Insulated Gate Bipolar Transistor (Trench IGBT), 140 A

SOT-227

PRIMARY CHARACTERISTICS	
V_{CES}	600 V
I_C DC	140 A at 90 °C
$V_{CE(on)}$ 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 configuration	Single switch with AP diode

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

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	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

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			Torque to terminal	-	-	1.1 (9.7)	Nm (lbf.in)
			Torque to heatsink	-	-	1.8 (15.9)	Nm (lbf.in)
Case style		SOT-227					

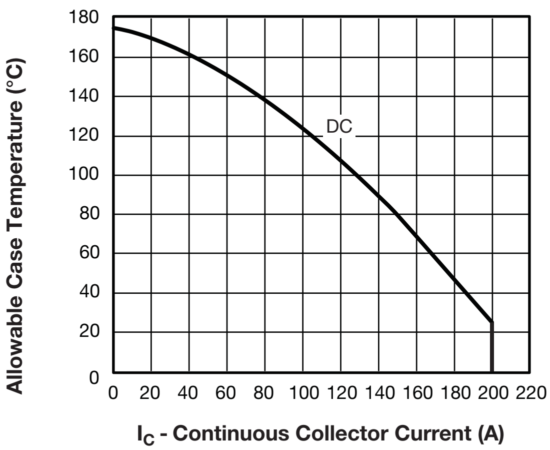


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

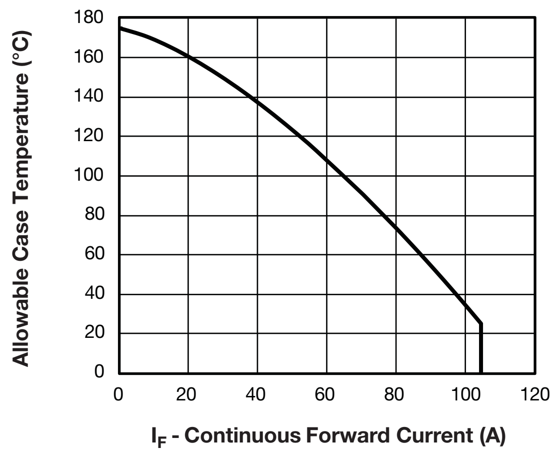


