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

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	146	A
		T_C = 90 °C	92	
Pulsed collector current	I_{CM}	T_C = 150 °C, t_p = 6 ms, V_{GE} = 15 V	300	
Clamped inductive load current	I_{LM}		300	
Diode continuous forward current	I_F	T_C = 25 °C	100	
		T_C = 90 °C	108	
Gate-to-emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	T_C = 25 °C	446	W
		T_C = 90 °C	214	
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 = 400 μA	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 100 A	-	1.64	2.15	
		V_{GE} = 15 V, I_C = 100 A, T_J = 125 °C	-	1.85	-	
		V_{GE} = 15 V, I_C = 100 A, T_J = 150°C	-	1.91	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 1.0 mA	2.9	4.1	5.3	
		V_{CE} = V_{GE}, I_C = 1 mA, T_J = 125 °C	-	3.1	-	
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	-	1.5	100	μA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C	-	1.0	-	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 150 °C	-	3.5	-	
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	-	
		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} = 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	-	
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	-	mJ
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	°C
Junction to case	IGBT	R_{thJC}		-	-	0.28	°C/W
	Diode			-	-	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					

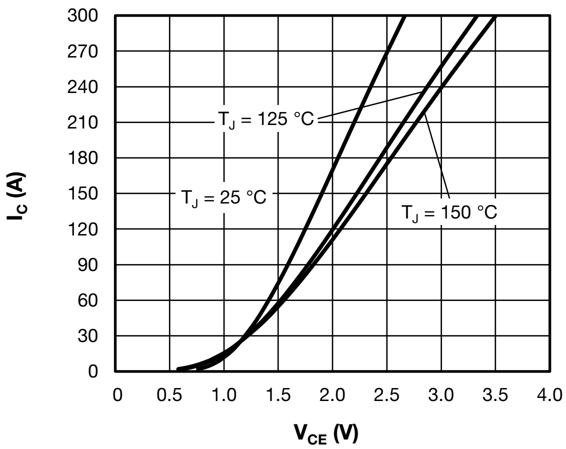


Fig. 1 - Typical Trench IGBT Output Characteristics, V_{GE} = 15 V

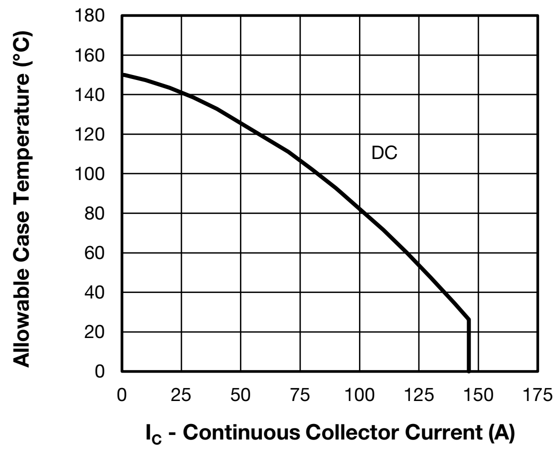


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

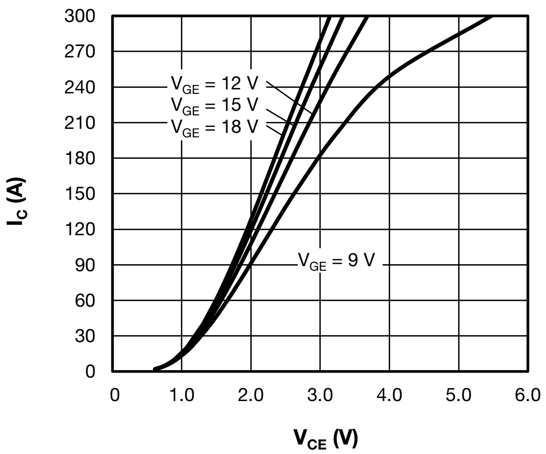


Fig. 2 - Typical Trench IGBT Output Characteristics, T_J = 125 °C

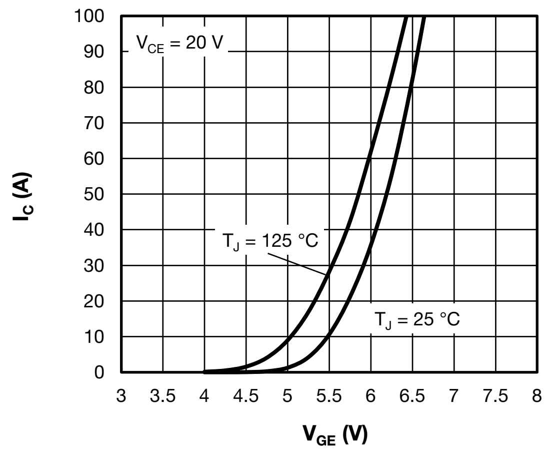


Fig. 4 - Typical Trench IGBT Transfer Characteristics

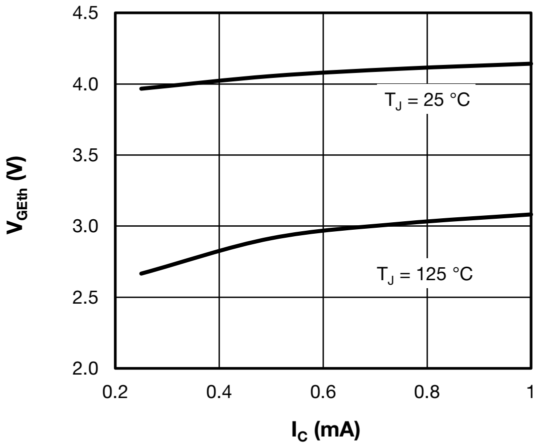


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

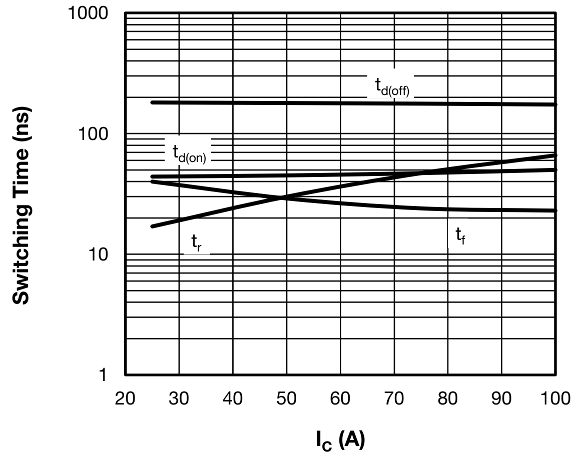


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 15 Ω, V_{GE} = +15 V/-15 V, L = 500 µH

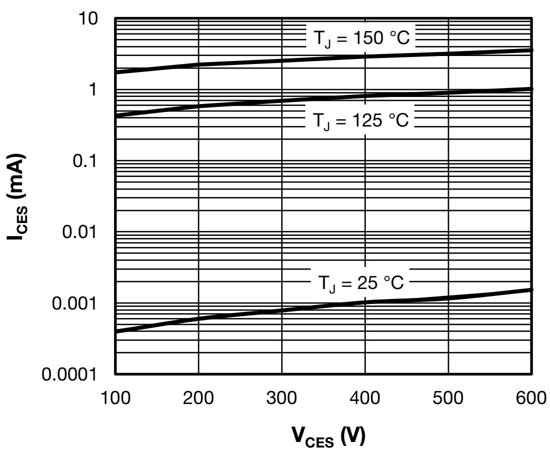


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

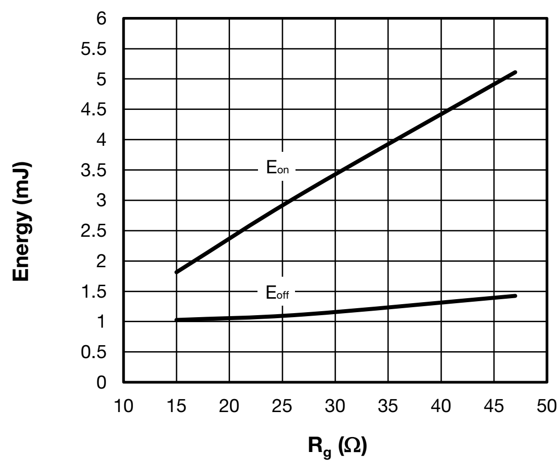


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, I_C = 100A, V_{GE} = +15 V/-15 V, L = 500 µH

