Insulated Gate Bipolar Transistor (Ultrafast IGBT), 106 A

SOT-227

FEATURES

- Trench IGBT technology
- Square RBSOA
- HEXFRED® low Q_{rr}, low switching energy
- Positive $V_{CE(on)}$ temperature coefficient
- 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 on heatsink
- Plug-in compatible with other SOT-227 packages
- Low EMI, requires less snubbing

PRIMARY CHARACTERISTICS	
V_{CES}	1200 V
I_C DC	106 A at 90 °C
$V_{CE(on)}$ typical at 75 A, 25 °C	2.17 V
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit configuration	Single switch with AP diode

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		1200	V
Continuous collector current	I_C	T_C = 25 °C	169	A
		T_C = 90 °C	106	
Pulsed collector current	I_{CM}	T_J = 150 °C, t_p = 6 ms, V_{GE} = 15 V	350	
Clamped inductive load current	I_{LM}		250	
Diode continuous forward current	I_F	T_C = 25 °C	76	
		T_C = 90 °C	46	
Gate to emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	T_C = 25 °C	781	W
		T_C = 90 °C	375	
Power dissipation, diode	P_D	T_C = 25 °C	357	
		T_C = 90 °C	171	
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 = 4 mA	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 75 A	-	2.17	2.60	
		V_{GE} = 15 V, I_C = 75 A, T_J = 125 °C	-	2.44	-	
		V_{GE} = 15 V, I_C = 75 A, T_J = 150 °C	-	2.49	-	
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 4 mA	4.6	5.9	7.6	
		V_{CE} = V_{GE}, I_C = 4 mA, T_J = 125 °C	-	4.63	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 4 mA (25 °C to 125 °C)	-	-13	-	mV/°C
Collector to emitter leakage current	I_{CES}	V_{GE} = 0 V, V_{CE} = 1200 V	-	0.9	100	μA
		V_{GE} = 0 V, V_{CE} = 1200 V, T_J = 125 °C	-	750	-	
		V_{GE} = 0 V, V_{CE} = 1200 V, T_J = 150 °C	-	2.7	-	mA
Forward voltage drop, diode	V_{FM}	V_{GE} = 0 V, I_F = 75 A	-	3.4	5.0	V
		V_{GE} = 0 V, I_F = 75 A, T_J = 125 °C	-	3.2	-	
		V_{GE} = 0 V, I_F = 75 A, T_J = 150 °C	-	3.05	-	
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 250	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 = 90 A, V_{CC} = 960 V, V_{GE} = 15 V		-	307	-	nC
Gate to emitter charge (turn-on)	Q_{ge}			-	33	-	
Gate to collector charge (turn-on)	Q_{gc}			-	160	-	
Turn-on switching loss	E_{on}	I_C = 75 A, V_{CC} = 600 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 HFA16PB120	-	2.15	-	mJ
Turn-off switching loss	E_{off}			-	2.59	-	
Total switching loss	E_{tot}			-	4.74	-	
Turn-on delay time	$t_{d(on)}$			-	36	-	ns
Rise time	t_r			-	26	-	
Turn-off delay time	$t_{d(off)}$			-	116	-	
Fall time	t_f			-	82	-	
Turn-on switching loss	E_{on}	I_C = 75 A, V_{CC} = 600 V, V_{GE} = 15 V, R_g = 5 Ω, L = 500 μH, T_J = 125 °C		-	2.23	-	mJ
Turn-off switching loss	E_{off}			-	3.87	-	
Total switching loss	E_{tot}			-	6.1	-	
Turn-on delay time	$t_{d(on)}$			-	34	-	ns
Rise time	t_r			-	27	-	
Turn-off delay time	$t_{d(off)}$			-	123	-	
Fall time	t_f			-	147	-	
Reverse bias safe operating area	RBSOA	T_J = 150 °C, I_C = 250 A, R_g = 4.7 Ω, V_{GE} = 15 V to 0 V, V_{CC} = 800 V, V_P = 1200 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		-	140	-	ns
Diode peak reverse current	I_{rr}			-	13	-	A
Diode recovery charge	Q_{rr}			-	860	-	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		-	210	-	ns
Diode peak reverse current	I_{rr}			-	19	-	A
Diode recovery charge	Q_{rr}			-	1880	-	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}		-	-	0.16	°C/W
	Diode			-	-	0.35	
Case to heatsink		R_{thCS}	Flat, greased surface	-	0.05	-	
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					