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

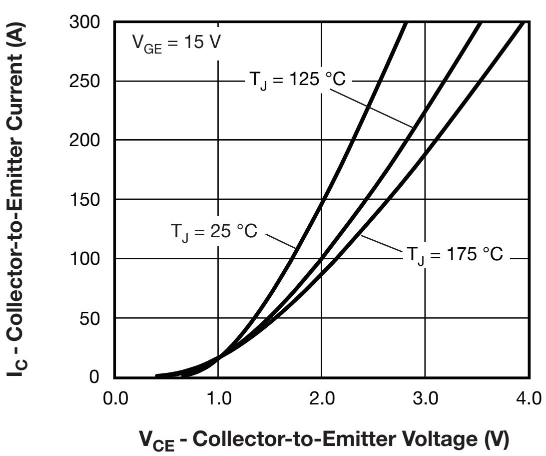


Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

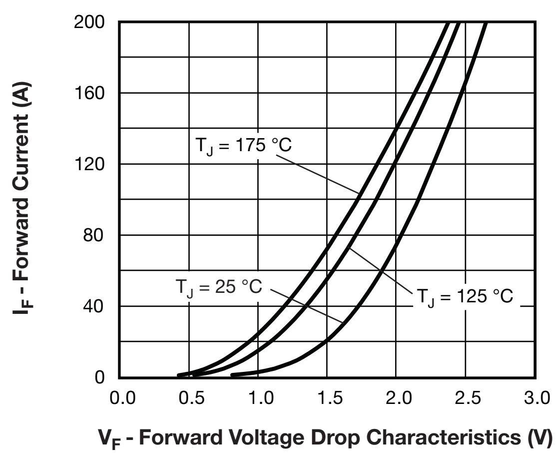


Fig. 4 - Typical Diode Forward Voltage Drop Characteristics

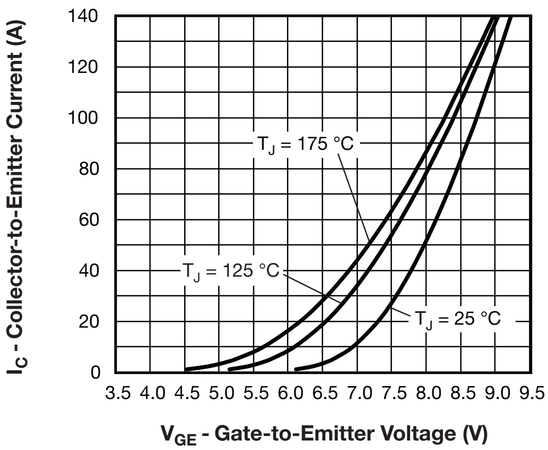


Fig. 5 - Typical IGBT Transfer Characteristics

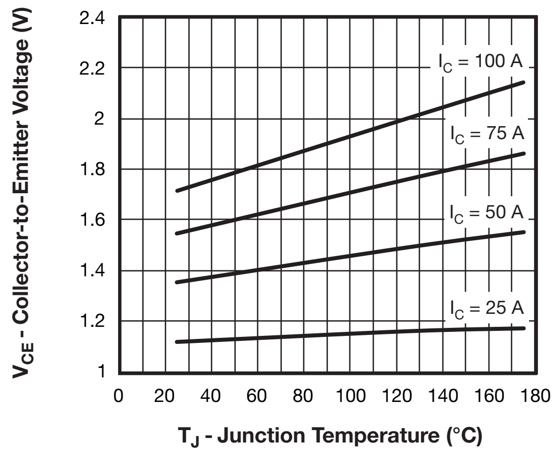


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, V_{GE} = 15 V

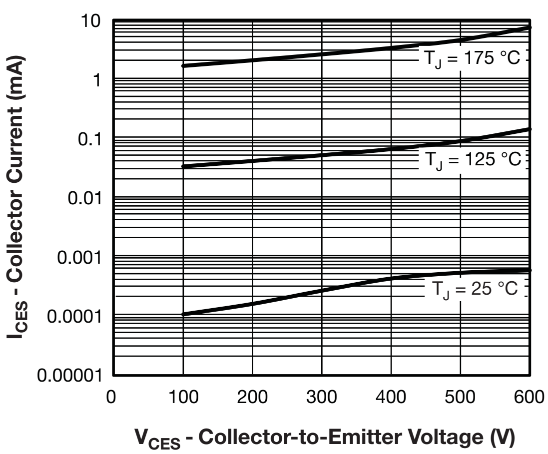


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

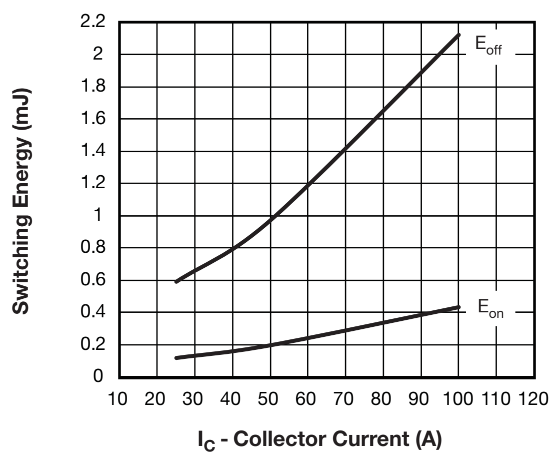


Fig. 9 - Typical IGBT Energy Losses vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

