6	7	8

- 1 - Vishay Semiconductors product
- 2 - Insulated Gate Bipolar Transistor (IGBT)
- 3 - T = Trench IGBT Technology
- 4 - Current rating (140 = 140 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)

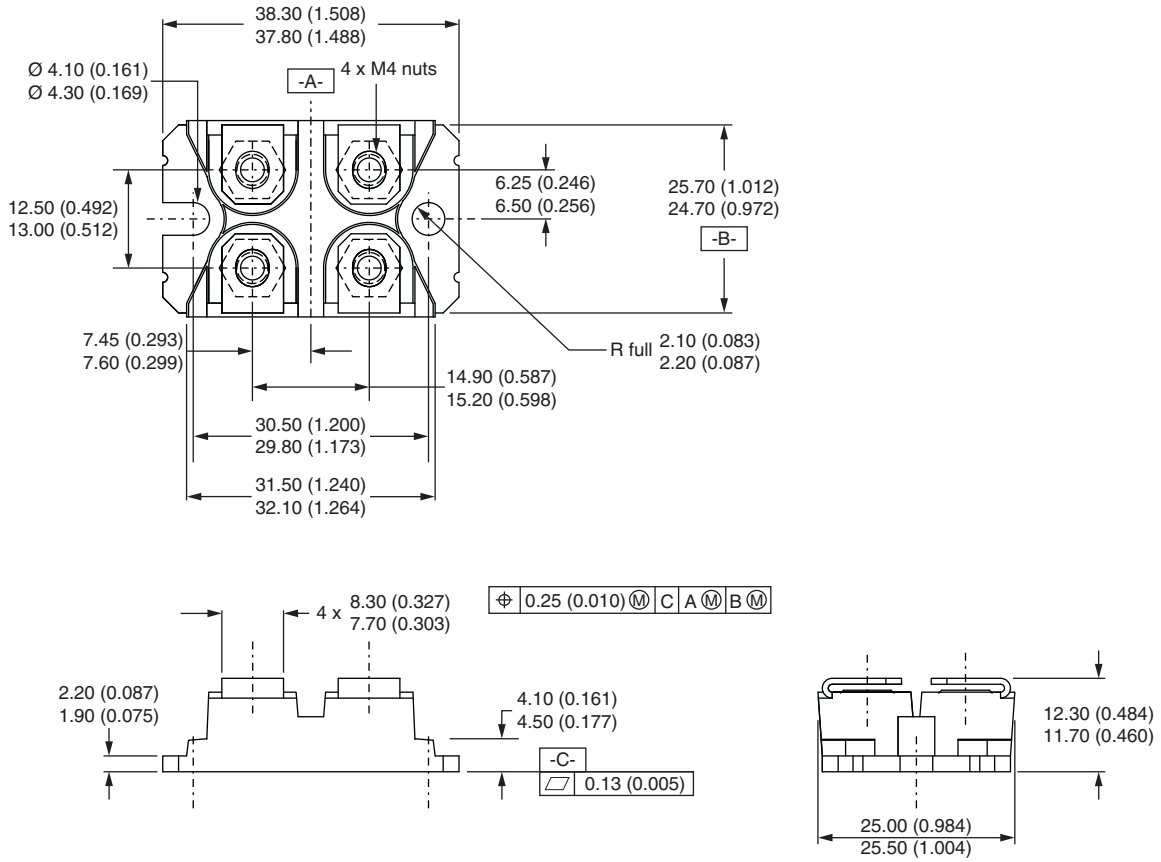
CIRCUIT CONFIGURATION

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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