

Insulated Gate Bipolar Transistor (High Speed Trench IGBT), 93 A



SOT-227

PRIMARY CHARACTERISTICS

V_{CES}	600 V
I_C DC	90 A at 92 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	1.64 V
I_F DC	90 A at 103 °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
- HEXFRED® anti-parallel 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
- 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	$T_C = 25\text{ °C}$	146	A
		$T_C = 90\text{ °C}$	92	
Pulsed collector current	I_{CM}	$T_C = 150\text{ °C}$, $t_p = 6\text{ ms}$, $V_{GE} = 15\text{ V}$	300	
Clamped inductive load current	I_{LM}		300	
Diode continuous forward current	I_F	$T_C = 25\text{ °C}$	100	
		$T_C = 90\text{ °C}$	108	
Gate-to-emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	$T_C = 25\text{ °C}$	446	W
		$T_C = 90\text{ °C}$	214	
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, $t = 1\text{ min}$	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	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}$, $I_C = 400\text{ }\mu\text{A}$	600	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$	-	1.64	2.15	V
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.85	-	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	1.91	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 1.0\text{ mA}$	2.9	4.1	5.3	
		$V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	3.1	-	
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}	$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$	-	1.5	100	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	1.0	-	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	3.5	-	
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	-	
		$I_C = 100\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	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} = 520 V, V _{GE} = 15 V		-	247	-	nC	
Gate to emitter charge (turn-on)	Q _{ge}			-	39	-		
Gate to collector charge (turn-on)	Q _{gc}			-	85	-		
Turn-on switching loss	E _{on}	I _C = 100 A, V _{CC} = 300 V, V _{GE} = 15 V, R _g = 15 Ω, L = 500 μH, T _J = 25 °C	Energy losses include tail and diode recovery. Used Antiparallel diode	-	1.89	-	mJ	
Turn-off switching loss	E _{off}			-	0.88	-		
Total switching loss	E _{tot}			-	2.77	-		
Turn-on delay time	t _{d(on)}			-	50	-	ns	
Rise time	t _r			-	67	-		
Turn-off delay time	t _{d(off)}			-	162	-		
Fall time	t _f			-	25	-	mJ	
Turn-on switching loss	E _{on}	I _C = 100 A, V _{CC} = 300 V, V _{GE} = 15 V, R _g = 15 Ω, L = 500 μH, T _J = 125 °C		-	1.81	-		
Turn-off switching loss	E _{off}			-	1.0	-		
Total switching loss	E _{tot}			-	2.81	-		
Turn-on delay time	t _{d(on)}			-	50	-	ns	
Rise time	t _r			-	66	-		
Turn-off delay time	t _{d(off)}			-	174	-		
Fall time	t _f			-	23	-		
Reverse bias safe operating area	RBSOA	T _J = 150 °C, I _C = 100 A, R _g = 15 Ω, V _{GE} = 15 V to 0 V, V _{CC} = 300 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	$^{\circ}\text{C}$
Junction to case	R_{thJC}		-	-	0.28	$^{\circ}\text{C/W}$
			-	-	0.33	
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					