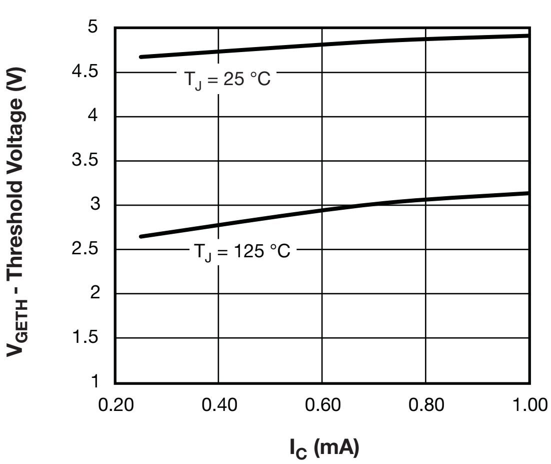


Fig. 7 - Typical IGBT Threshold Voltage

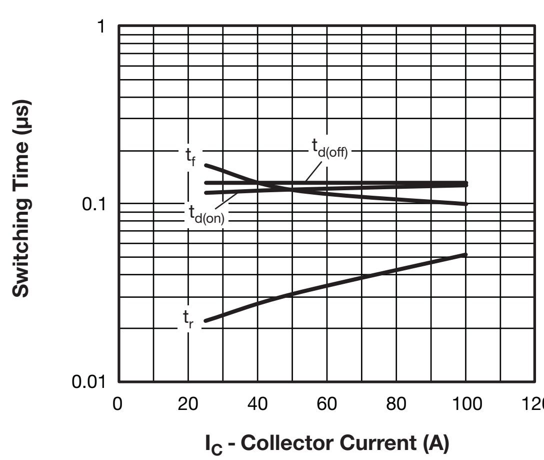


Fig. 10 - Typical IGBT Switching Time vs. I_C
T_J = 125 °C, L = 500 µH, V_{CC} = 360 V,
R_g = 5 Ω, V_{GE} = 15 V, Diode used: 60APH06

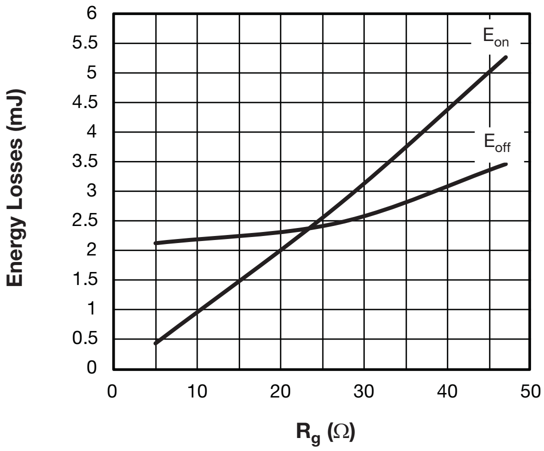


Fig. 11 - Typical IGBT Energy Loss vs. R_g
T_J = 125 °C, I_C = 100 A, L = 500 μH,
V_{CC} = 360 V, V_{GE} = 15 V, Diode used: 60APH06

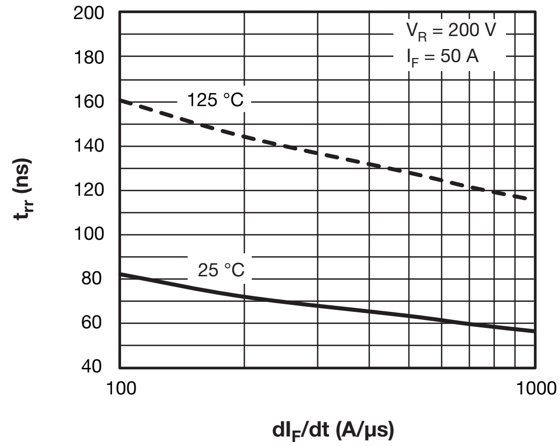


Fig. 13 - Typical Reverse Recovery Time vs. dI_F/dt of Diode

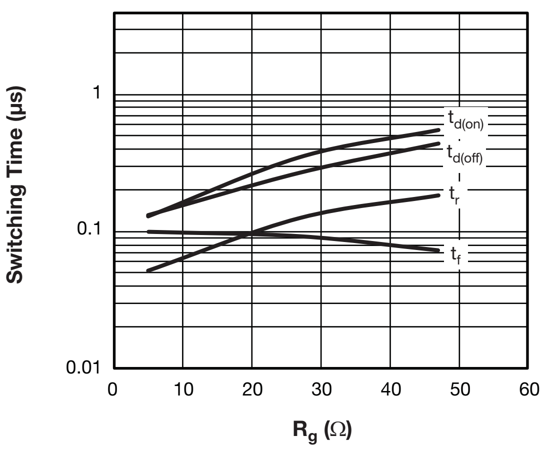


Fig. 12 - Typical IGBT Switching Time vs. R_g
T_J = 125 °C, L = 500 μH, V_{CC} = 360 V,
I_C = 100 A, V_{GE} = 15 V, Diode used: 60APH06

