

Insulated Gate Bipolar Transistor (Ultrafast IGBT), 100 A



SOT-227

FEATURES

- Trench IGBT high speed
- 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	100 A at 108 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	1.93 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	$T_C = 25$ °C	187	A
		$T_C = 90$ °C	123	
Pulsed collector current	I_{CM}		240	
Clamped inductive load current	I_{LM}		250	
Gate to emitter voltage	V_{GE}		± 20	V
Diode continuous forward current	I_F	$T_C = 25$ °C	97	A
		$T_C = 90$ °C	61	
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, $T_J = 25$ °C	350	
Power dissipation, IGBT	P_D	$T_C = 25$ °C	890	W
		$T_C = 90$ °C	500	
Power dissipation, diode	P_D	$T_C = 25$ °C	429	
		$T_C = 90$ °C	194	
Isolation voltage	V_{ISOL}	Any terminal to case, $t = 1$ 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	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}$, $I_C = 3.8\text{ mA}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$	-	1.93	2.55	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.26	-	
		$V_{GE} = 15\text{ V}$, $I_C = 100\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	2.35	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 3.8\text{ mA}$	4.5	5.8	7.0	
		$V_{CE} = V_{GE}$, $I_C = 3.8\text{ mA}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	4.6	-	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$, $I_C = 3.8\text{ mA}$ ($25\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$)	-	-12	-	mV/ $^{\circ}\text{C}$
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$	-	1.0	100	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	0.9	-	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	3.4	-	
Forward voltage drop, diode	V_{FM}	$V_{GE} = 0\text{ V}$, $I_F = 80\text{ A}$	-	2.8	3.5	V
		$V_{GE} = 0\text{ V}$, $I_F = 80\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	3.0	-	
		$V_{GE} = 0\text{ V}$, $I_F = 80\text{ A}$, $T_J = 150\text{ }^{\circ}\text{C}$	-	3.0	-	
Gate to emitter leakage current	I_{GES}	$V_{GE} = \pm 20\text{ V}$	-	-	± 220	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	$V_{GE} = -15\text{ V}$, $V_{GE} = +15\text{ V}$	-	800	-	nC
Input capacitance	C_{ies}	$V_{CE} = 25\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1\text{ MHz}$	-	6150	-	pF
Reverse transfer capacitance	C_{res}		-	345	-	
Turn-on switching loss	E_{on}	$I_C = 75\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 1.0\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	2.2	-	mJ
Turn-off switching loss	E_{off}		-	3.0	-	
Total switching loss	E_{tot}		-	5.2	-	
Turn-on delay time	$t_{d(on)}$		-	131	-	ns
Rise time	t_r		-	55	-	
Turn-off delay time	$t_{d(off)}$	$I_C = 75\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 1.0\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	244	-	
Fall time	t_f		-	118	-	mJ
Turn-on switching loss	E_{on}		-	2.9	-	
Turn-off switching loss	E_{off}		-	5.3	-	ns
Total switching loss	E_{tot}		-	8.2	-	
Turn-on delay time	$t_{d(on)}$	$I_C = 100\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 1.0\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	147	-	
Rise time	t_r		-	61	-	mJ
Turn-off delay time	$t_{d(off)}$		-	358	-	
Fall time	t_f		-	132	-	ns
Turn-on switching loss	E_{on}		-	3.0	-	
Turn-off switching loss	E_{off}	$I_C = 100\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 1.0\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	4.0	-	mJ
Total switching loss	E_{tot}		-	7.0	-	
Turn-on delay time	$t_{d(on)}$		-	134	-	
Rise time	t_r		-	66	-	ns
Turn-off delay time	$t_{d(off)}$		-	242	-	
Fall time	t_f		-	108	-	

