

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**

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

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

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		1200	V
Continuous collector current	I_C	$T_C = 25\text{ °C}$	169	A
		$T_C = 90\text{ °C}$	106	
Pulsed collector current	I_{CM}	$T_J = 150\text{ °C}$, $t_p = 6\text{ ms}$, $V_{GE} = 15\text{ V}$	350	
Clamped inductive load current	I_{LM}		250	
Diode continuous forward current	I_F	$T_C = 25\text{ °C}$	76	
		$T_C = 90\text{ °C}$	46	
Gate to emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	$T_C = 25\text{ °C}$	781	W
		$T_C = 90\text{ °C}$	375	
Power dissipation, diode	P_D	$T_C = 25\text{ °C}$	357	
		$T_C = 90\text{ °C}$	171	
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	$V_{BR(CE)}$	$V_{GE} = 0\text{ V}$, $I_C = 4\text{ mA}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$	-	2.17	2.60	
		$V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.44	-	
		$V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	2.49	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 4\text{ mA}$	4.6	5.9	7.6	
		$V_{CE} = V_{GE}$, $I_C = 4\text{ mA}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	4.63	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$, $I_C = 4\text{ mA}$ ($25\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$)	-	-13	-	mV/ $^{\circ}\text{C}$
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$	-	0.9	100	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	750	-	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	2.7	-	
Forward voltage drop, diode	V_{FM}	$V_{GE} = 0\text{ V}$, $I_F = 75\text{ A}$	-	3.4	5.0	V
		$V_{GE} = 0\text{ V}$, $I_F = 75\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	3.2	-	
		$V_{GE} = 0\text{ V}$, $I_F = 75\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	3.05	-	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 250	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	$I_C = 90\text{ A}$, $V_{CC} = 960\text{ V}$, $V_{GE} = 15\text{ V}$		-	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}	$I_C = 75\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 5\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^\circ\text{C}$	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	-	mJ
Turn-on switching loss	E_{on}	$I_C = 75\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 5\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^\circ\text{C}$	Energy losses include tail and diode recovery Diode used HFA16PB120	-	2.23	-	
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	$T_J = 150\text{ }^\circ\text{C}$, $I_C = 250\text{ A}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = 15\text{ V}$ to 0 V , $V_{CC} = 800\text{ V}$, $V_P = 1200\text{ V}$, $L = 500\text{ }\mu\text{H}$		Fullsquare			
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $dI_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$		-	140	-	ns
Diode peak reverse current	I_{rr}			-	13	-	A
Diode recovery charge	Q_{rr}			-	860	-	nC
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $dI_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$		-	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	$^{\circ}\text{C}$
Junction to case	IGBT	R_{thJC}	-	-	0.16	$^{\circ}\text{C}/\text{W}$
	Diode		-	-	0.35	
Case to heatsink	R_{thCS}	Flat, greased surface	-	0.05	-	g
Weight			-	30	-	
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				