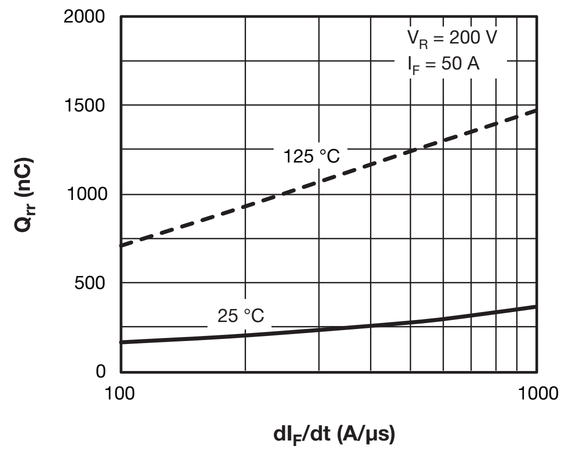


Fig. 14 - Typical Stored Charge vs. dI_F/dt of Diode

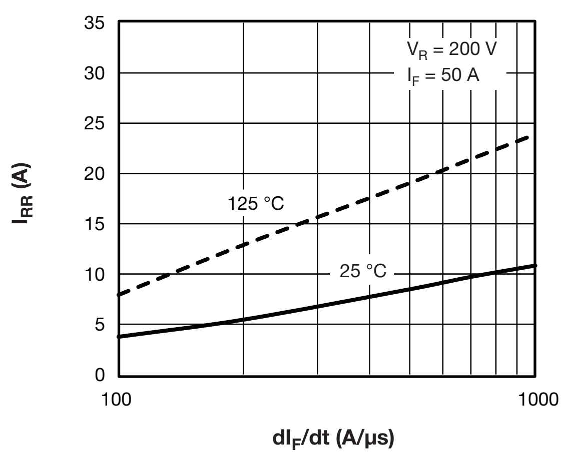


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode

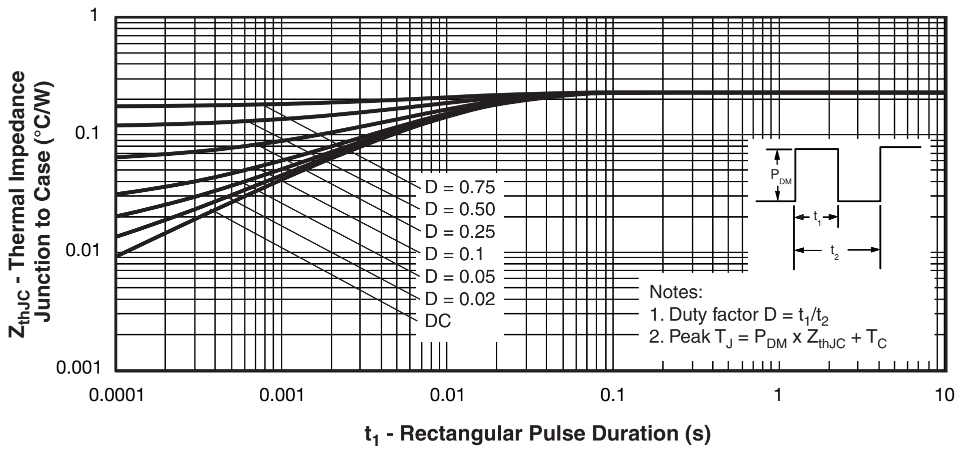


Fig. 16 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

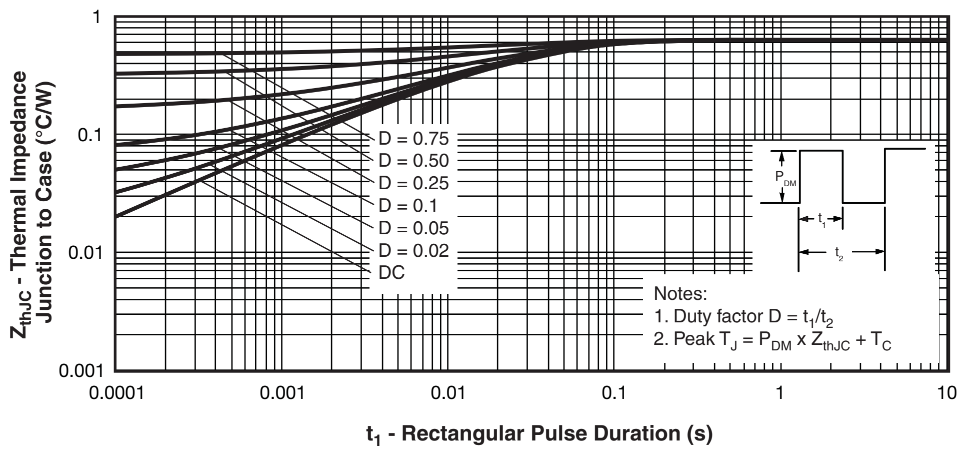


Fig. 17 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