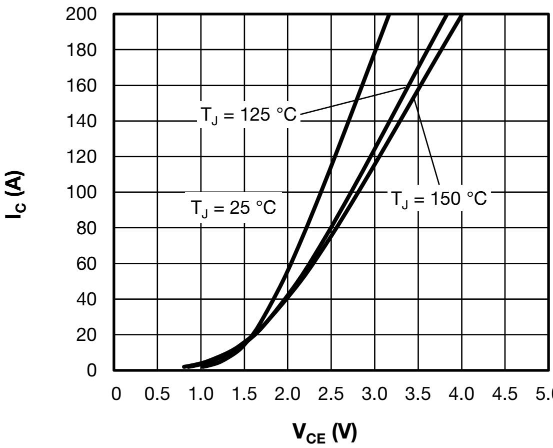


Fig. 1 - Typical Trench IGBT Output Characteristics, V_{GE} = 15 V

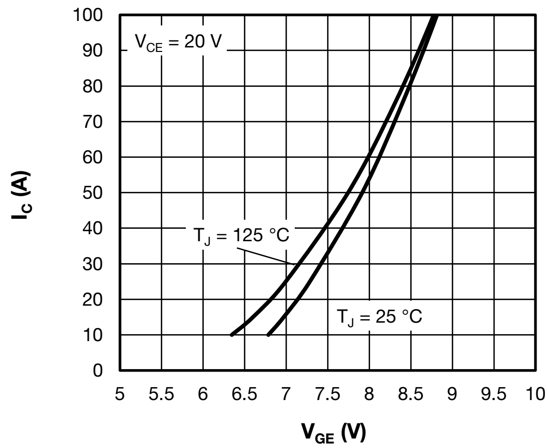


Fig. 4 - Typical Trench IGBT Transfer Characteristics

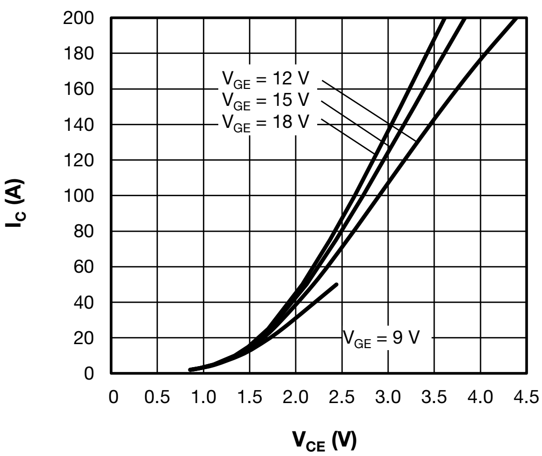


Fig. 2 - Typical Trench IGBT Output Characteristics, T_J = 125 °C

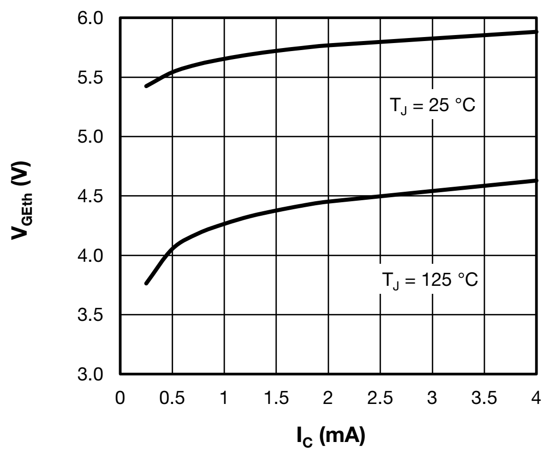


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

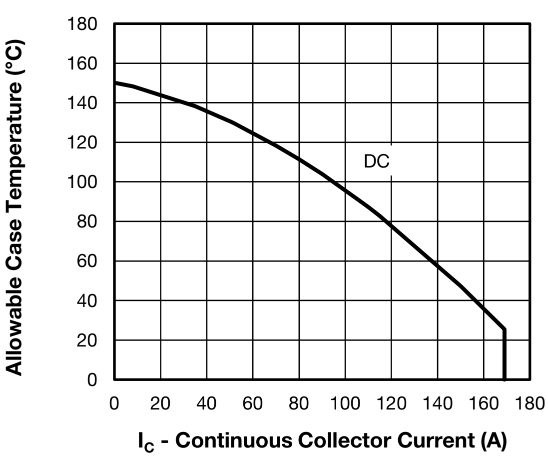