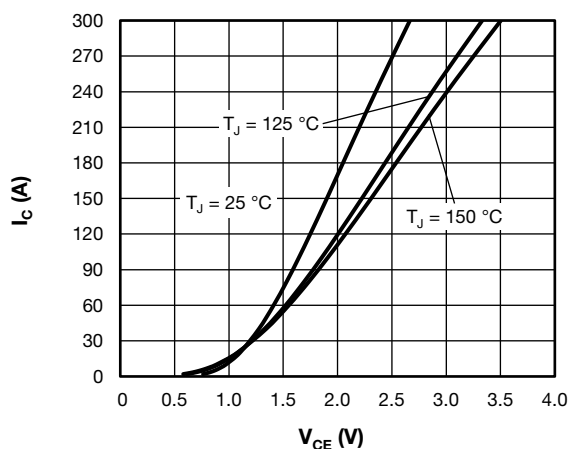


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

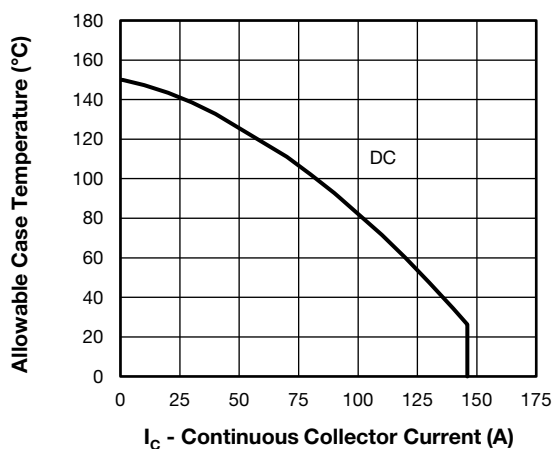


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

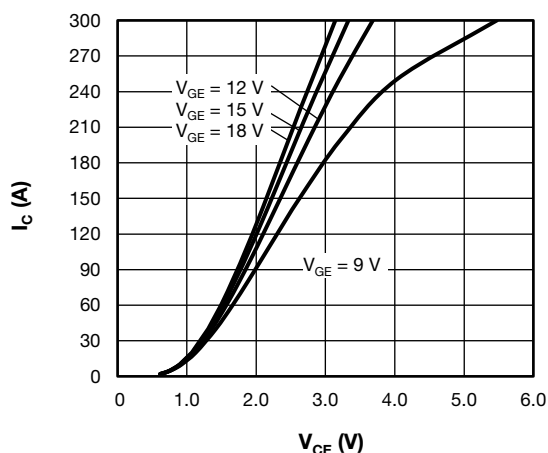


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ }^{\circ}\text{C}$

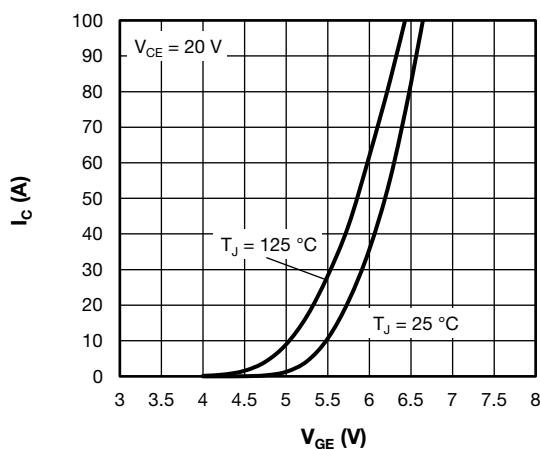


Fig. 4 - Typical Trench IGBT Transfer Characteristics

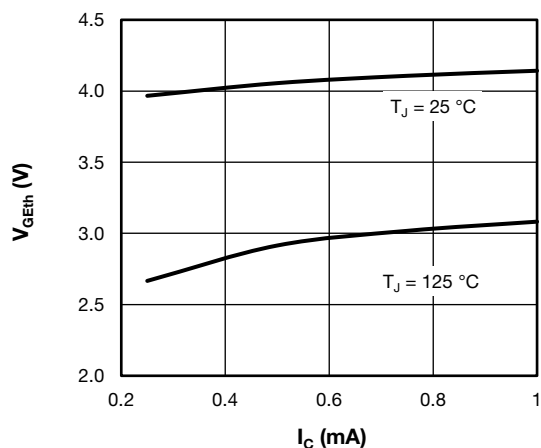
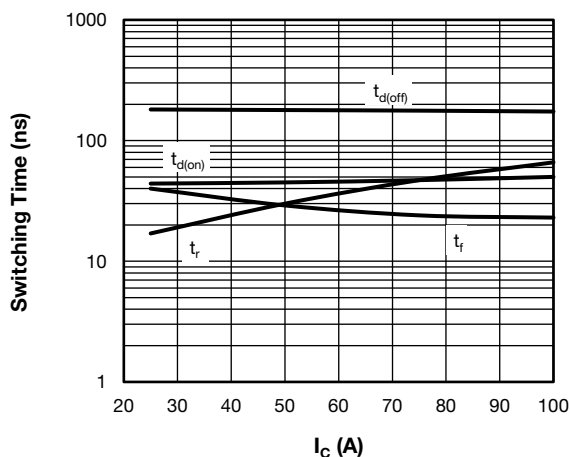