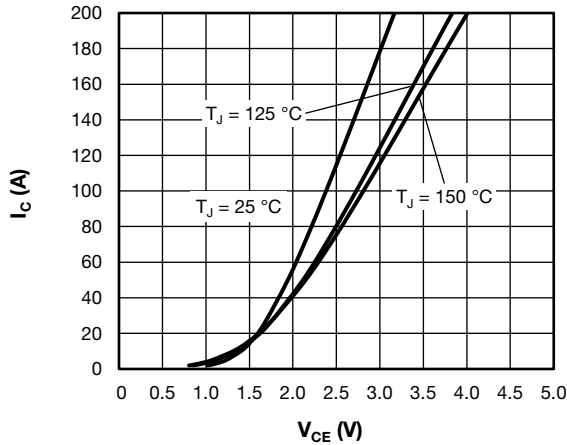


Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15 \text{ V}$

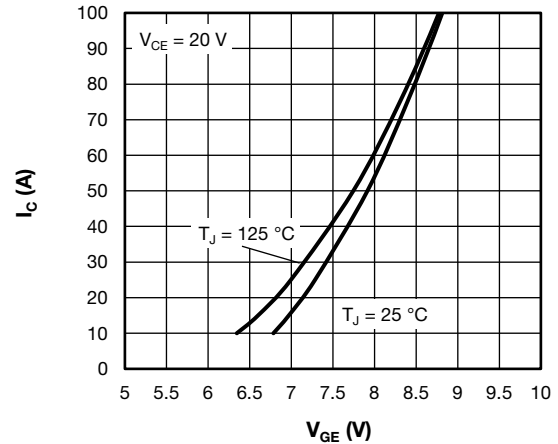


Fig. 4 - Typical Trench IGBT Transfer Characteristics

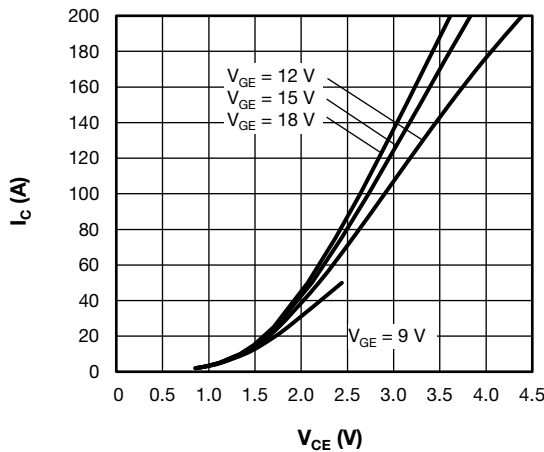


Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125 \text{ °C}$

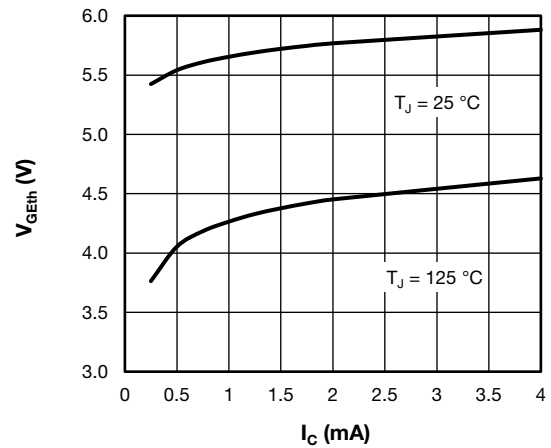


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

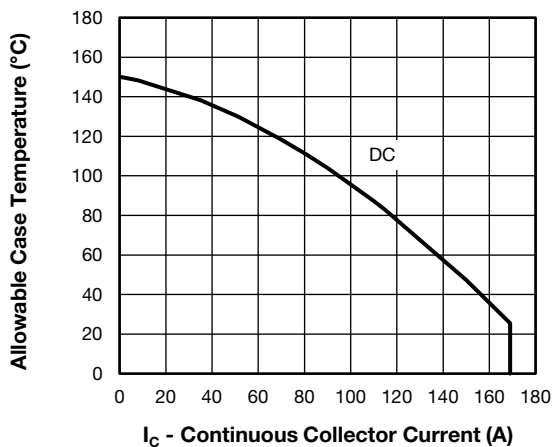


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

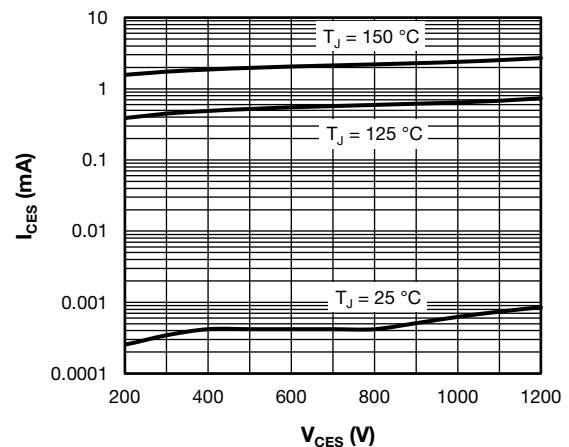


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

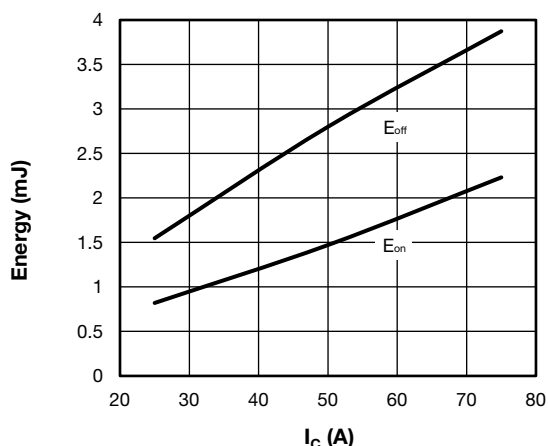


Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

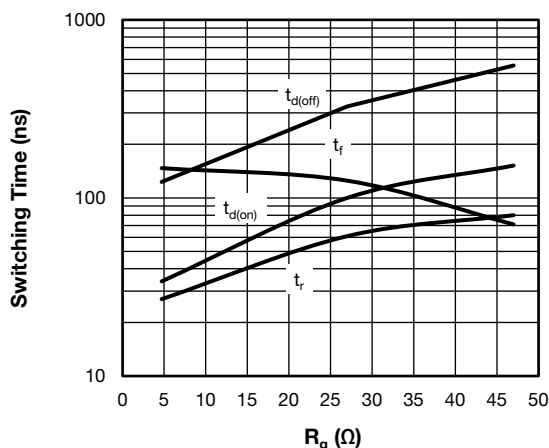


Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 75\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

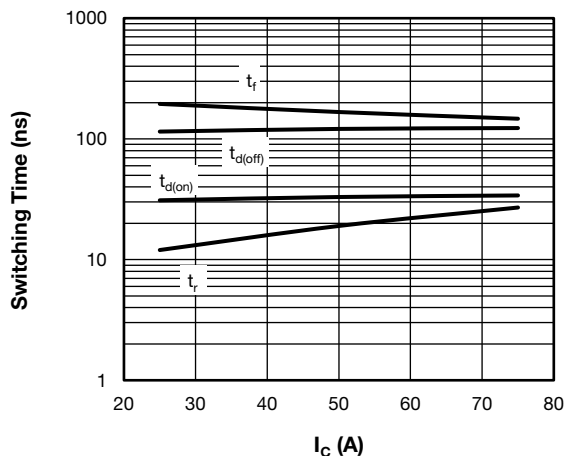


Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

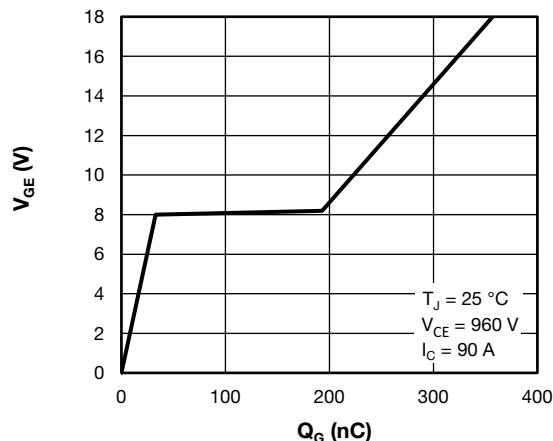


Fig. 11 - Typical Trench IGBT Gate Charge vs.
Gate to Emitter Voltage

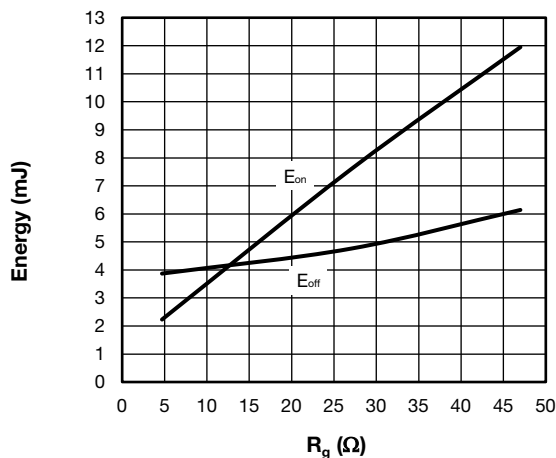


Fig. 9 - Typical Trench IGBT Energy Loss vs. R_g
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 75\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\ \mu\text{H}$