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

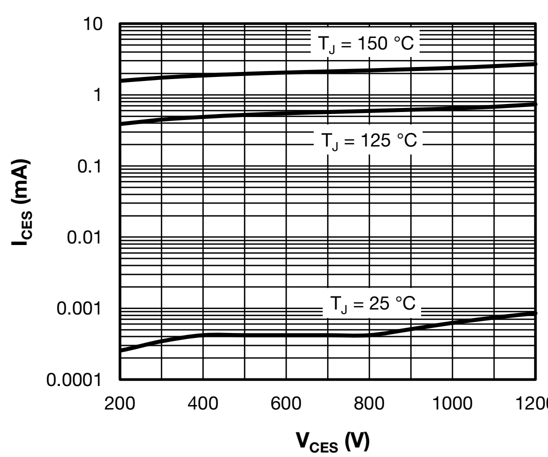


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

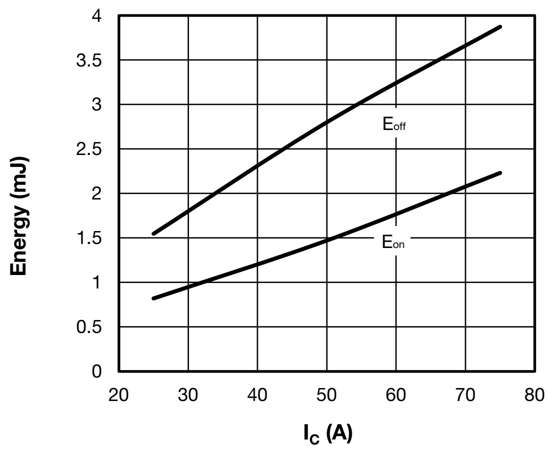


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 600 V, R_g = 4.7 Ω, V_{GE} = +15 V/-15 V, L = 500 µH

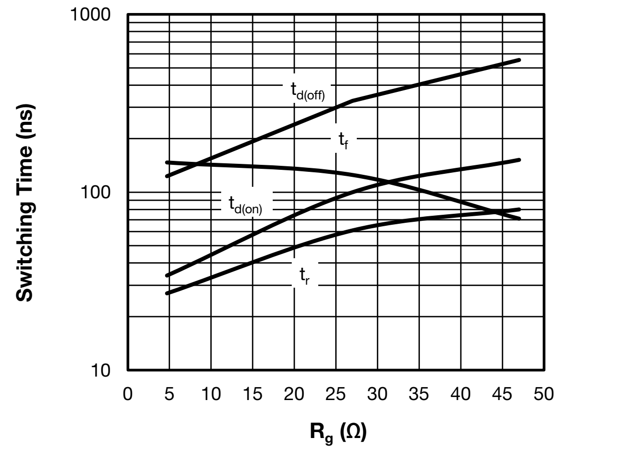


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 600 V, I_C = 75 A, V_{GE} = +15 V/-15 V, L = 500 µH