**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 A, V _{CC} = 600 V, V _{GE} = 15 V, R _g = 1.0 Ω, L = 500 μH, T _J = 125 °C	Energy losses include tail and diode recovery Diode used HFA16PB120	-	3.9	-	mJ
Turn-off switching loss	E _{off}			-	7.1	-	
Total switching loss	E _{tot}			-	11.0	-	
Turn-on delay time	t _{d(on)}			-	154	-	ns
Rise time	t _r			-	72	-	
Turn-off delay time	t _{d(off)}			-	346	-	
Fall time	t _f			-	120	-	
Reverse bias safe operating area	RBSOA	T _J = 150 °C, I _C = 250 A, R _g = 1.0 Ω, V _{GE} = 15 V to 0 V, V _{CC} = 800 V, V _P = 1200 V, L = 500 μH		Fullsquare			
Short circuit safe operating area	SCSOA	V _{GE} = 15 V, V _{CC} = 800 V, V _{CE} max. = 1200 V, T _{VJ} = 150 °C		-	-	10	μs
Diode reverse recovery time	t _{rr}	I _F = 50 A, dI _F /dt = 200 A/μs, V _R = 400 V		-	183	-	ns
Diode peak reverse current	I _{rr}			-	12	-	A
Diode recovery charge	Q _{rr}			-	1093	-	nC
Diode reverse recovery time	t _{rr}	I _F = 50 A, dI _F /dt = 200 A/μs, V _R = 400 V, T _J = 125 °C		-	278	-	ns
Diode peak reverse current	I _{rr}			-	18.2	-	A
Diode recovery charge	Q _{rr}			-	2541	-	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		-	-	0.14	$^{\circ}\text{C}/\text{W}$
	Diode		-	-	0.31	
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	-	-	1.3 (11.5)	Nm (lbf. in)
Case style	SOT-227					

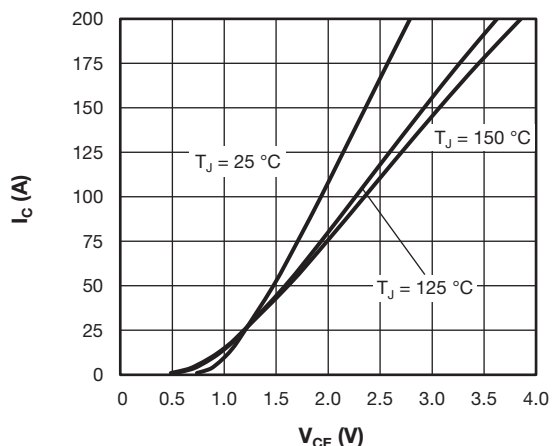
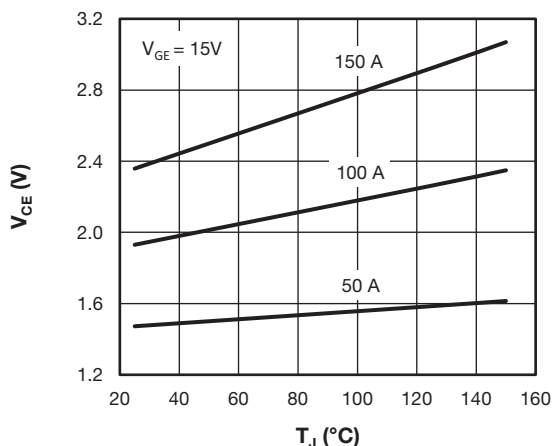

Fig. 1 - Typical IGBT Output Characteristics, $V_{GE} = 15\text{ V}$


Fig. 4 - Collector to Emitter Voltage vs. Junction Temperature

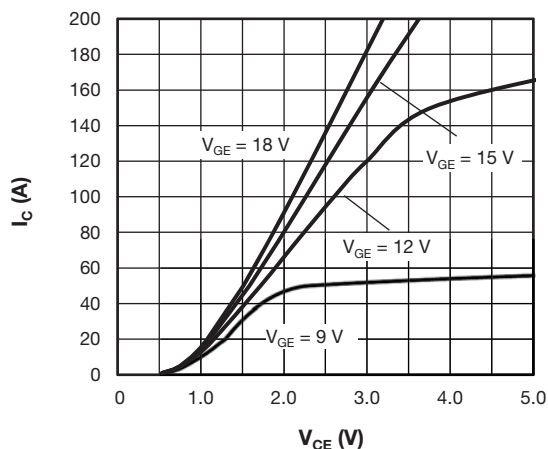
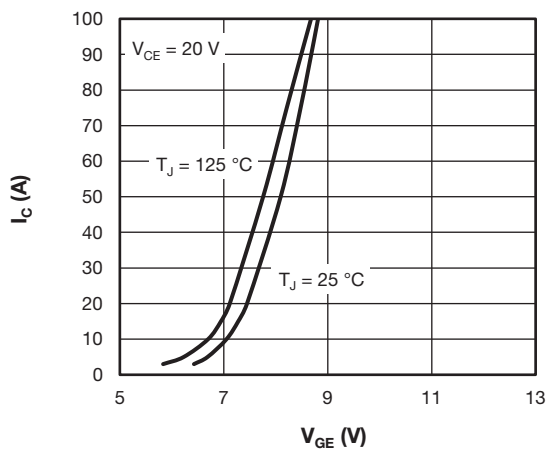