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
(with Antiparallel Diode)

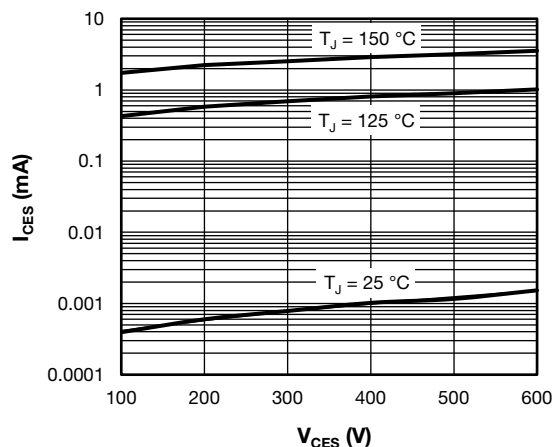
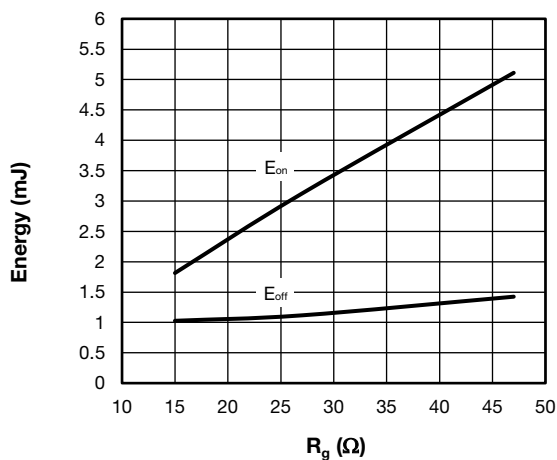
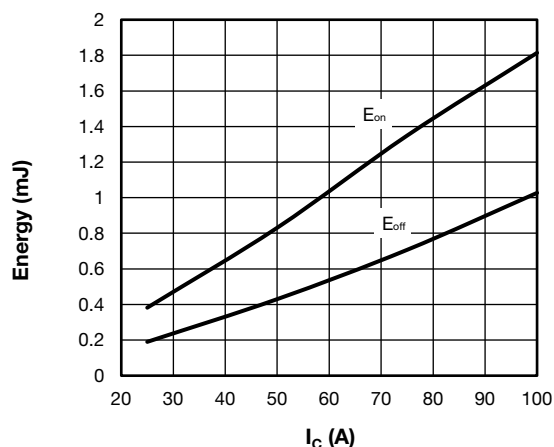
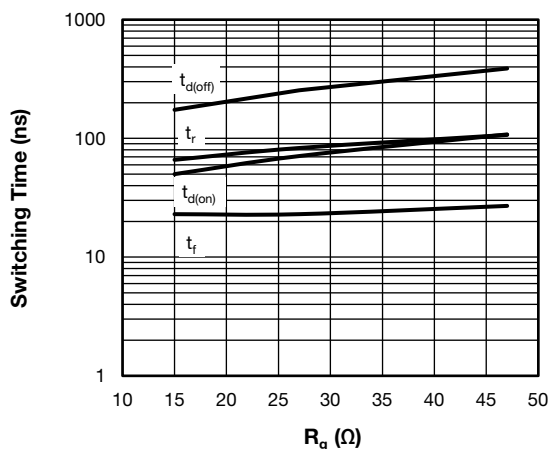
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 300\text{ V}$, $R_g = 15\text{ }\Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
(with Antiparallel Diode)

 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 300\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
(with Antiparallel Diode)

 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 300\text{ V}$, $R_g = 15\text{ }\Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 300\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