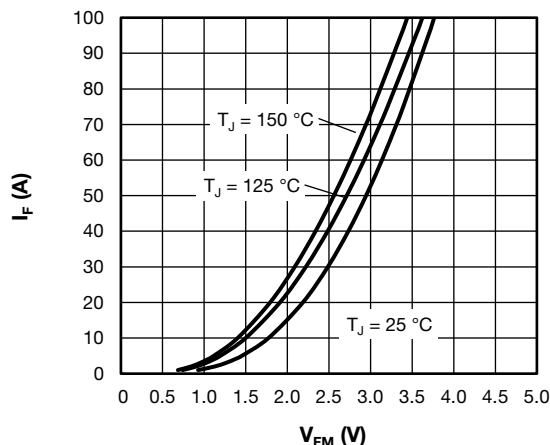


Fig. 12 - Typical Antiparallel Diode Forward Characteristics

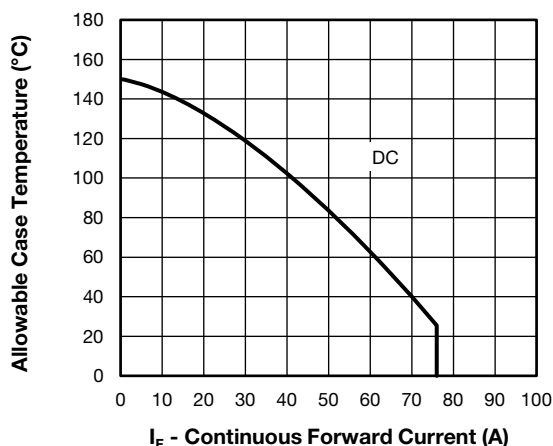


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

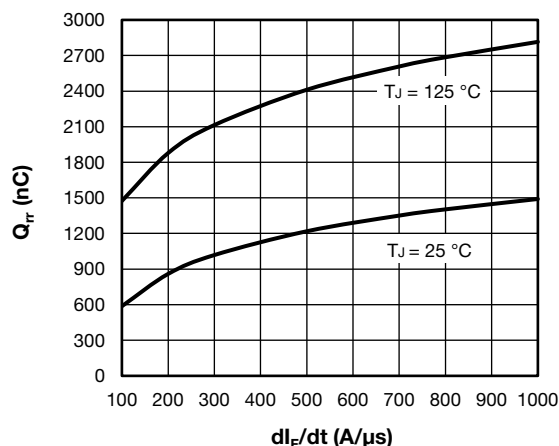


Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs. di_F/dt , $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

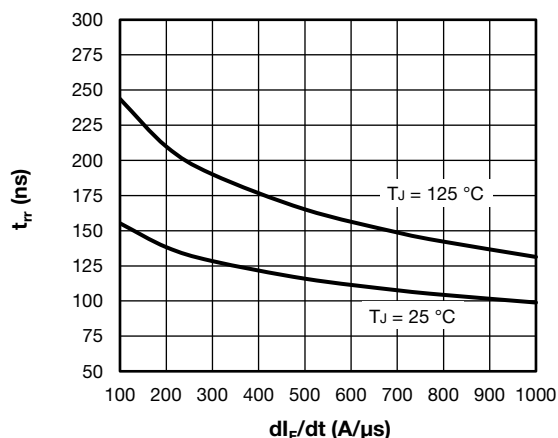


Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs. di_F/dt , $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

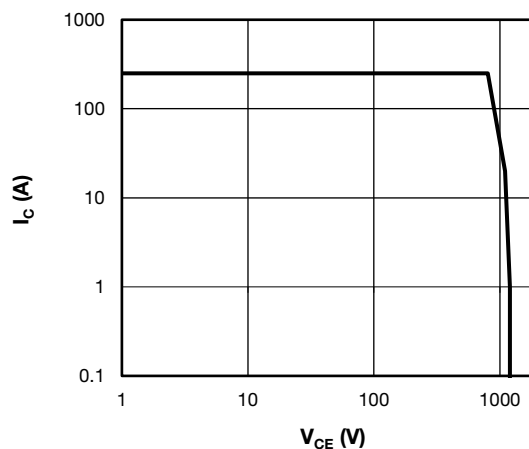


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 150^\circ\text{C}$, $V_{CC} = 800\text{ V}$, $I_C = 250\text{ A}$, $V_{GE} = +15\text{ V}$, $V_p = 1200\text{ V}$

