

Insulated Gate Bipolar Transistor (Trench IGBT), 140 A


SOT-227

PRIMARY CHARACTERISTICS

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 configuration	Single switch with AP diode

Note

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

FEATURES

- Trench IGBT technology with positive temperature coefficient
- Square RBSOA
- 3 μ s 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


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 ⁽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 ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CES)}$	$V_{GE} = 0\text{ V}$, $I_C = 250\text{ }\mu\text{A}$	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$	-	1.7	2.0	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.0	2.2	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 175\text{ }^{\circ}\text{C}$	-	2.15	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	3.5	4.6	6.5	
		$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.65	-	
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 $125\text{ }^{\circ}\text{C}$)	-	-16.8	-	mV/ $^{\circ}\text{C}$
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$	-	0.6	100	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	0.15	3	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 175\text{ }^{\circ}\text{C}$	-	8	-	
Forward voltage drop, diode	V_{FM}	$I_F = 40\text{ A}$, $V_{GE} = 0\text{ V}$	-	1.74	2.2	V
		$I_F = 40\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.35	1.74	
		$I_F = 40\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	1.2	-	
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
Turn-on switching loss	E_{on}	$I_C = 100\text{ A}$, $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 5\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	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}	$I_C = 100\text{ A}$, $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 5\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	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	$T_J = 175\text{ }^{\circ}\text{C}$, $I_C = 350\text{ A}$, $R_g = 22\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0 V , $V_{CC} = 400\text{ V}$, $V_P = 600\text{ V}$, $L = 500\text{ }\mu\text{H}$	Fullsquare			
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $di_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$	-	72	-	ns
Diode reverse recovery current	I_{rr}		-	5.5	-	A
Diode recovery charge	Q_{rr}		-	200	-	nC
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $di_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	144	-	ns
Diode peak reverse current	I_{rr}		-	13	-	A
Diode recovery charge	Q_{rr}		-	930	-	nC
Short circuit safe operating area	SCSOA	$T_J = 175\text{ }^{\circ}\text{C}$, $R_g = 22\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0 V , $V_{CC} = 400\text{ V}$, $V_P = 600\text{ V}$	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	R_{thJC}	IGBT	-	-	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				

