

“Low Side Chopper” IGBT SOT-227 (Trench IGBT), 47 A



SOT-227


RoHS
COMPLIANT

FEATURES

- Trench IGBT technology
- Square RBSOA
- HEXFRED® clamping diode
- Positive $V_{CE(on)}$ temperature coefficient
- Fully isolated package
- Speed 8 kHz to 60 kHz
- 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

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	50 A at 73 °C
$V_{CE(on)}$ typical at 50 A, 25 °C	2.39 V
Package	SOT-227
Circuit configuration	Low side chopper

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		1200	V
Continuous collector current	I_C	$T_C = 25\text{ °C}$	68	A
		$T_C = 80\text{ °C}$	47	
Pulsed collector current	I_{CM}	$T_J = 150\text{ °C}$, $T_p = 6\text{ ms}$, $V_{GE} = 15\text{ V}$	150	
Clamped inductive load current	I_{LM}		250	
Diode continuous forward current	I_F	$T_C = 25\text{ °C}$	87	
		$T_C = 80\text{ °C}$	59	
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, $T_J = 25\text{ °C}$	310	
Gate to emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	$T_C = 25\text{ °C}$	291	W
		$T_C = 80\text{ °C}$	163	
Power dissipation, diode	P_D	$T_C = 25\text{ °C}$	338	
		$T_C = 80\text{ °C}$	190	
RMS 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	$V_{BR(CES)}$	$V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$	1200	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}$, $I_C = 25\text{ A}$	-	1.95	-	
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$	-	2.39	2.8	
		$V_{GE} = 15\text{ V}$, $I_C = 25\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.13	-	
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.76	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$, $I_C = 2\text{ mA}$	4.6	5.8	7.6	
Temperature coefficient of threshold voltage	$V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}$, $I_C = 2\text{ mA}$ ($25\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$)	-	-13	-	mV/ $^{\circ}\text{C}$
Collector to emitter leakage current	I_{CES}	$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$	-	1.7	50	μA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	26.2	-	
Diode reverse breakdown voltage	V_{BR}	$I_R = 1\text{ mA}$	1200	-	-	V
Diode forward voltage drop	V_{FM}	$I_F = 25\text{ A}$, $V_{GE} = 0\text{ V}$	-	2.11	2.42	V
		$I_F = 50\text{ A}$, $V_{GE} = 0\text{ V}$	-	2.72	-	
		$I_F = 25\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.04	-	
		$I_F = 50\text{ A}$, $V_{GE} = 0\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	2.83	-	
Diode reverse leakage current	I_{RM}	$V_R = 1200\text{ V}$	-	4	50	μA
		$T_J = 125\text{ }^{\circ}\text{C}$, $V_R = 1200\text{ V}$	-	0.8	-	mA
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	$I_C = 40\text{ A}$, $V_{CC} = 960\text{ V}$, $V_{GE} = 15\text{ V}$	-	171	-	nC
Gate to emitter charge (turn-on)	Q_{ge}		-	22	-	
Gate to collector charge (turn-on)	Q_{gc}		-	86	-	
Turn-on switching loss	E_{on}	$I_C = 50\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	2.7	-	mJ
Turn-off switching loss	E_{off}		-	1.4	-	
Total switching loss	E_{tot}		-	4.1	-	
Turn-on switching loss	E_{on}		-	4.1	-	
Turn-off switching loss	E_{off}		-	2.3	-	
Total switching loss	E_{tot}		-	6.4	-	
Turn-on delay time	$t_{d(on)}$	$I_C = 50\text{ A}$, $V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $R_g = 4.7\text{ }\Omega$, $L = 500\text{ }\mu\text{H}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	8	-	ns
Rise time	t_r		-	11	-	
Turn-off delay time	$t_{d(off)}$		-	81	-	
Fall time	t_f		-	179	-	
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 , $V_{CC} = 700\text{ V}$, $V_P = 1200\text{ V}$	Fullsquare			
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $di_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$	-	129	-	ns
Diode peak reverse current	I_{rr}		-	11	-	A
Diode recovery charge	Q_{rr}		-	710	-	nC
Diode reverse recovery time	t_{rr}	$I_F = 50\text{ A}$, $di_F/dt = 200\text{ A}/\mu\text{s}$, $V_R = 200\text{ V}$, $T_J = 125\text{ }^{\circ}\text{C}$	-	208	-	ns
Diode peak reverse current	I_{rr}		-	17	-	A
Diode recovery charge	Q_{rr}		-	1768	-	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	R_{thJC}		-	-	0.43	°C/W
IGBT			-	-	-	
Diode			-	-	0.37	
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				