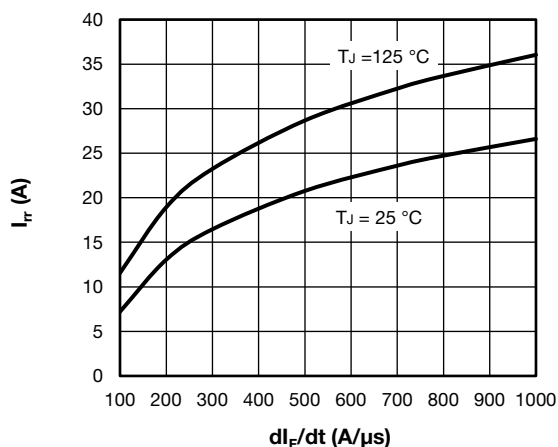


Fig. 15 - Typical Antiparallel Reverse Recovery Current vs. di_F/dt
 $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

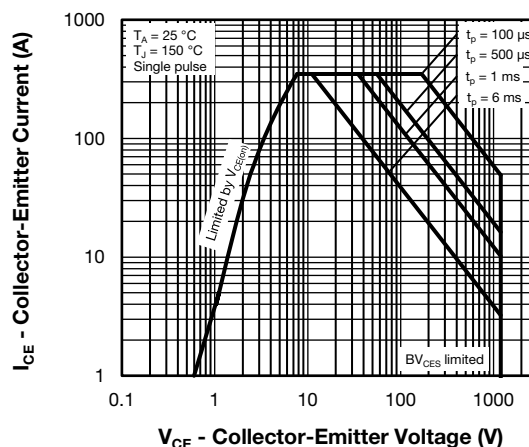


Fig. 18 - IGBT Reverse Bias Safe Operating Area

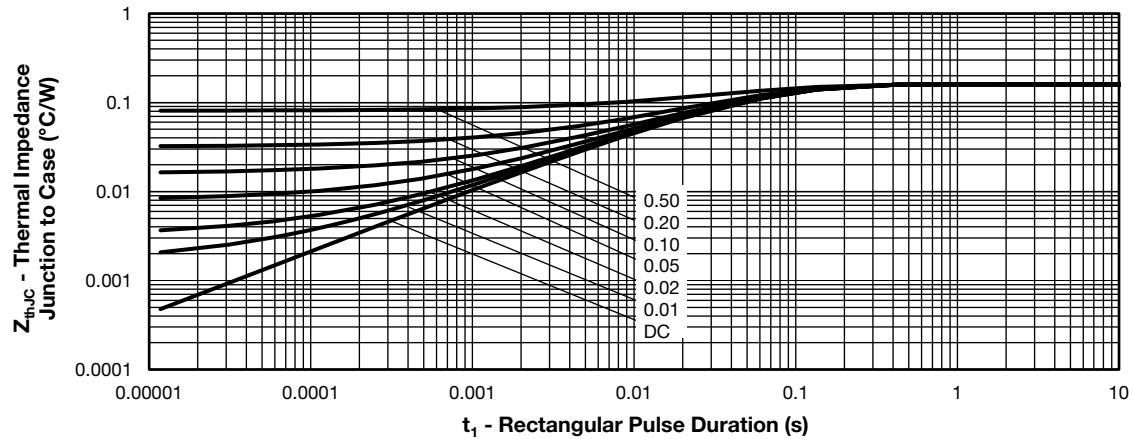


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

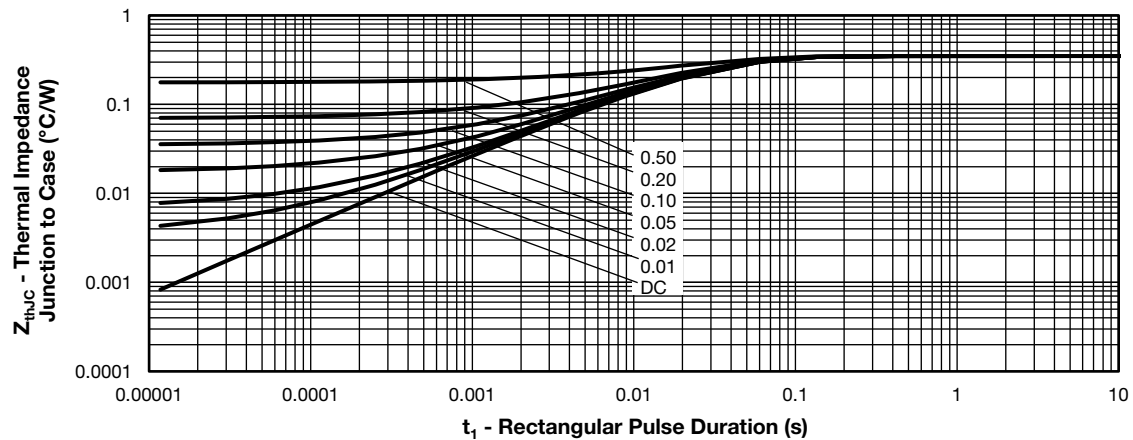
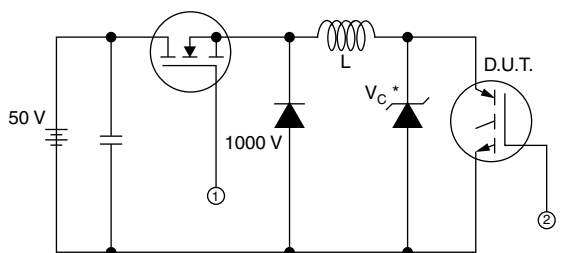