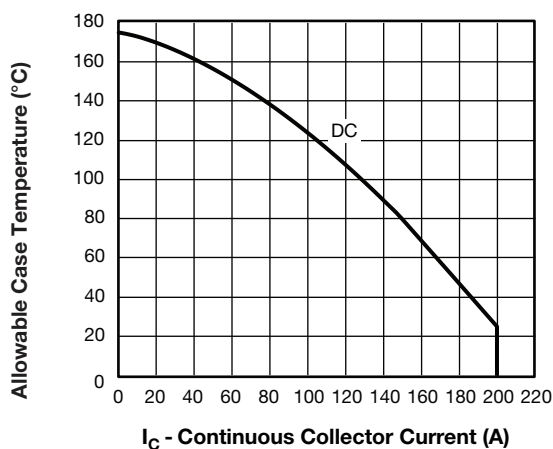


Fig. 1 - Maximum DC IGBT Collector Current vs. Case Temperature

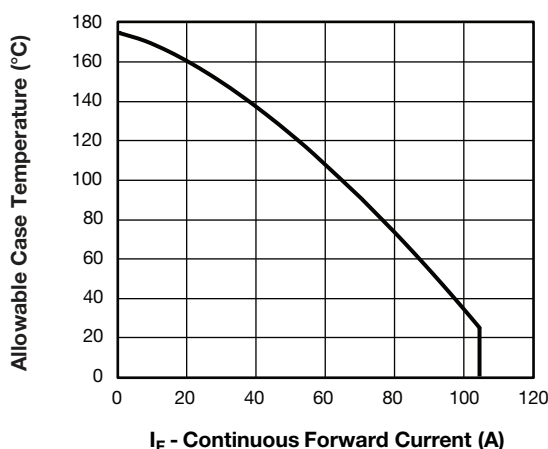


Fig. 3 - Maximum Allowable Forward Current vs. Case Temperature, Diode Leg

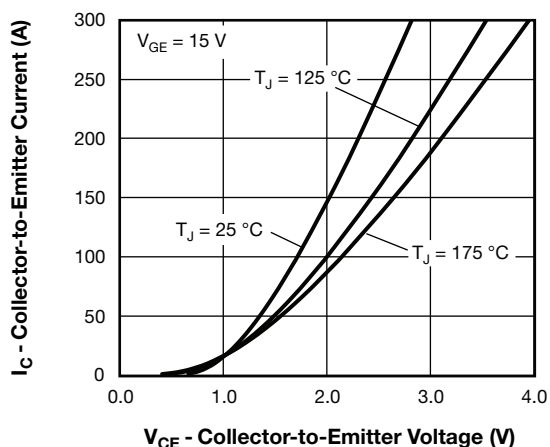


Fig. 2 - Typical Collector to Emitter Current Output Characteristics of IGBT

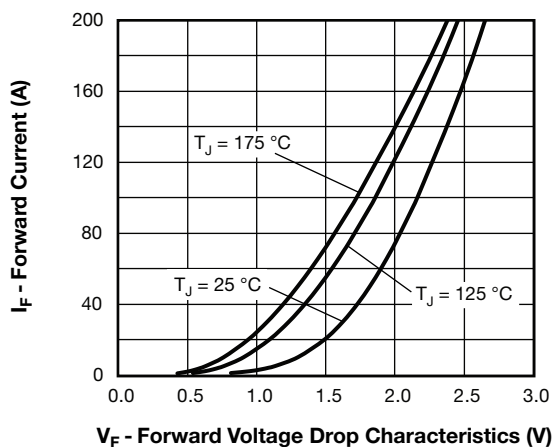


Fig. 4 - Typical Diode Forward Voltage Drop Characteristics

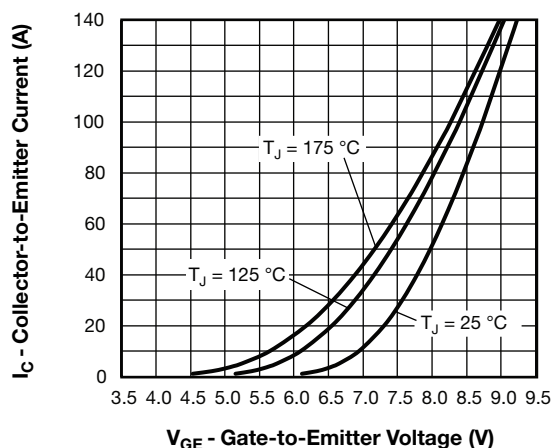


Fig. 5 - Typical IGBT Transfer Characteristics

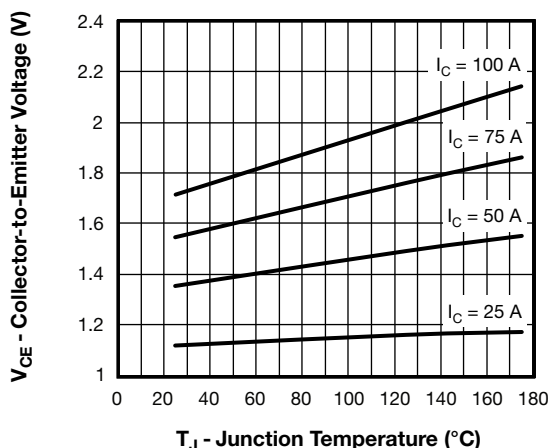