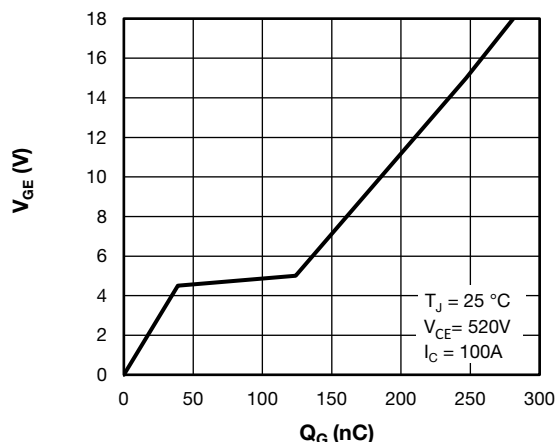


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

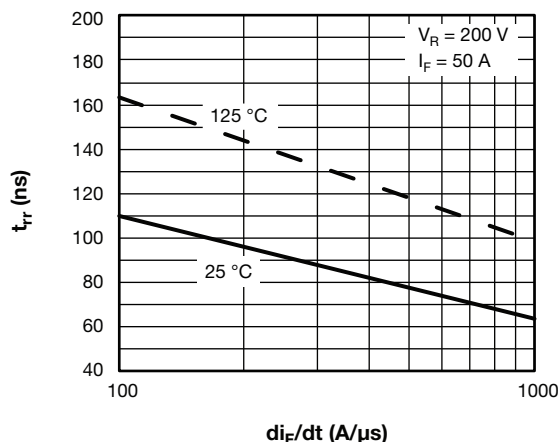


Fig. 14 - Typical Reverse Recovery Time vs. di_F/dt of Diode

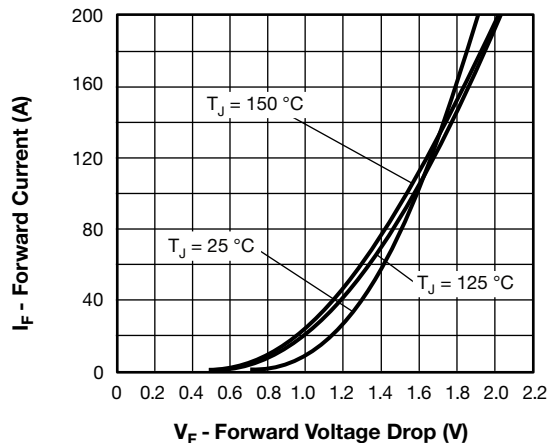


Fig. 12 - Typical Forward Voltage Drop Characteristics

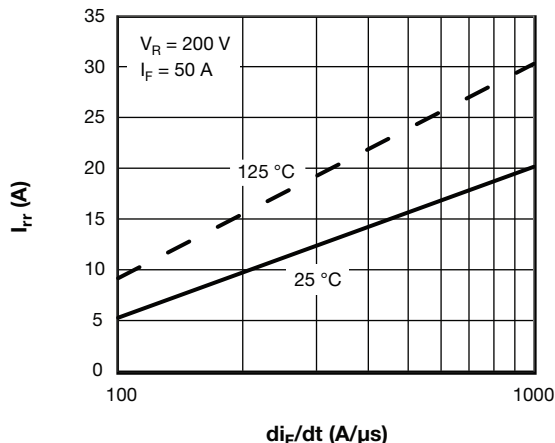


Fig. 15 - Typical Reverse Recovery Current vs. di_F/dt of Diode

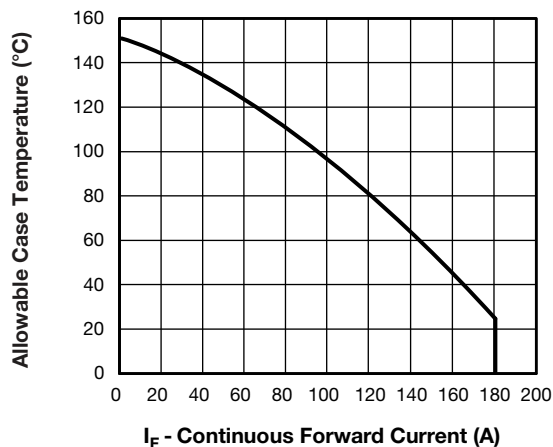


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

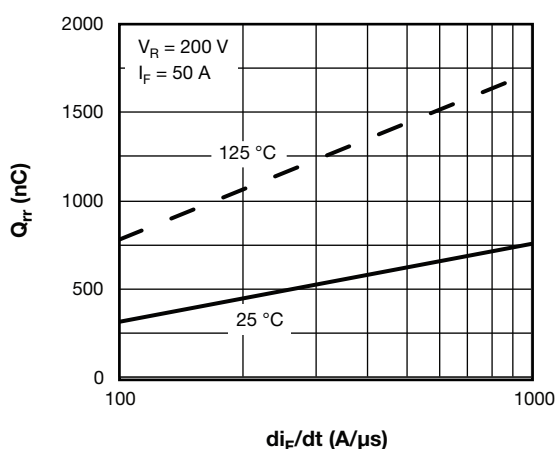


Fig. 16 - Typical Stored Charge vs. di_F/dt of Diode

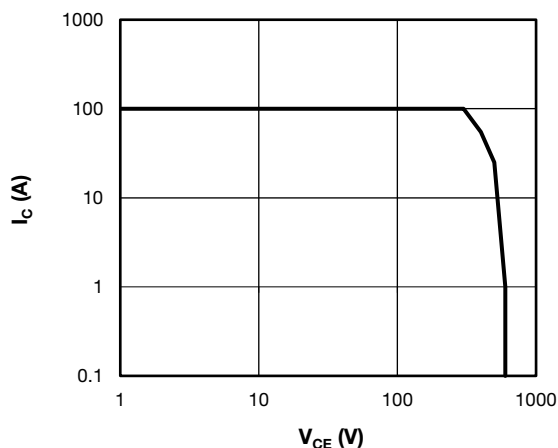


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 150\text{ }^{\circ}\text{C}$, $I_C = 100\text{ A}$, $R_{\theta} = 15\text{ }^{\circ}\text{C/W}$, $V_{GE} = +15\text{ V/0 V}$,
 $V_{CC} = 300\text{ V}_p = 600\text{ V}$