Fig. 2 - Typical IGBT Output Characteristics, $T_J = 125\text{ °C}$


Fig. 5 - Typical IGBT Transfer Characteristics

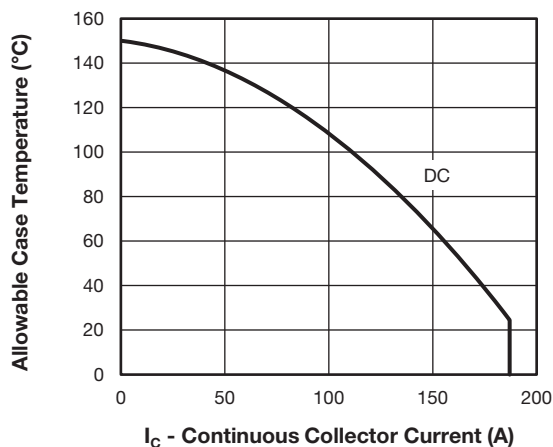


Fig. 3 - Maximum IGBT Continuous Collector Current vs. Case Temperature

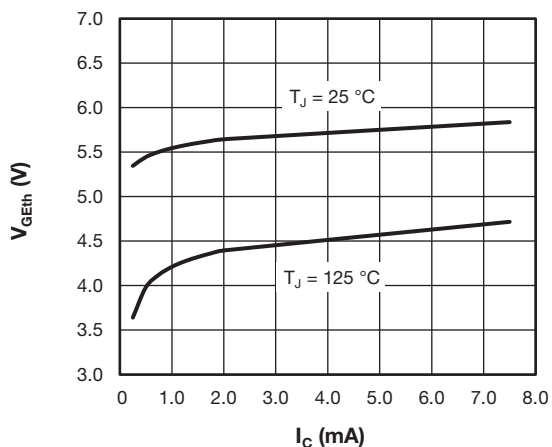


Fig. 6 - Typical IGBT Gate Threshold Voltage

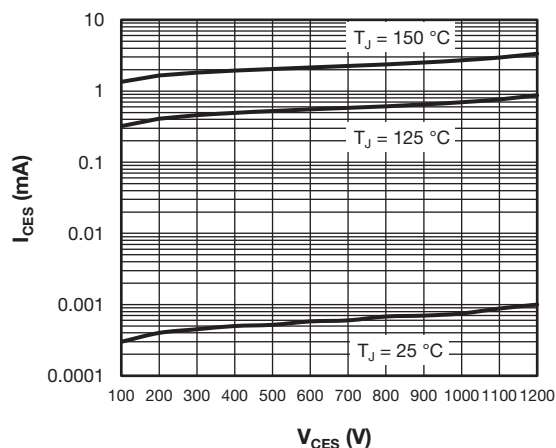


Fig. 7 - Typical IGBT Zero Gate Voltage Collector Current

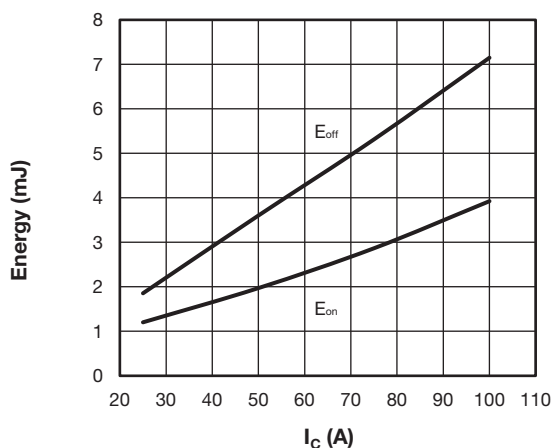
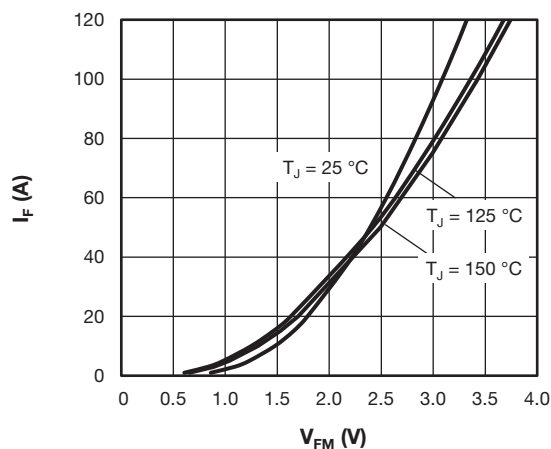