Fig. 8 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE} = 15\text{ V}$

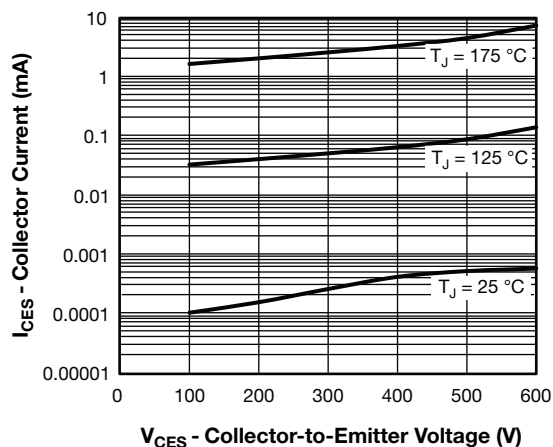


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

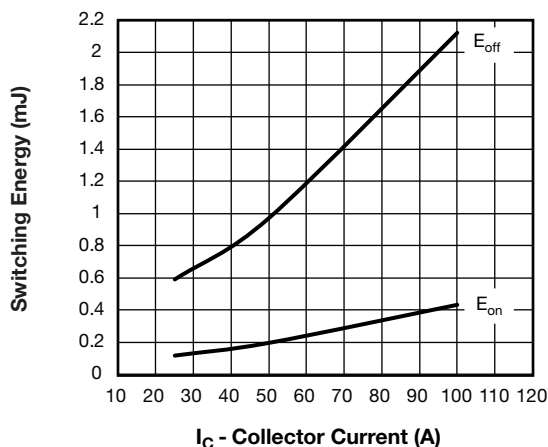


Fig. 9 - Typical IGBT Energy Losses vs. I_C
 $T_J = 125\text{ °C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

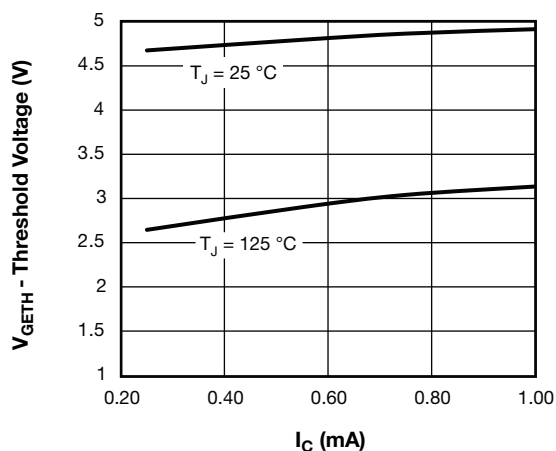


Fig. 7 - Typical IGBT Threshold Voltage

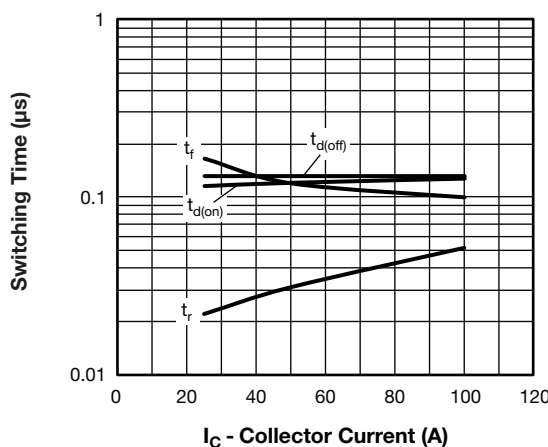


Fig. 10 - Typical IGBT Switching Time vs. I_C
 $T_J = 125\text{ °C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $R_g = 5\text{ }\Omega$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