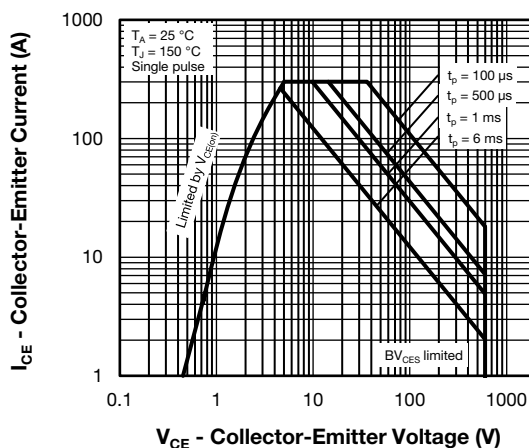


Fig. 18 - Trench IGBT Safe Operating Area

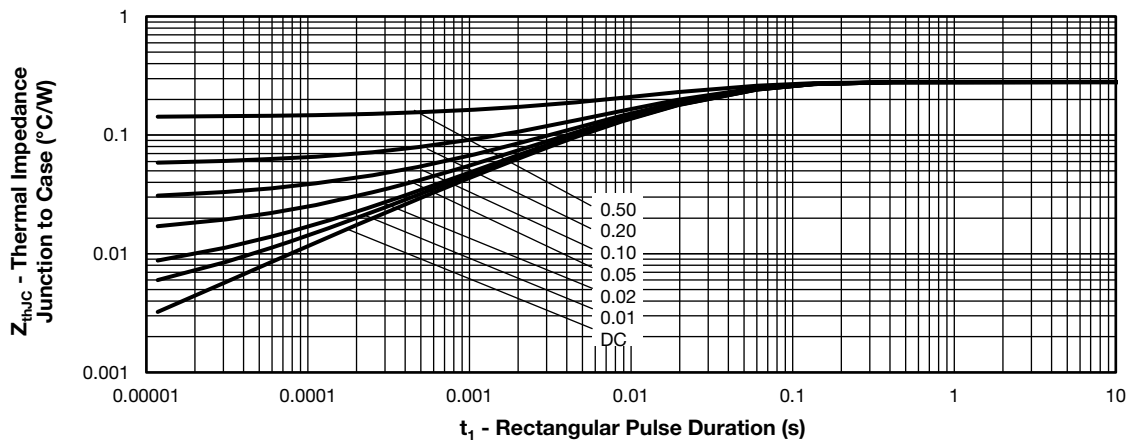


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

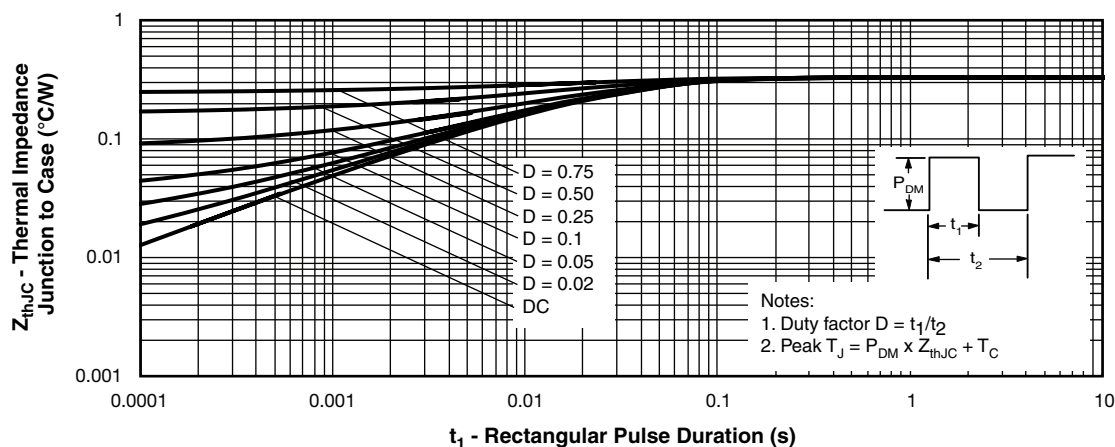
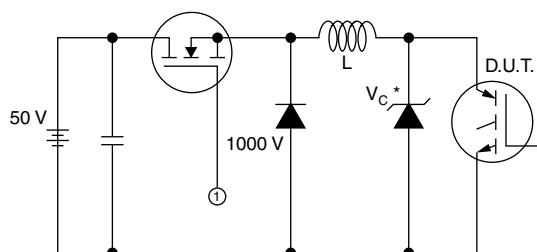


Fig. 20 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode