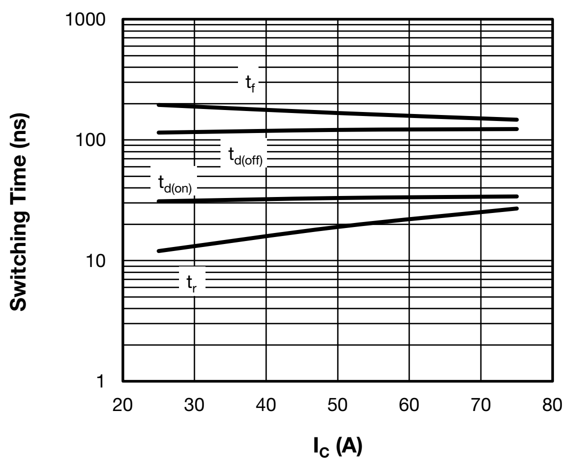


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 600 V, R_g = 4.7 Ω, V_{GE} = +15 V/-15 V, L = 500 µH

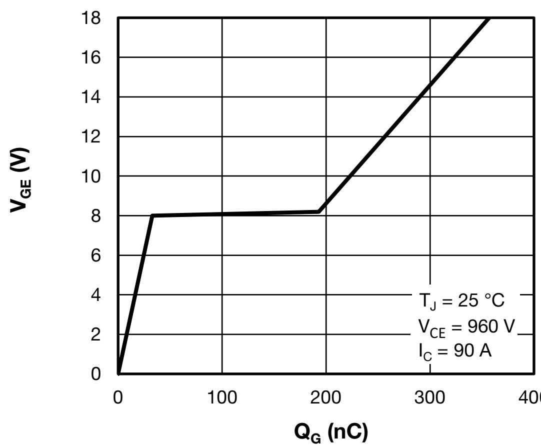


Fig. 11 - Typical Trench IGBT Gate Charge vs.
Gate to Emitter Voltage

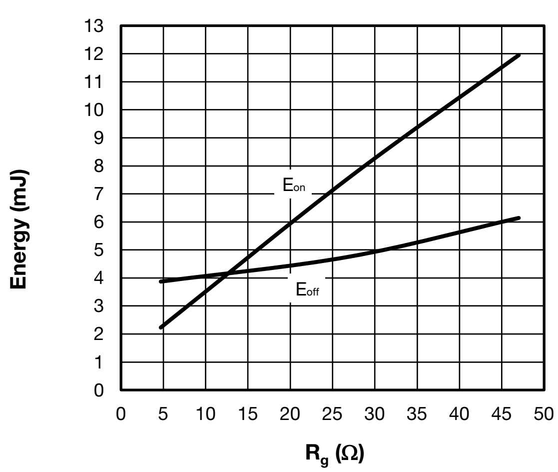


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
(with Antiparallel Diode)
T_J = 125 °C, V_{CC} = 600 V, I_C = 75 A, V_{GE} = +15 V/-15 V, L = 500 µH