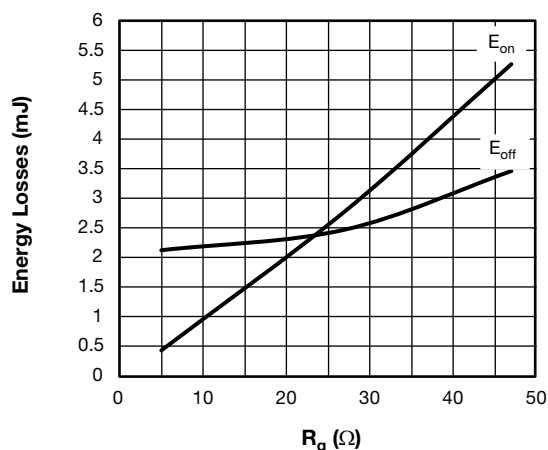


Fig. 11 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125^\circ\text{C}$, $I_C = 100\text{ A}$, $L = 500\text{ }\mu\text{H}$,
 $V_{CC} = 360\text{ V}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

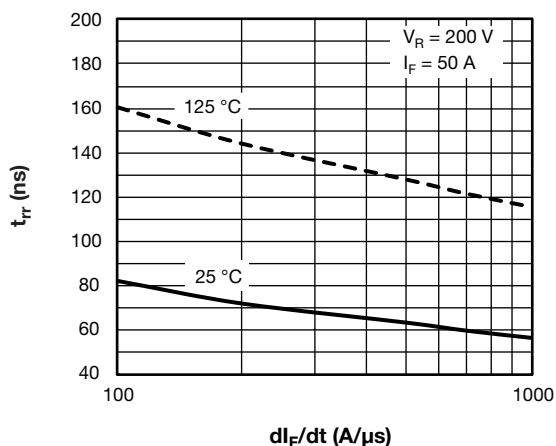


Fig. 13 - Typical Reverse Recovery Time vs. dI_F/dt of Diode

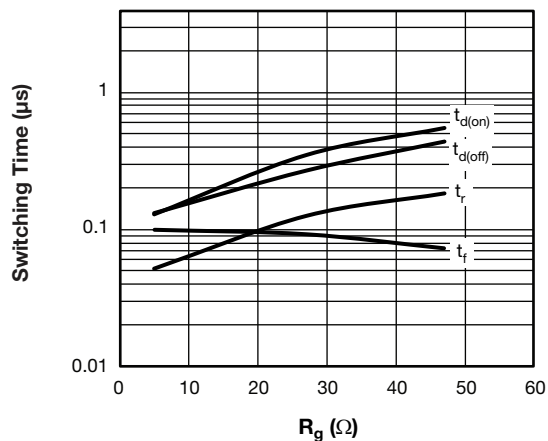


Fig. 12 - Typical IGBT Switching Time vs. R_g
 $T_J = 125^\circ\text{C}$, $L = 500\text{ }\mu\text{H}$, $V_{CC} = 360\text{ V}$,
 $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, Diode used: 60APH06