* 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 I_d

Fig. 21 - Clamped Inductive Load Test Circuit

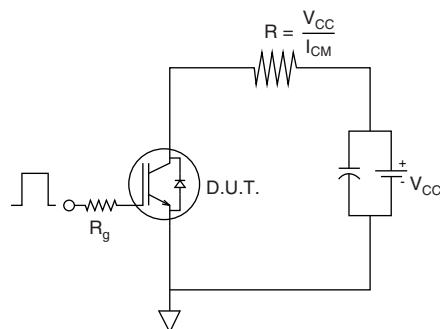


Fig. 22 - Pulsed Collector Current Test Circuit

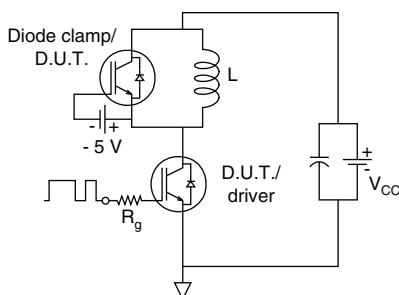


Fig. 23 - Switching Loss Test Circuit

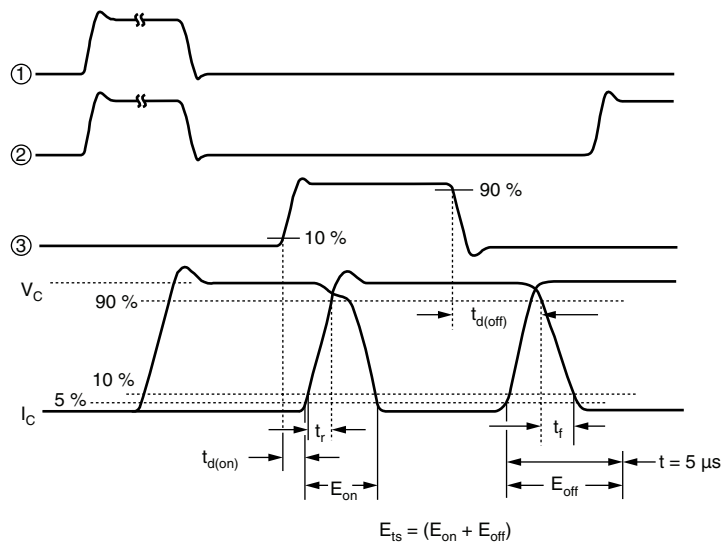
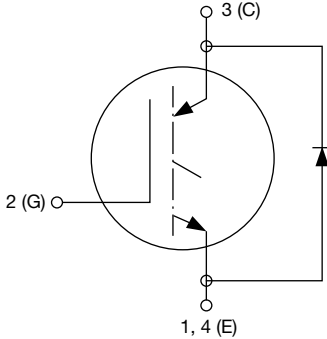