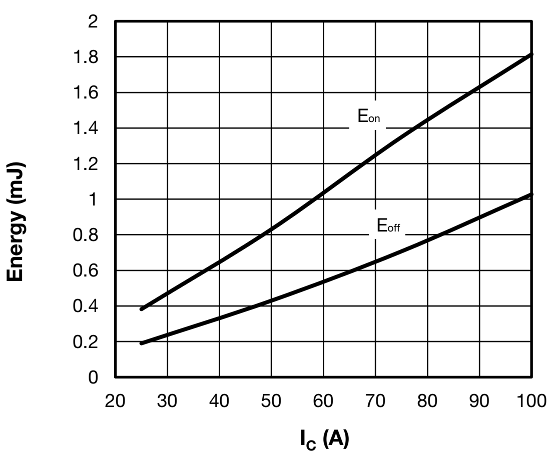


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 300 V, R_g = 15 Ω, V_{GE} = +15 V/-15 V, L = 500 µH

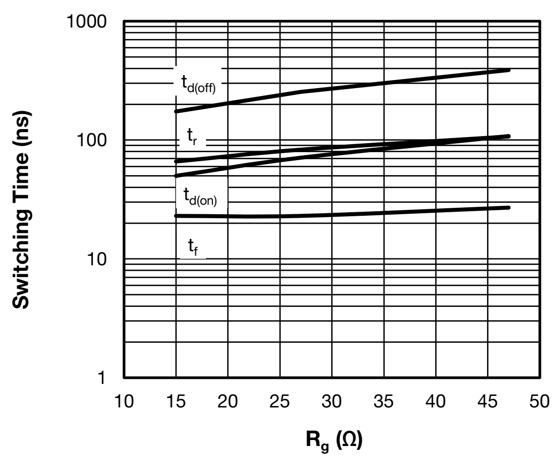


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
T_J = 125 °C, V_{CC} = 300 V, I_C = 100A, V_{GE} = +15 V/-15 V, L = 500 µH