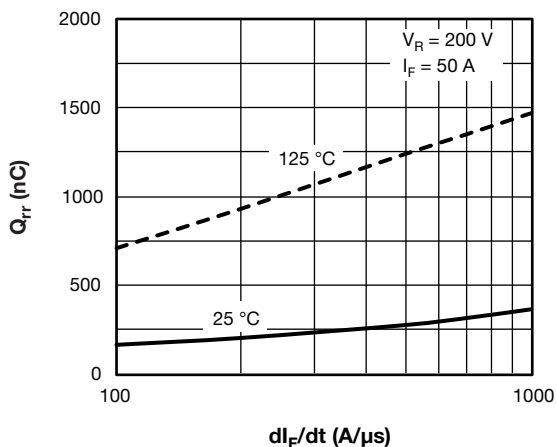


Fig. 14 - Typical Stored Charge vs. dI_F/dt of Diode

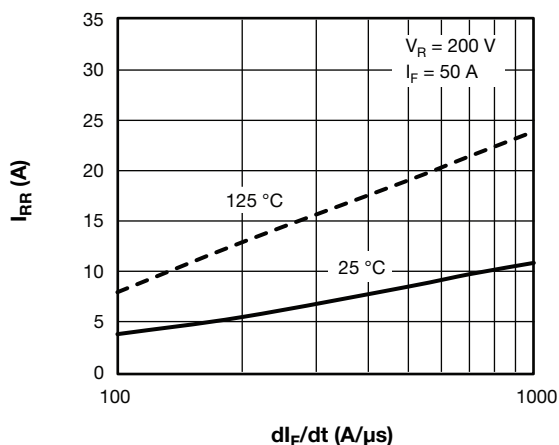
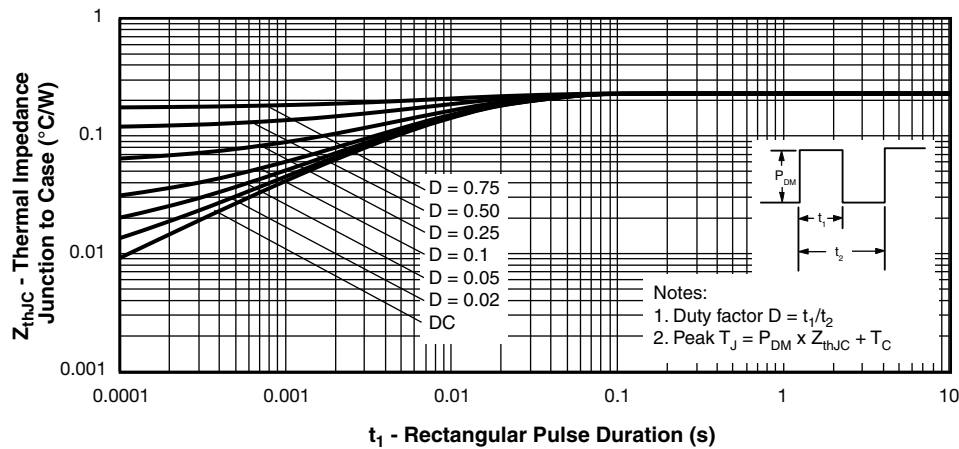
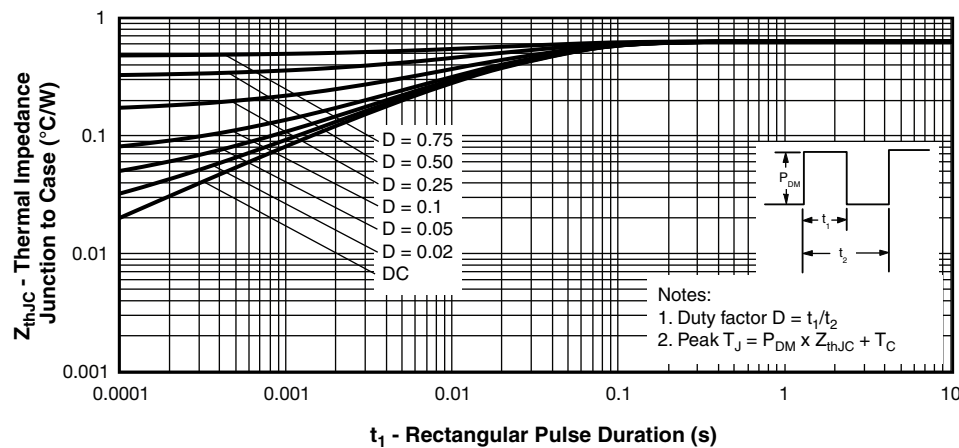
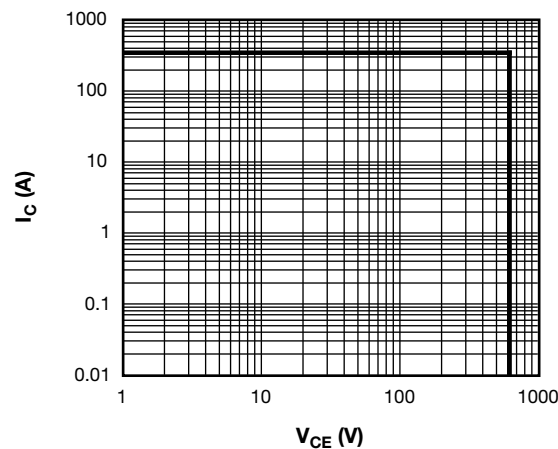