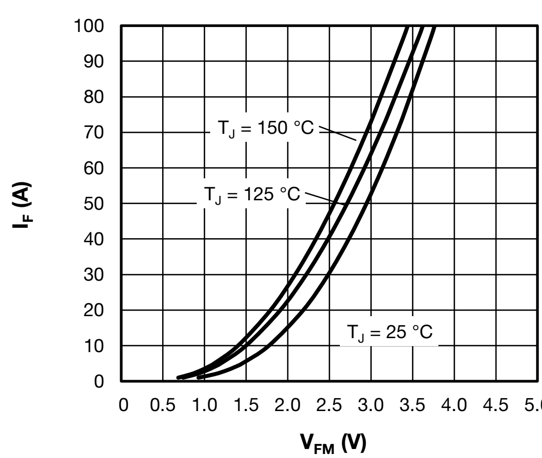


Fig. 12 - Typical Antiparallel Diode Forward Characteristics

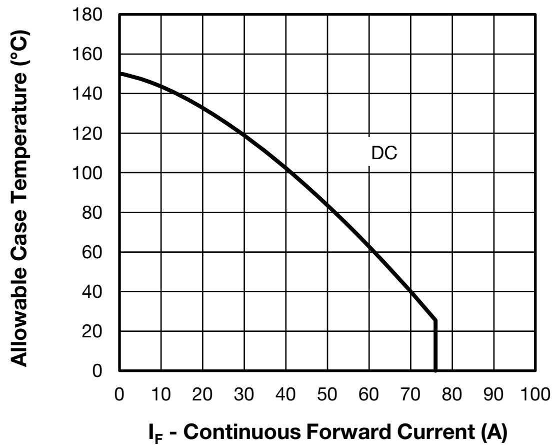


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

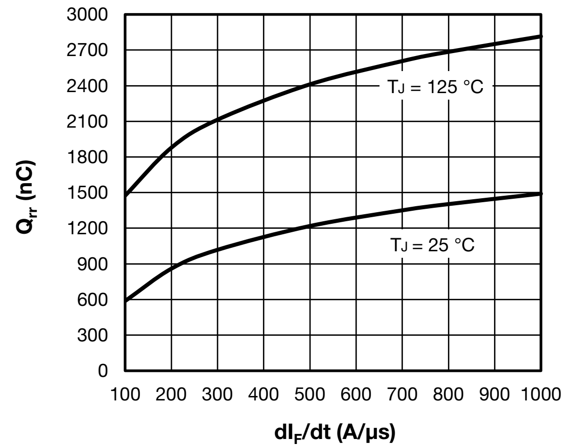


Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs. dI_F/dt, V_{rr} = 200 V, I_F = 50 A

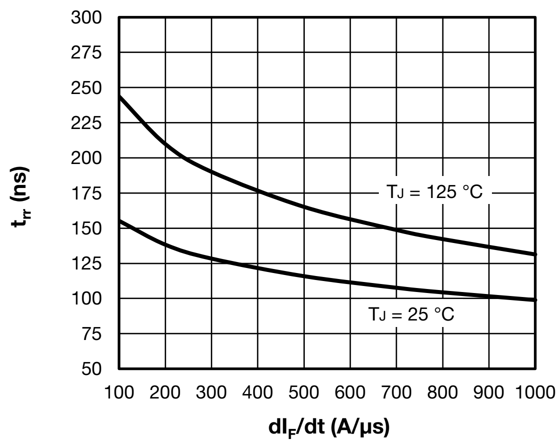


Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs. dI_F/dt, V_{rr} = 200 V, I_F = 50 A

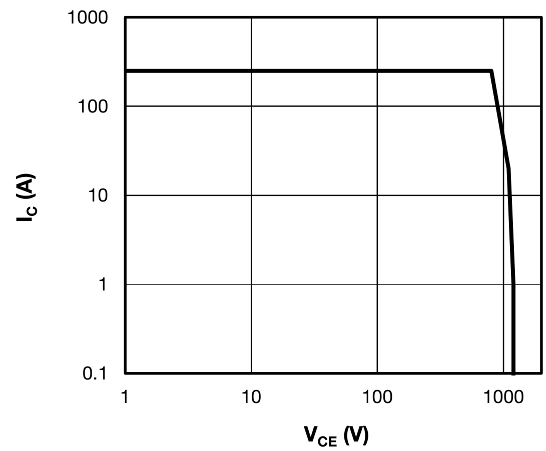


Fig. 17 - Trench IGBT Reverse BIAS SOA
T_J = 150 °C, V_{CC} = 800 V, I_C = 250 A, V_{GE} = +15 V/0, V_p = 1200 V

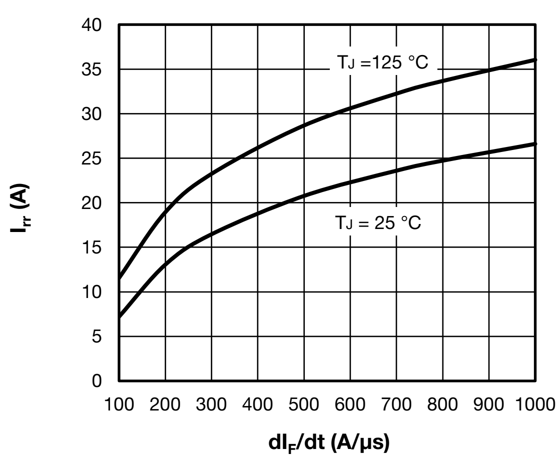


Fig. 15 - Typical Antiparallel Reverse Recovery Current vs. dI_F/dt
V_{rr} = 200 V, I_F = 50 A