Fig. 10 - Typical IGBT Energy Loss vs. I_C
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 1.0\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$


Fig. 8 - Typical Diode Forward Characteristics

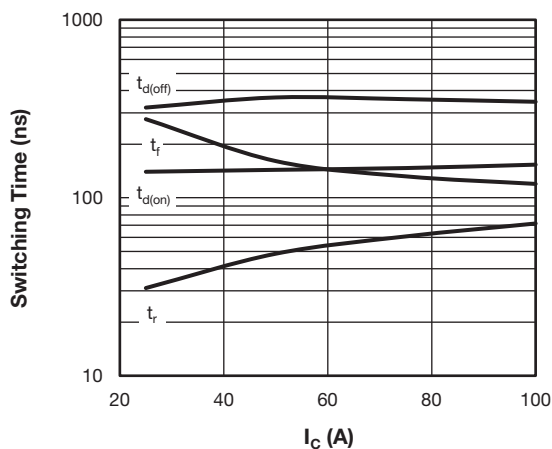
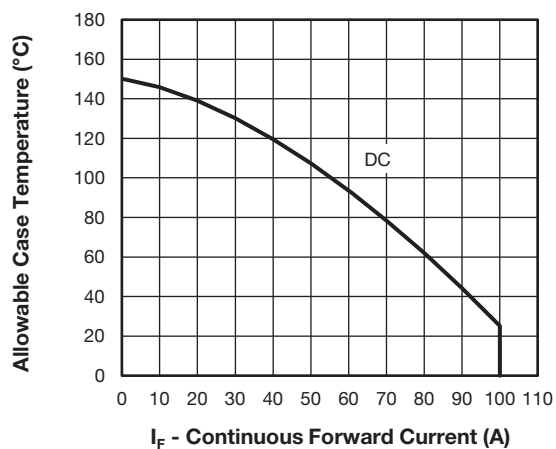
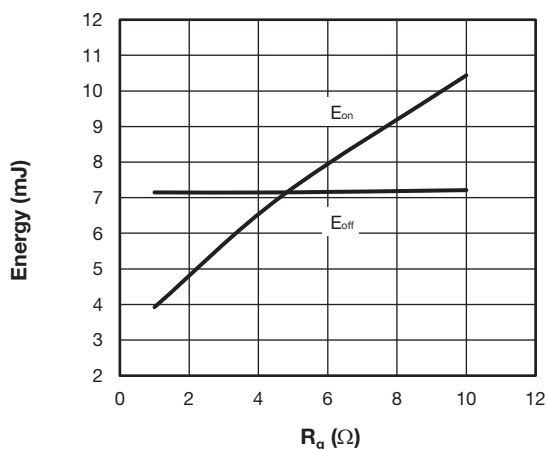

Fig. 11 - Typical IGBT Switching Time vs. I_C
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $R_g = 1.0\text{ }\Omega$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$