Fig. 20 - Maximum Antiparallel Diode Thermal Impedance Z_{thJC} Characteristics



* 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 I_d

Fig. 21 - Clamped Inductive Load Test Circuit

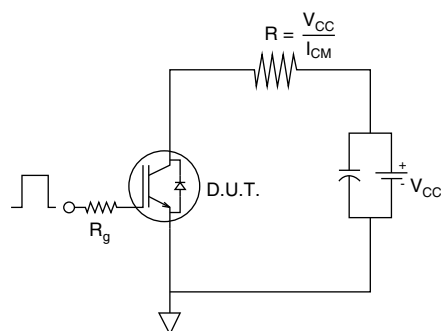


Fig. 22 - Pulsed Collector Current Test Circuit

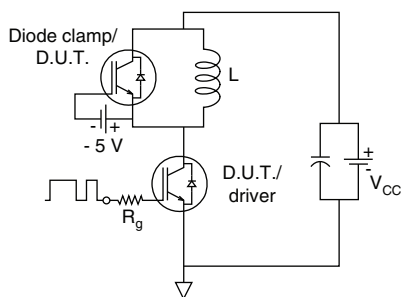


Fig. 23 - Switching Loss Test Circuit

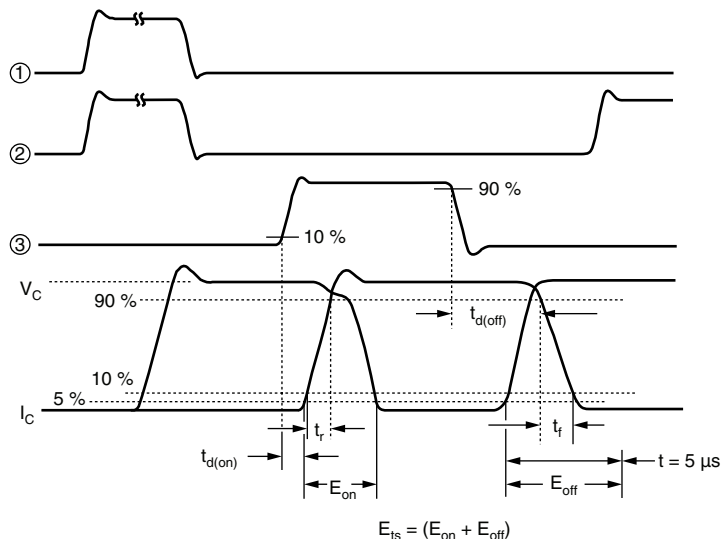
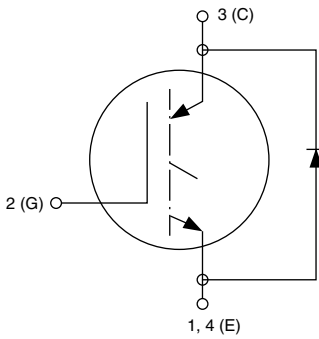
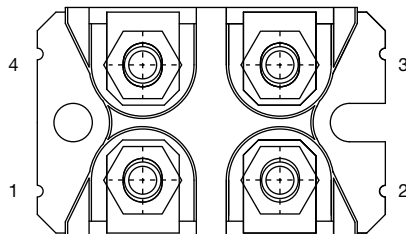