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode


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

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

Fig. 18 - IGBT Reverse BIAS SOA, $T_J = 175^{\circ}C$, $V_{GE} = 15V$

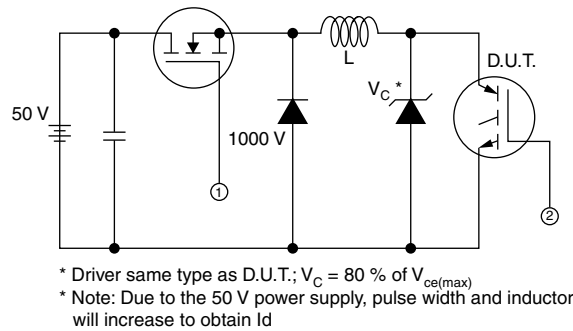


Fig. 19 - Clamped Inductive Load Test Circuit

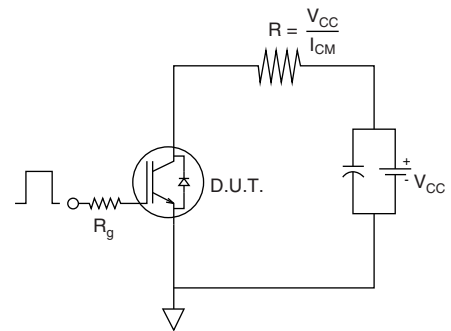


Fig. 20 - Pulsed Collector Current Test Circuit

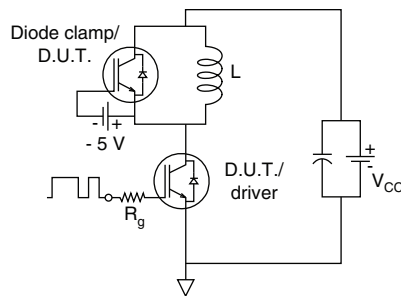


Fig. 21 - Switching Loss Test Circuit

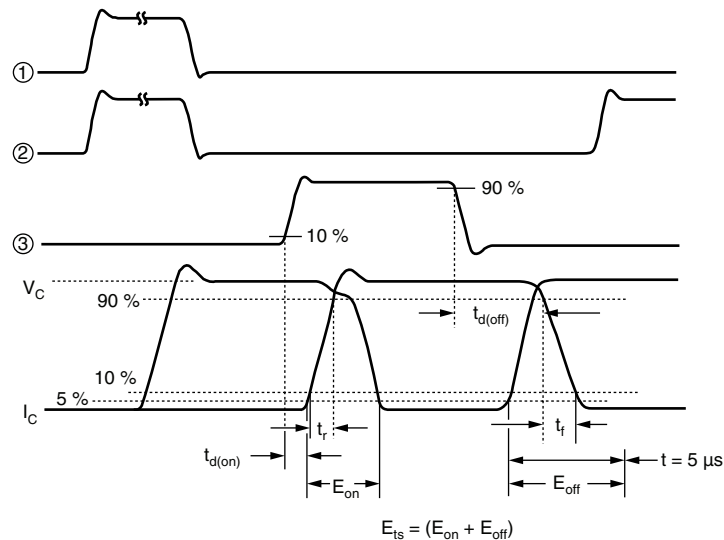
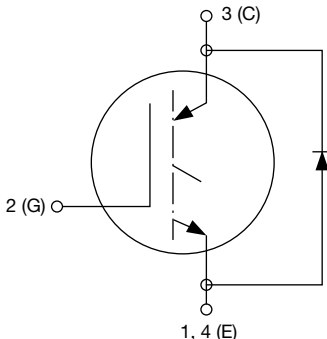
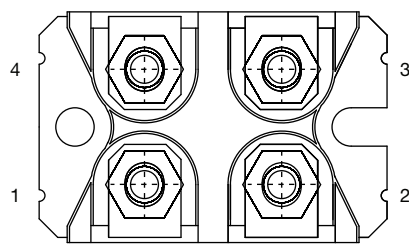