Fig. 9 - Maximum Diode Continuous Forward Current vs. Case Temperature


Fig. 12 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

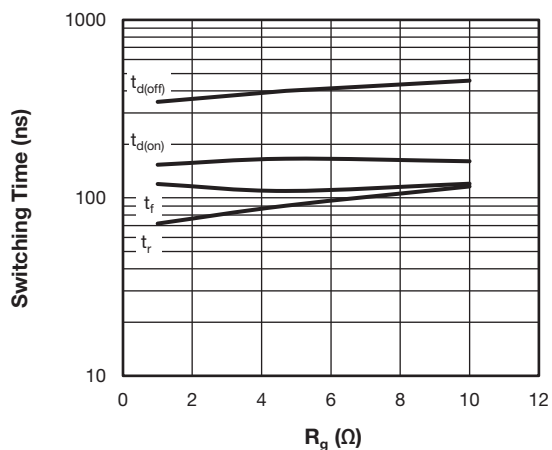


Fig. 13 - Typical IGBT Switching Time vs. R_g
 $T_J = 125\text{ }^{\circ}\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\text{ }\mu\text{H}$

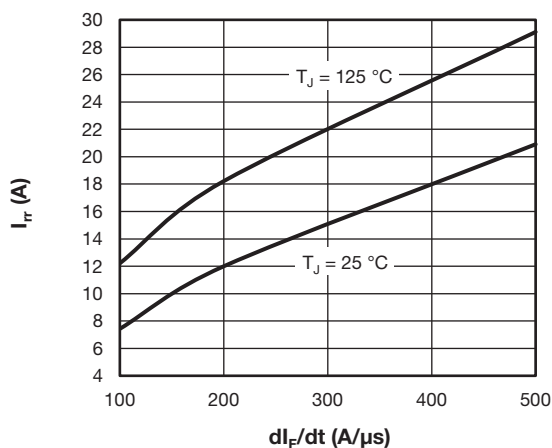


Fig. 15 - Typical Diode Reverse Recovery Current vs. di_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 50\text{ A}$

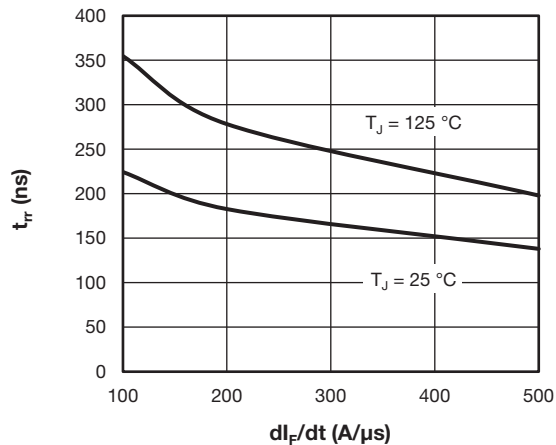


Fig. 14 - Typical Diode Reverse Recovery Time vs. di_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 50\text{ A}$

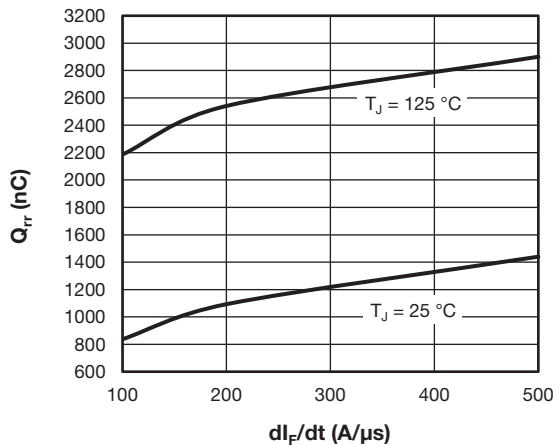


Fig. 16 - Typical Diode Reverse Recovery Charge vs. di_F/dt
 $V_{rr} = 400\text{ V}$, $I_F = 50\text{ A}$