Fig. 24 - Switching Loss Waveforms Test Circuit

ORDERING INFORMATION TABLE

Device code	VS-	G	T	90	D	A	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) |

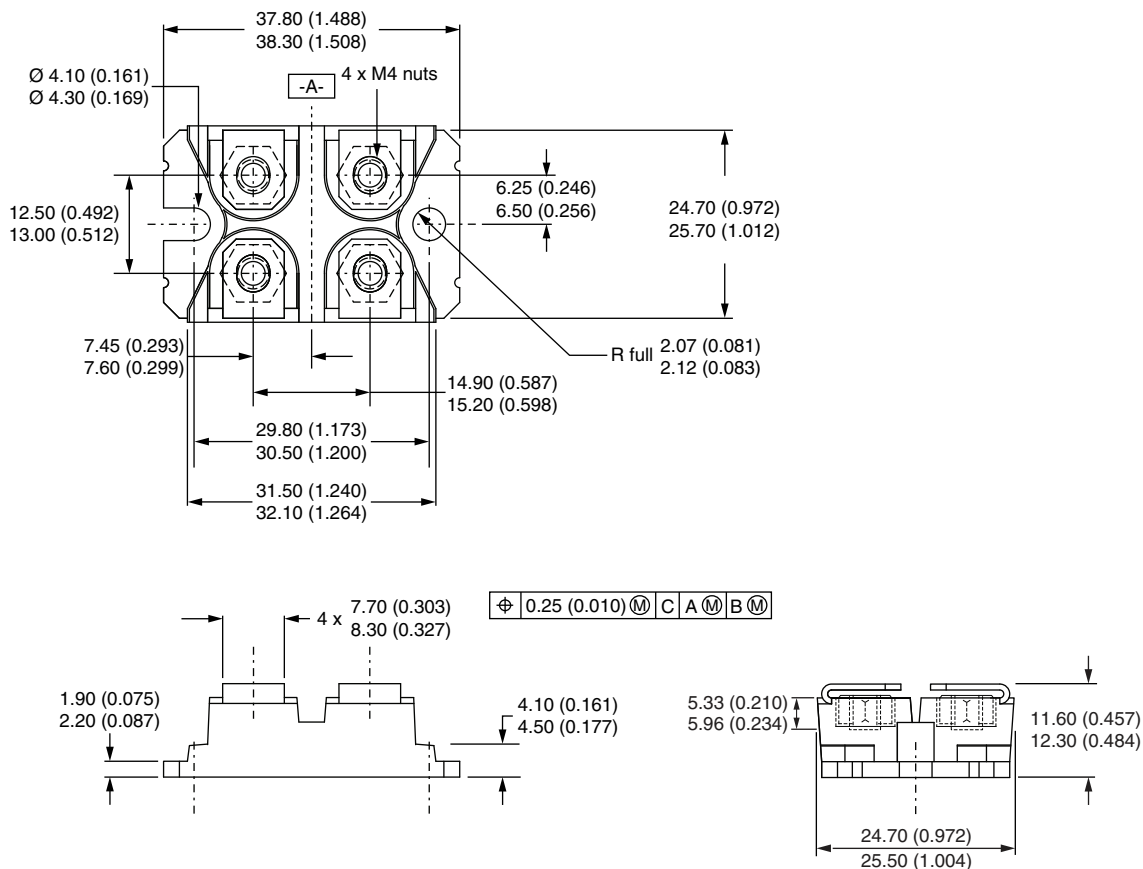
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch with AP diode	D	 

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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