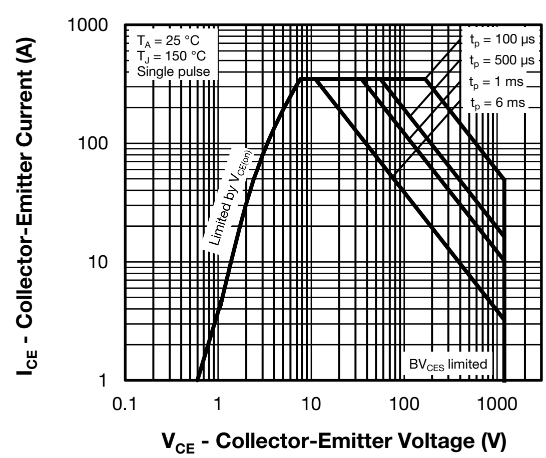


Fig. 18 - IGBT Reverse Bias Safe Operating Area

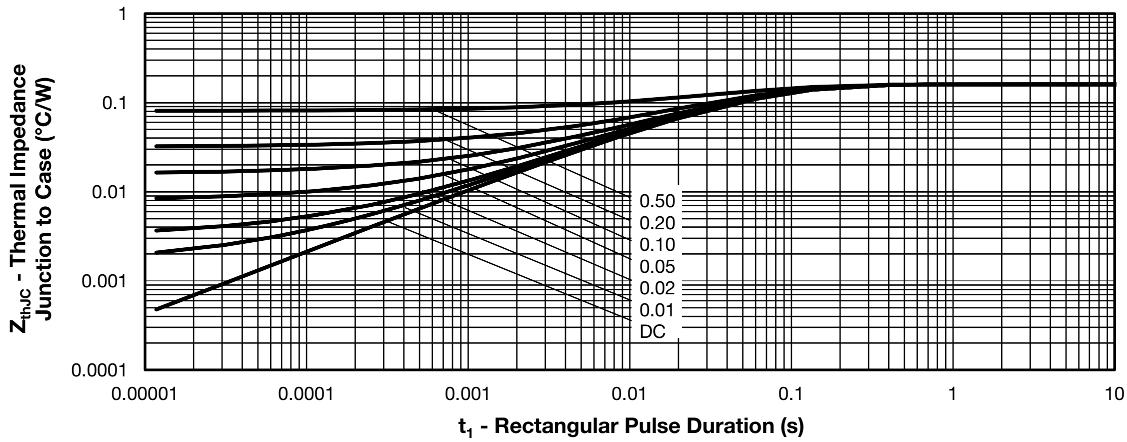


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

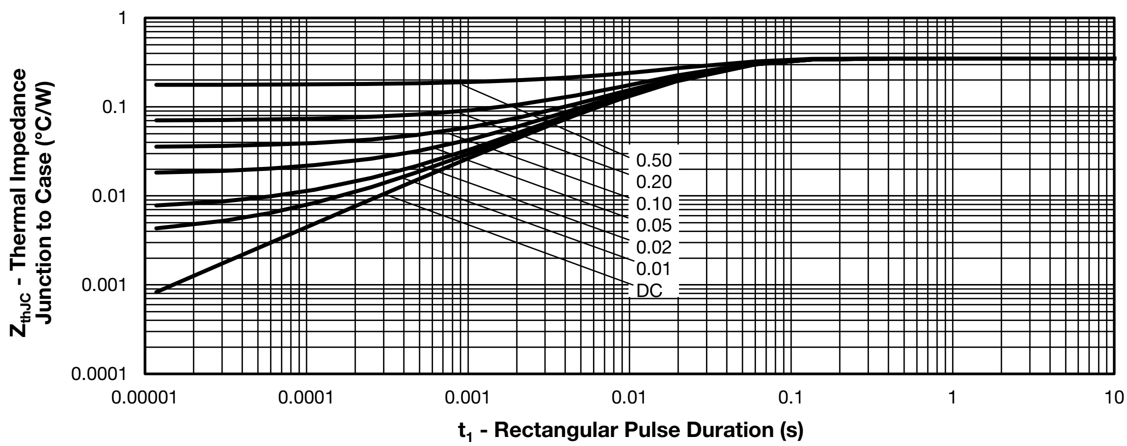
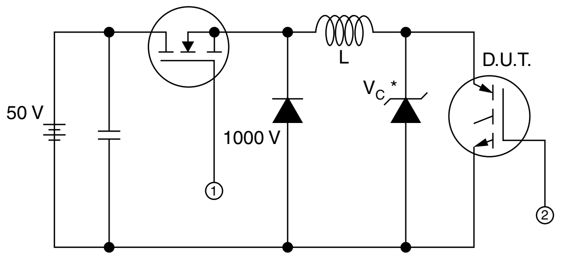


Fig. 20 - Maximum Antiparallel Diode Thermal Impedance Z_{thJC} Characteristics