Fig. 24 - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

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

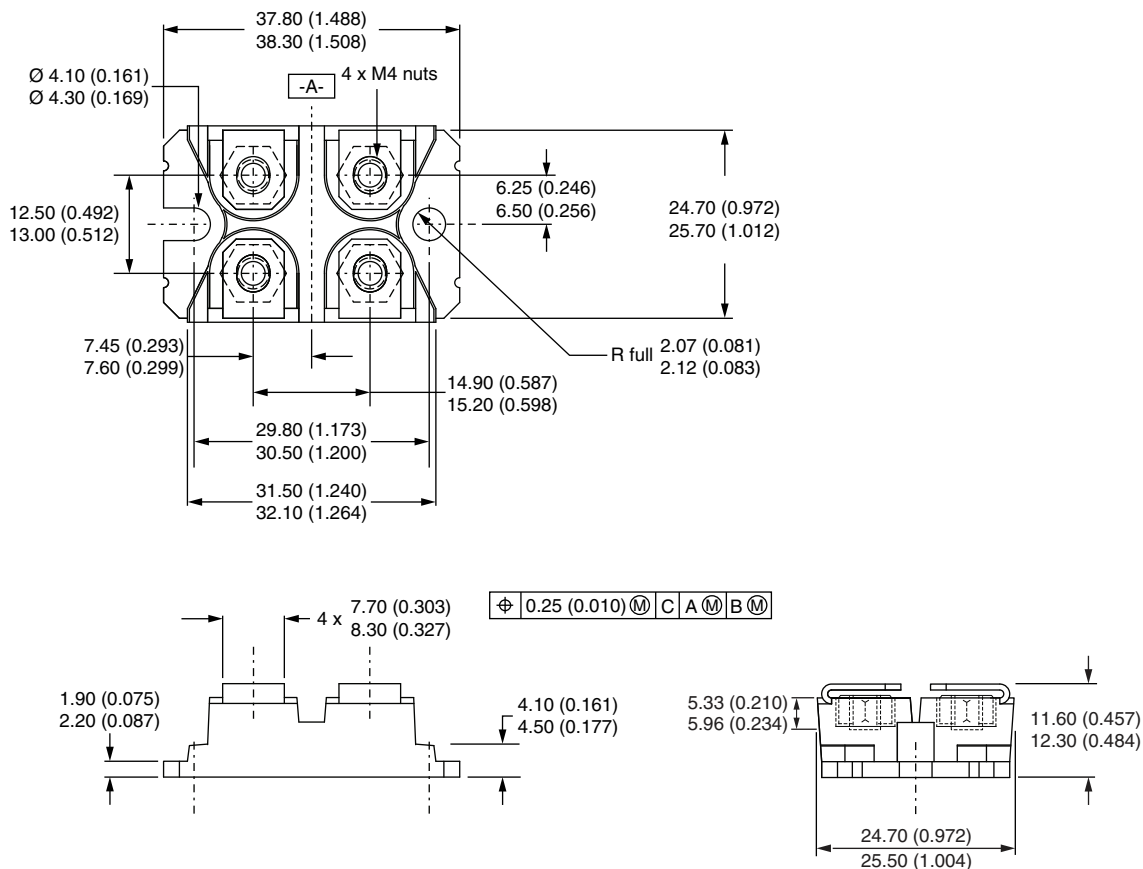
- | | | |
|----------|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated gate bipolar transistor (IGBT) |
| 3 | - | T = Trench IGBT |
| 4 | - | Current rating (90 = 90 A) |
| 5 | - | Circuit configuration (D = single switch with AP diode) |
| 6 | - | Package indicator (A = SOT-227) |
| 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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