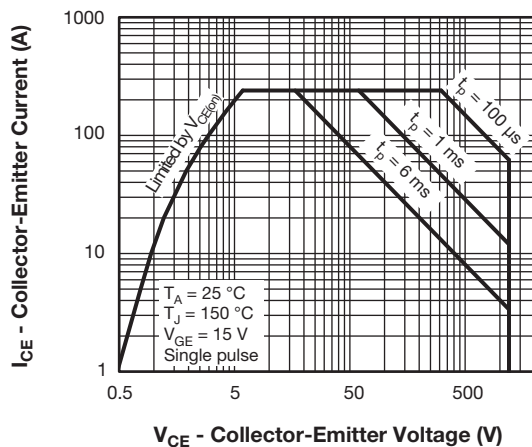


Fig. 17 - IGBT Safe Operating Area

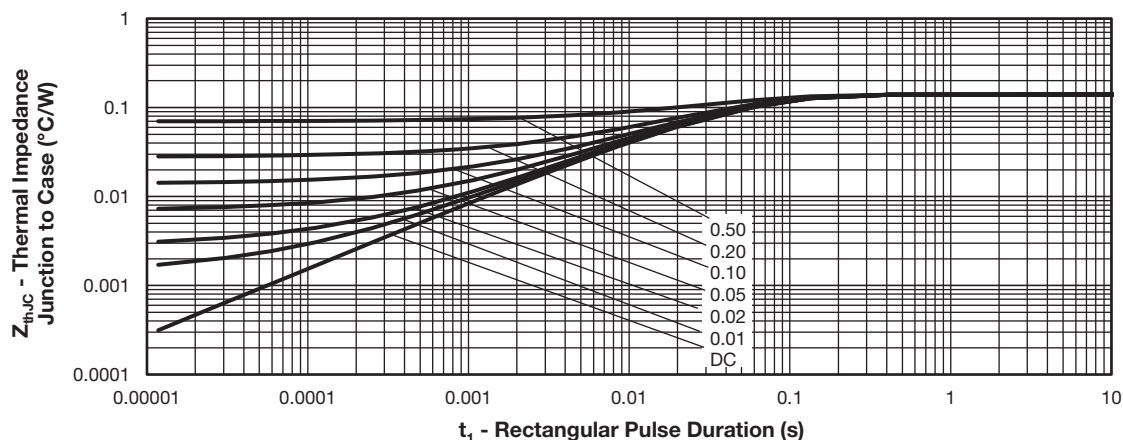


Fig. 18 - Maximum Thermal Impedance Z_{thJC} Characteristics - (IGBT)

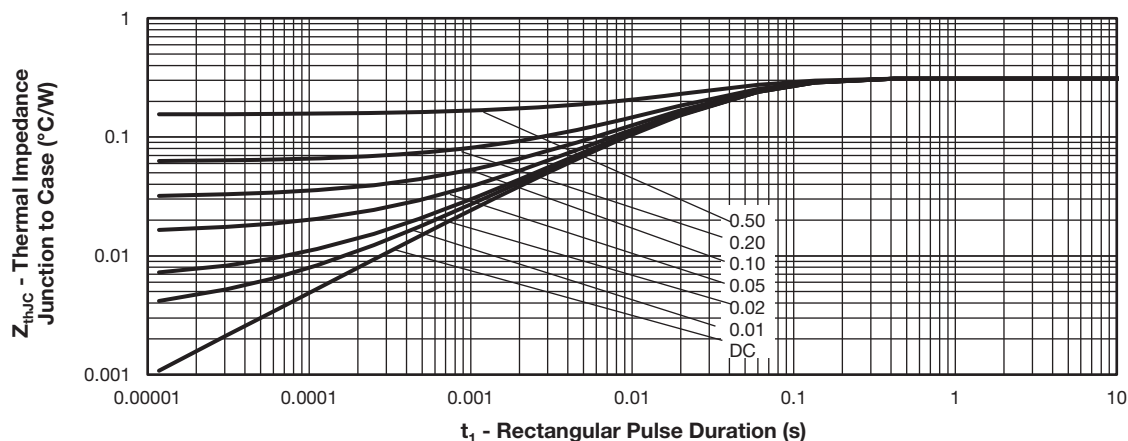


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics - (Diode)