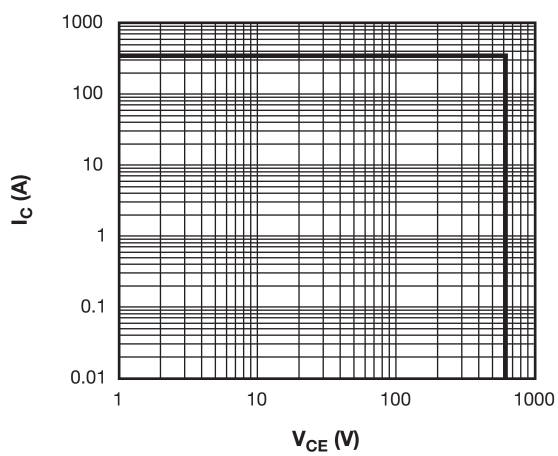
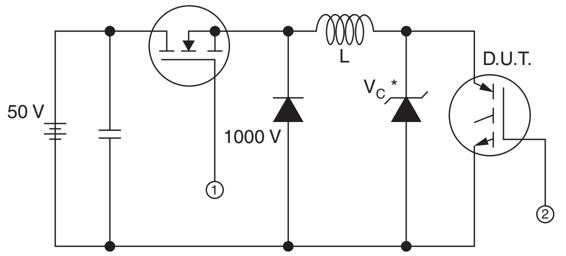


Fig. 18 - IGBT Reverse BIAS SOA, T_J = 175 °C, V_{GE} = 15 V



* 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

Fig. 19 - Clamped Inductive Load Test Circuit

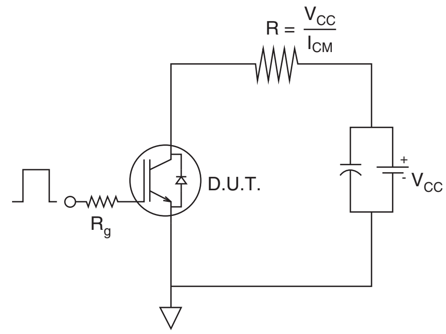


Fig. 20 - Pulsed Collector Current Test Circuit

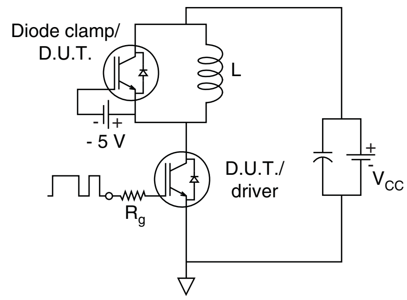
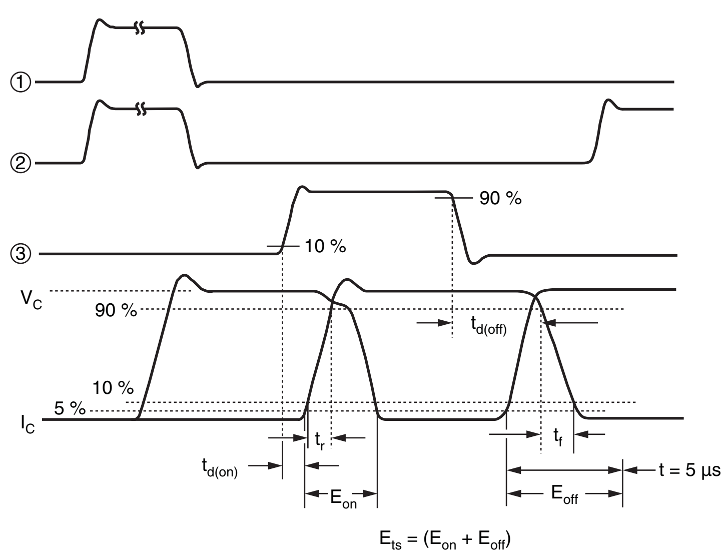