* 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

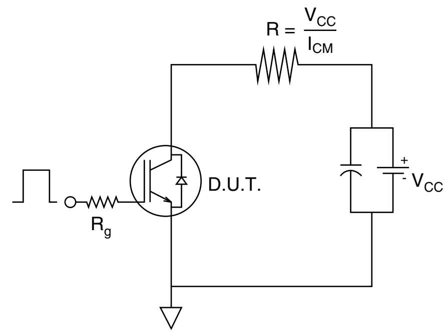


Fig. 22 - Pulsed Collector Current Test Circuit

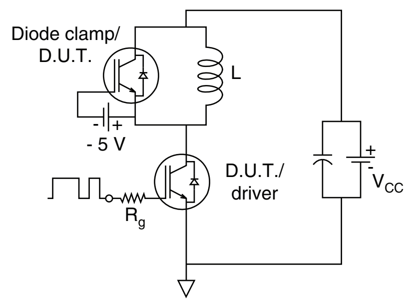


Fig. 23 - Switching Loss Test Circuit

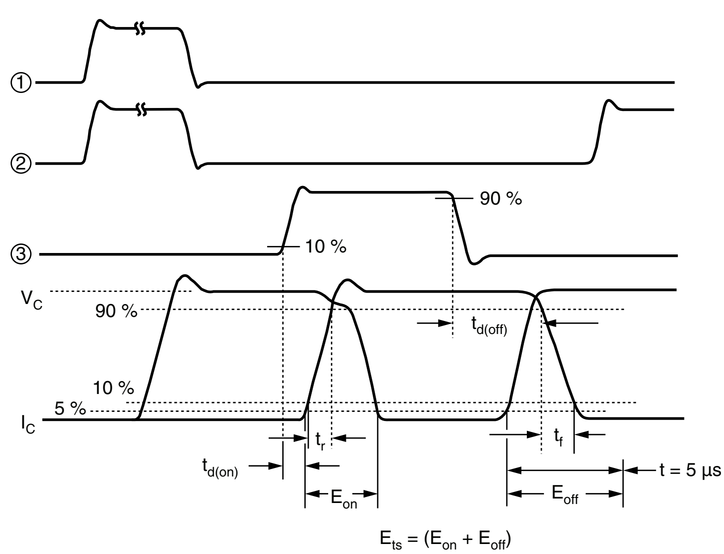


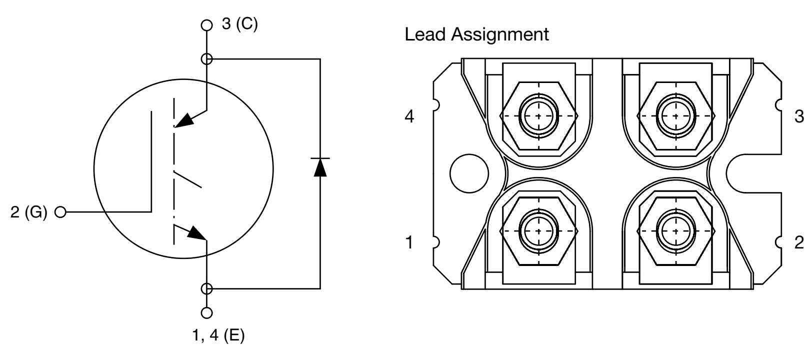
Fig. 24 - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