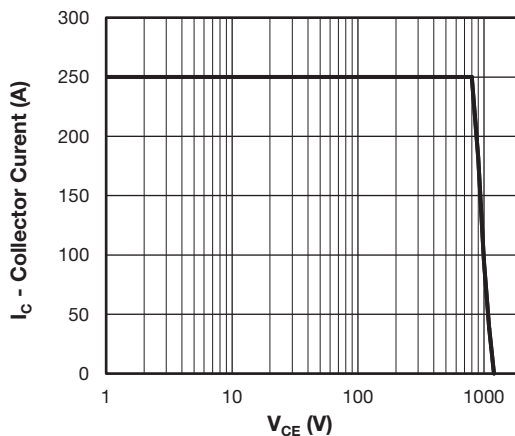
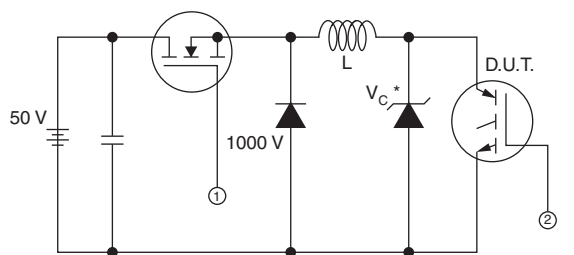


Fig. 20 - IGBT Reverse Bias SOA
 $V_{GE} = 15\text{ V}$, $T_J = 150^\circ\text{C}$



* 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

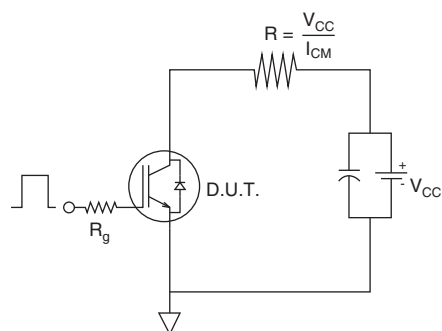


Fig. 22 - Pulsed Collector Current Test Circuit

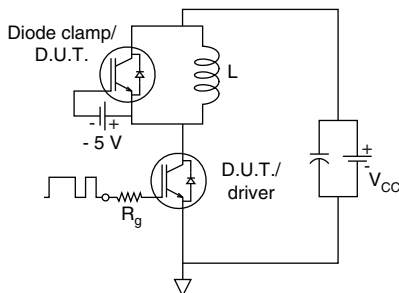


Fig. 23 - Switching Loss Test Circuit

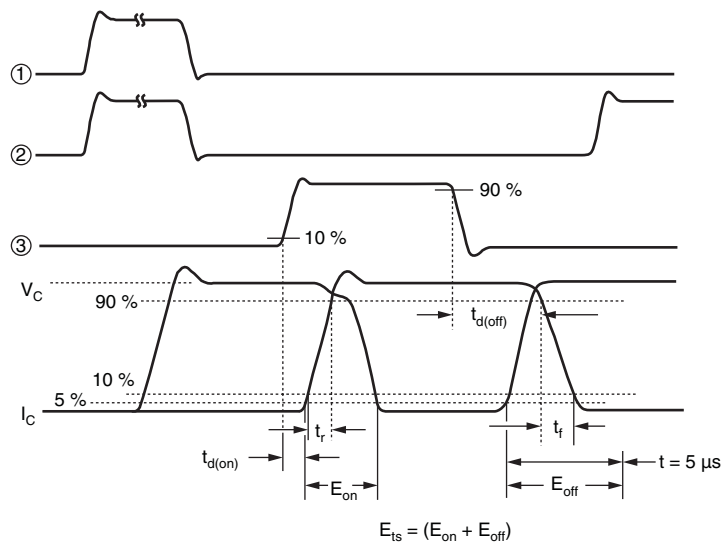


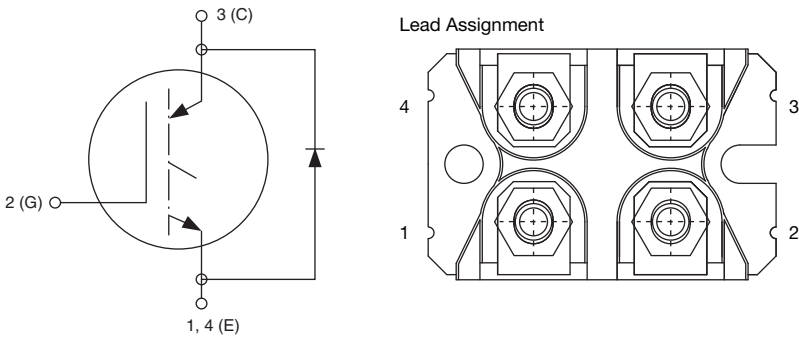
Fig. 24 - Switching Loss Waveforms Test Circuit