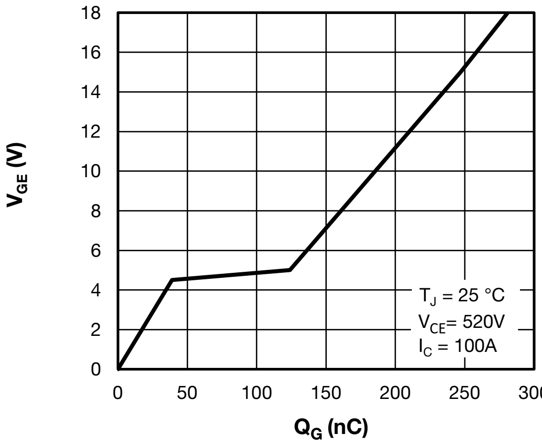


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

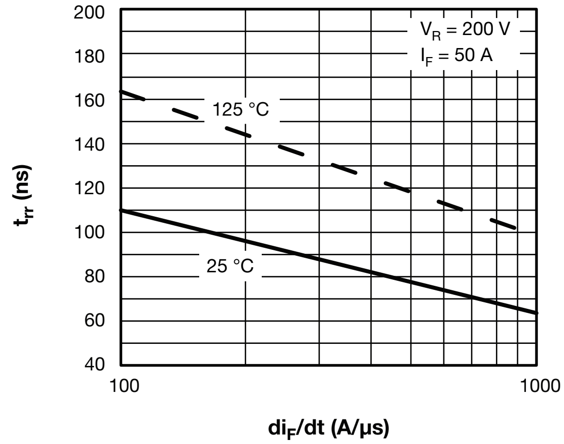


Fig. 14 - Typical Reverse Recovery Time vs. dI_F/dt of Diode

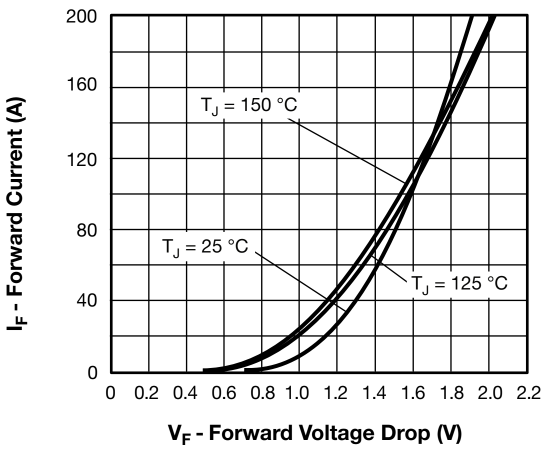


Fig. 12 - Typical Forward Voltage Drop Characteristics

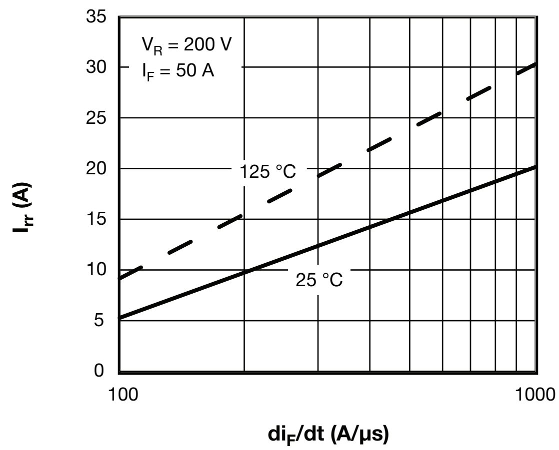


Fig. 15 - Typical Reverse Recovery Current vs. dI_F/dt of Diode

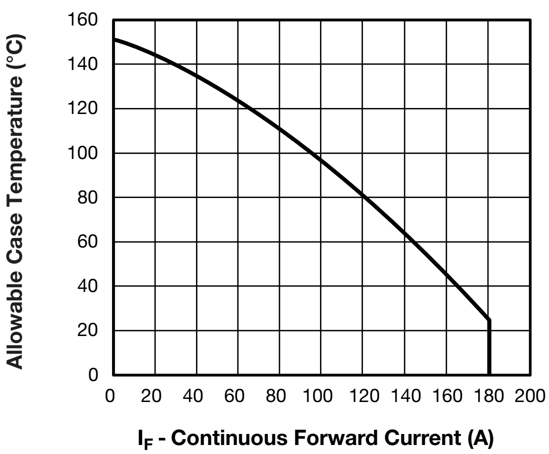


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

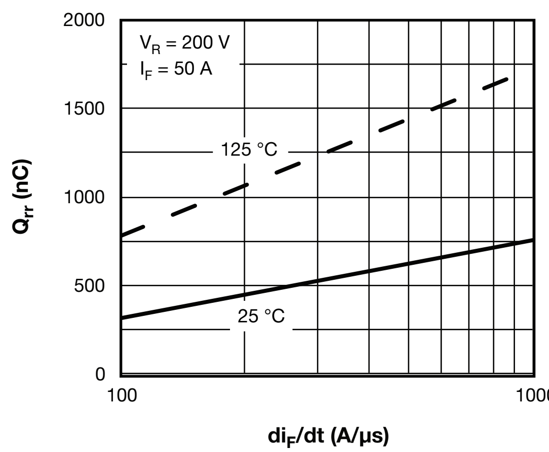


Fig. 16 - Typical Stored Charge vs. dI_F/dt of Diode

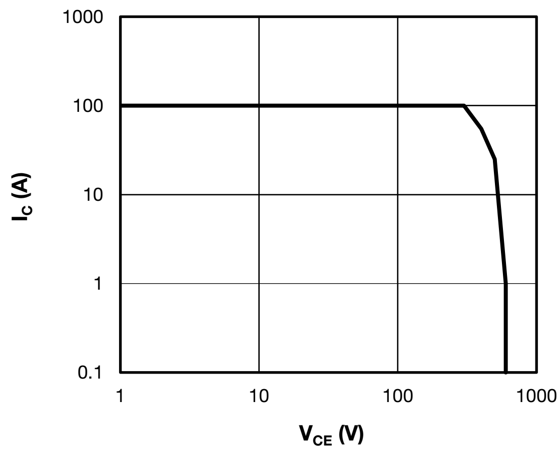


Fig. 17 - Trench IGBT Reverse BIAS SOA
T_J = 150 °C, I_C = 100A, R_g = 15 Ω, V_{GE} = +15 V/0 V,
V_{CC} = 300 V_p = 600 V