Device code							
VS-	G	T	90	D	A	120	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 (120 = 1200 V)
8 - Speed/type (U = ultrafast IGBT)

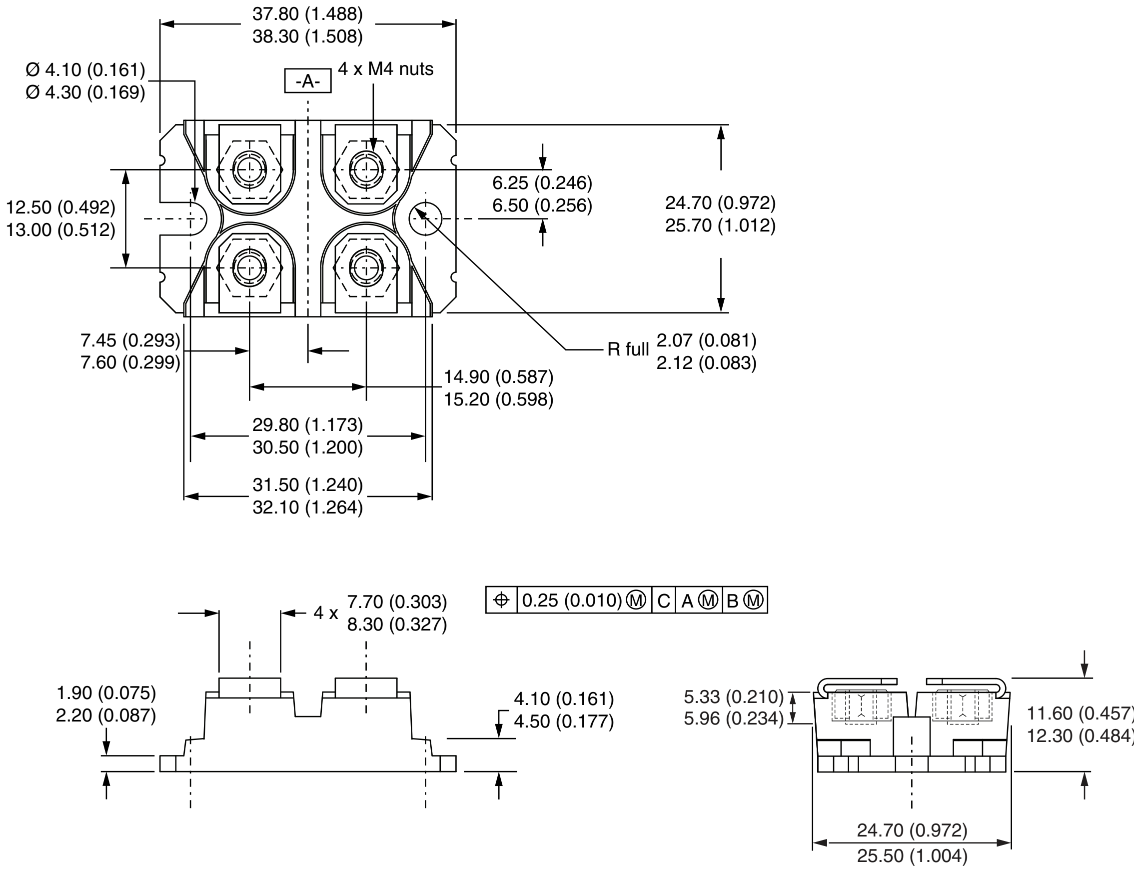
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch with AP diode	D	



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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