Fig. 21 - Switching Loss Test Circuit



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

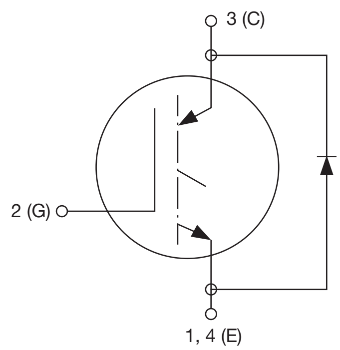
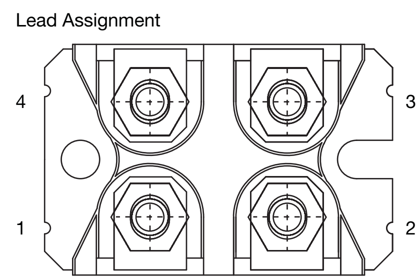
Fig. 22 - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

Device code

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

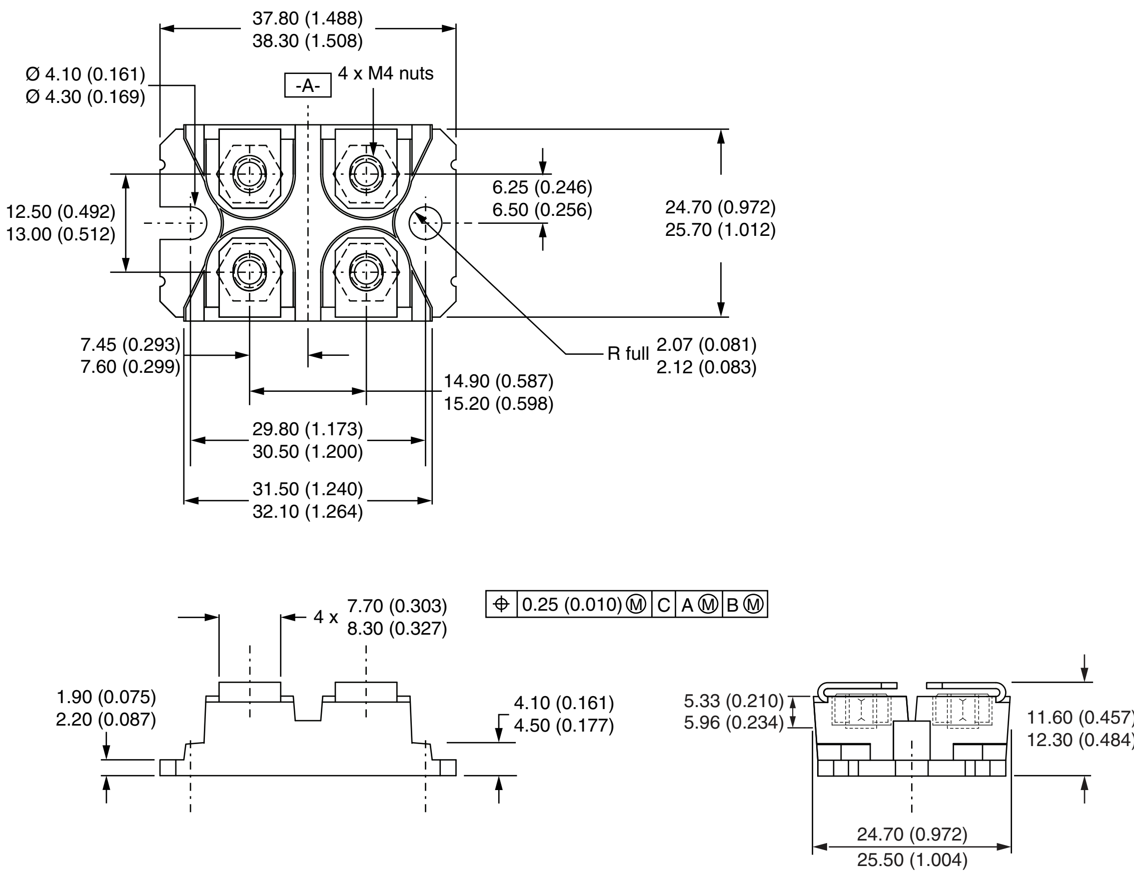
1 - Vishay Semiconductors product
2 - Insulated Gate Bipolar Transistor (IGBT)
3 - T = trench IGBT Technology
4 - Current rating (140 = 140 A)
5 - Circuit configuration (D = single switch with antiparallel diode)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (60 = 600 V)
8 - Speed/type (U = ultrafast IGBT)

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

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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