Fig. 22 - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

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

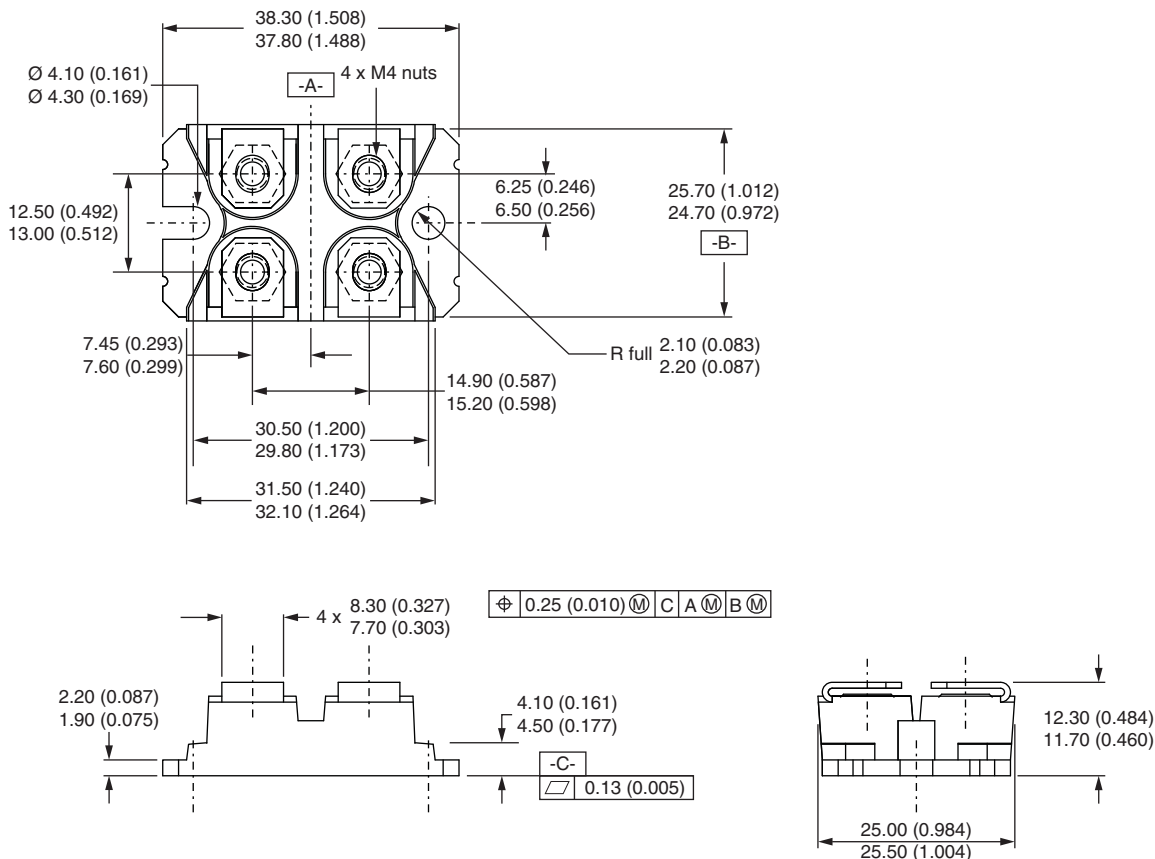
- | | | |
|----------|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated Gate Bipolar Transistor (IGBT) |
| 3 | - | T = trench IGBT Technology |
| 4 | - | Current rating (140 = 140 A) |
| 5 | - | Circuit configuration (D = single switch with antiparallel diode) |
| 6 | - | Package 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 II

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter



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