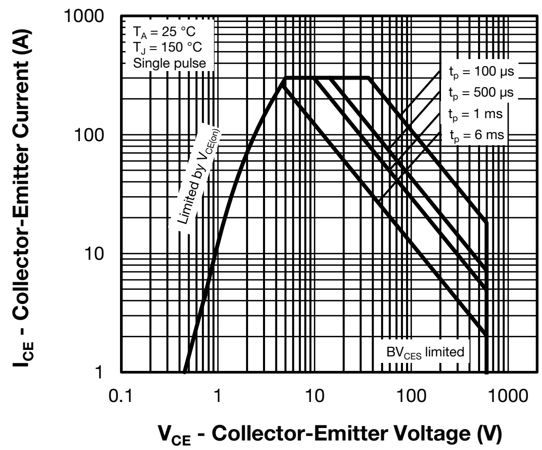


Fig. 18 - Trench IGBT Safe Operating Area

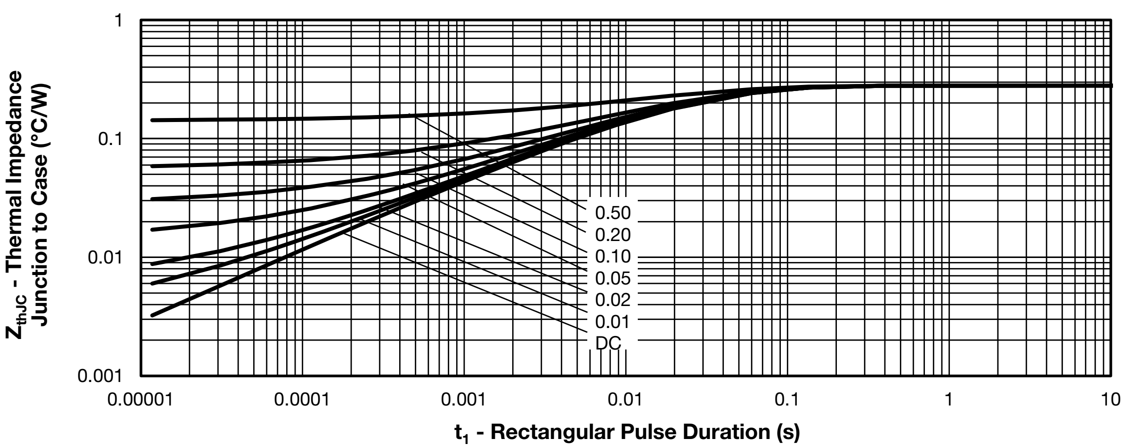


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

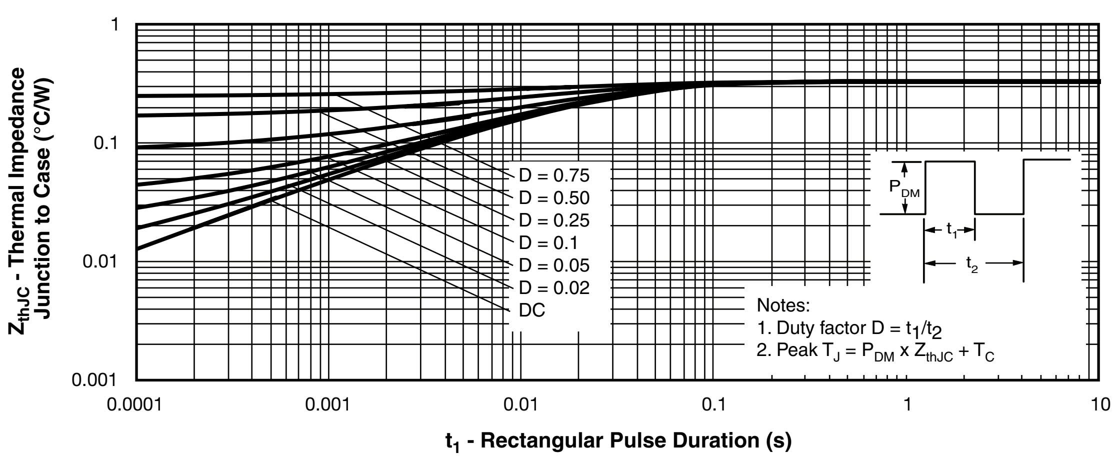
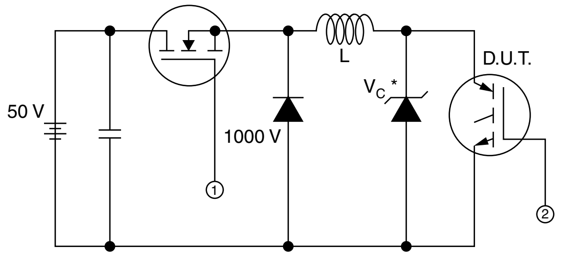


Fig. 20 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode



* 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 Id

Fig. 21 - Clamped Inductive Load Test Circuit

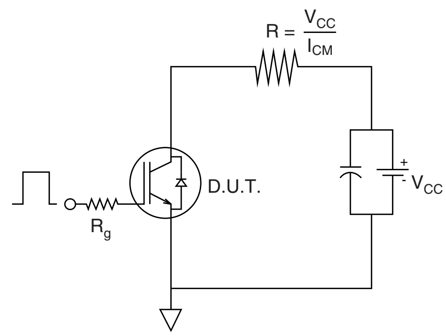


Fig. 22 - Pulsed Collector Current Test Circuit

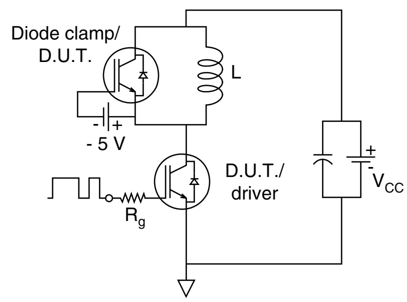
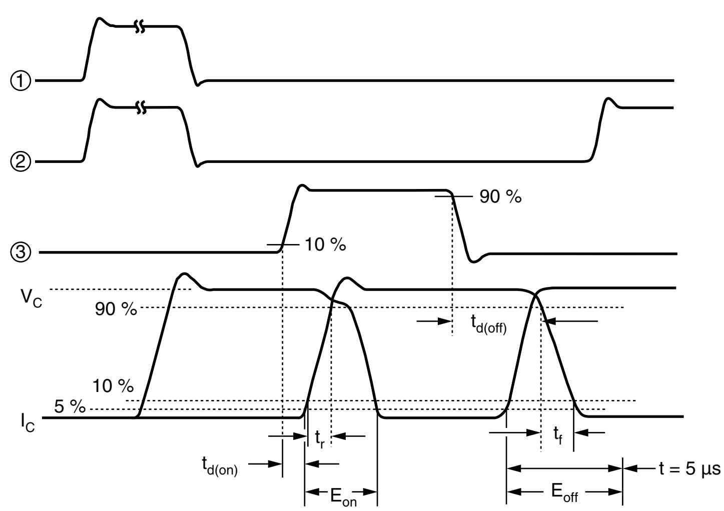