ORDERING INFORMATION TABLE

Device code	VS-	G	T	100	D	A	120	UF
	1	2	3	4	5	6	7	8

- | | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated Gate Bipolar Transistor (IGBT) |
| 3 | - | Trench IGBT technology |
| 4 | - | Current rating (100 = 100 A) |
| 5 | - | Circuit configuration (D = single switch with antiparallel diode) |
| 6 | - | Package indicator (A = SOT-227) |
| 7 | - | Voltage rating (120 = 1200 V) |
| 8 | - | Speed/type (UF = Trench ultrafast IGBT) |

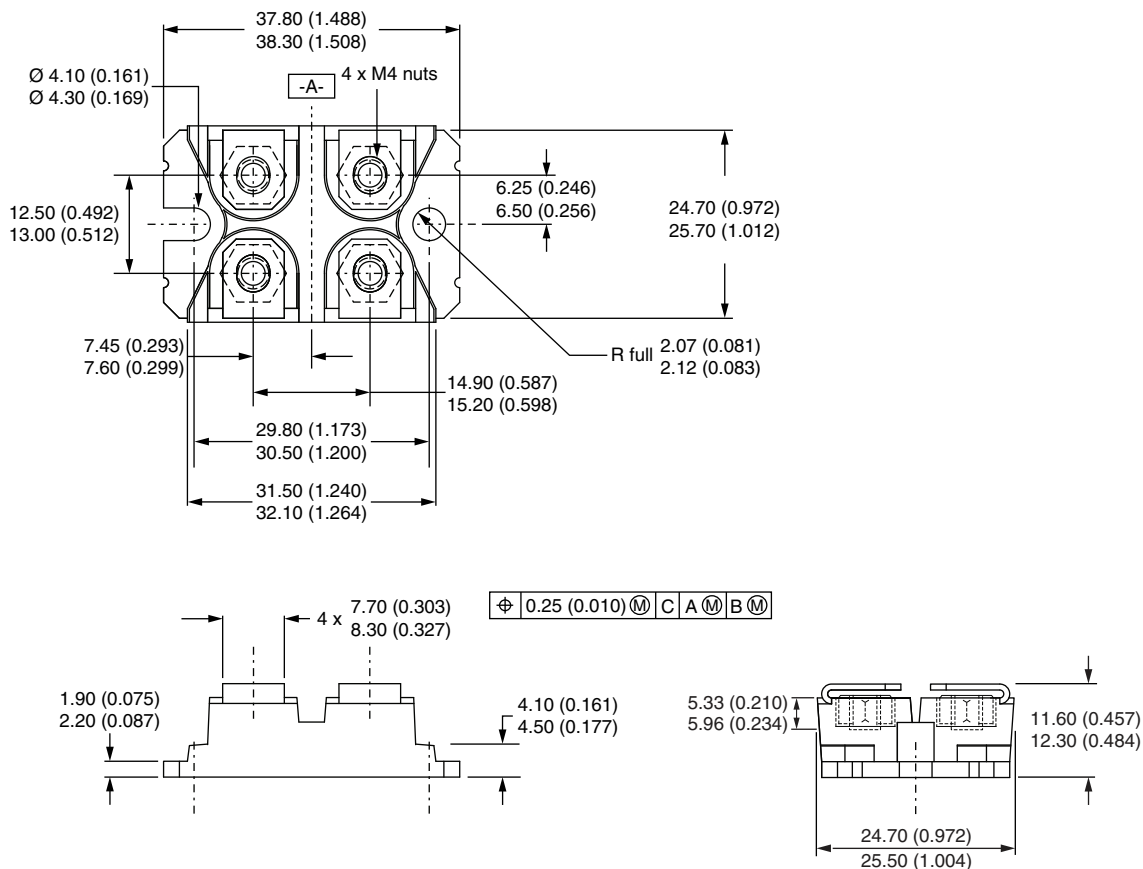
CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch with AP diode	D	

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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