Fig. 23 - Switching Loss Test Circuit



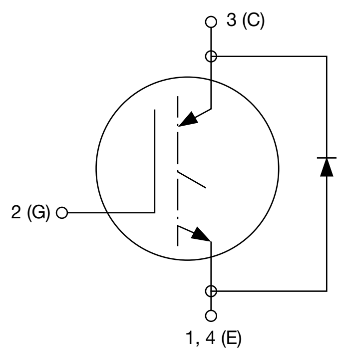
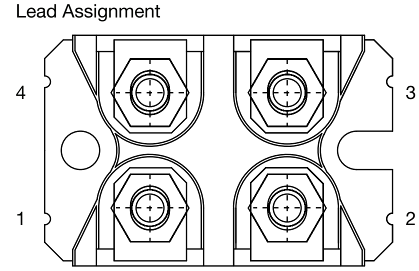
$E_{ts} = (E_{on} + E_{off})$

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

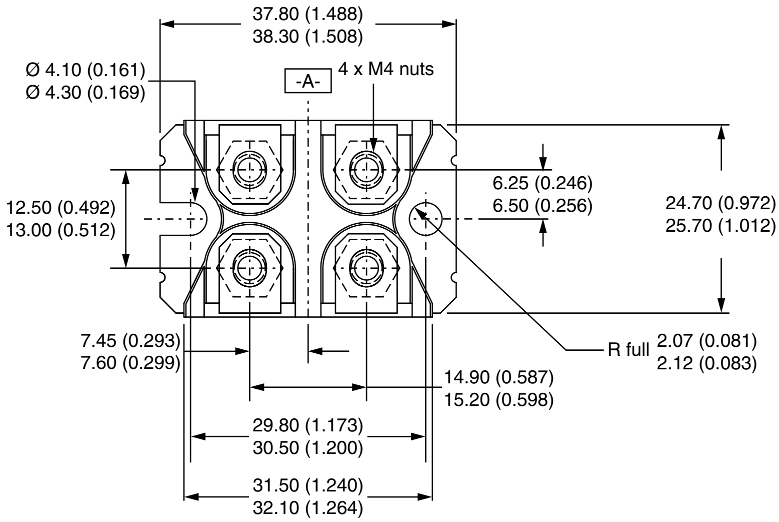
1 - Vishay Semiconductors product
2 - Insulated gate bipolar transistor (IGBT)
3 - T = Trench IGBT
4 - Current rating (90 = 90 A)
5 - Circuit configuration (D = single switch with AP diode)
6 - Package indicator (A = SOT-227)
7 - Voltage rating (60 = 600 V)
8 - Speed / type (U = ultrafast IGBT)

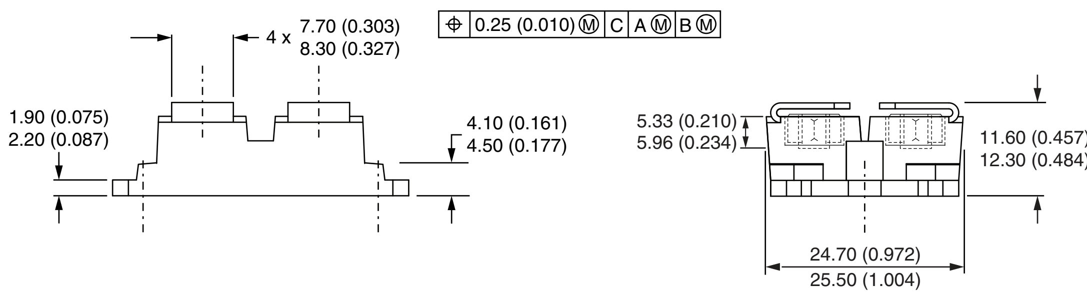
CIRCUIT CONFIGURATION		
CIRCUIT	**CIRCUIT CONFIGURATION CODE**	**CIRCUIT DRAWING**
Single switch with AP diode	D	 Lead Assignment 

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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