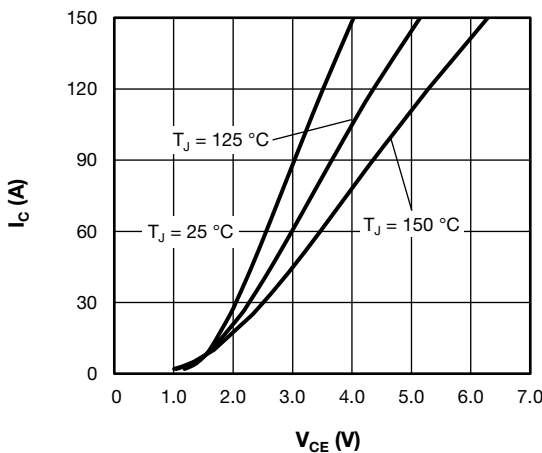
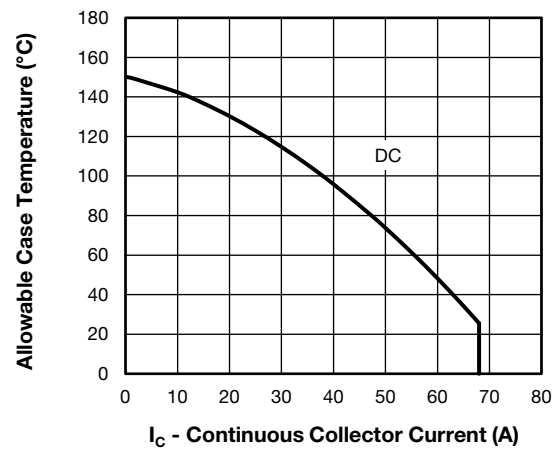

Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE} = 15\text{ V}$


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

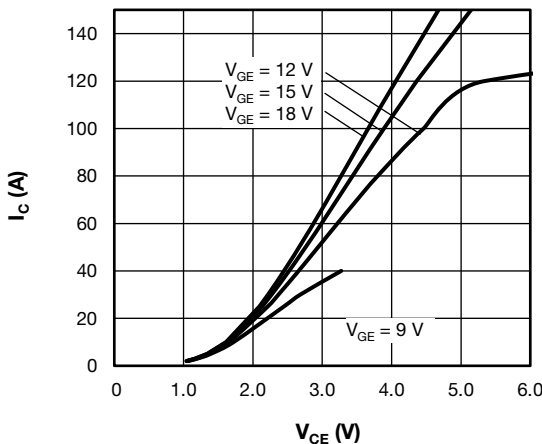
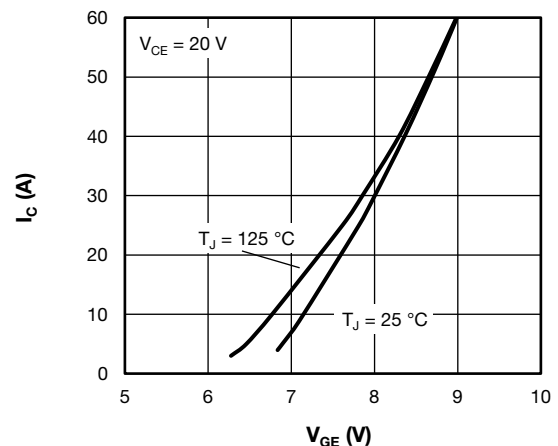

Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J = 125\text{ °C}$


Fig. 4 - Typical Trench IGBT Transfer Characteristic

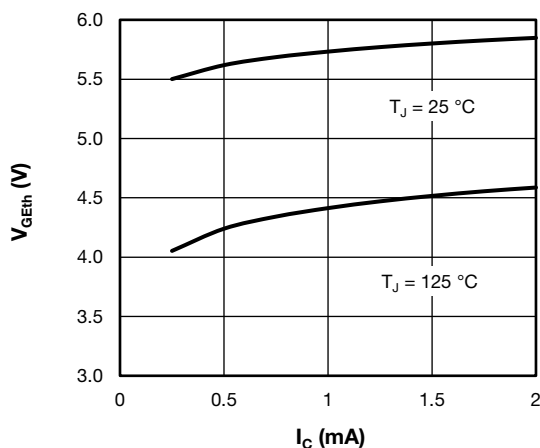


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

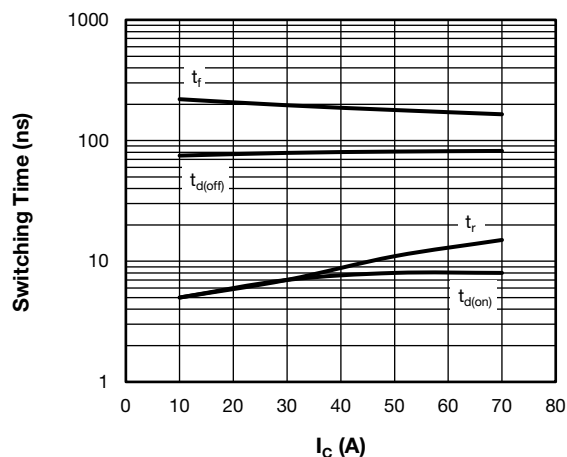
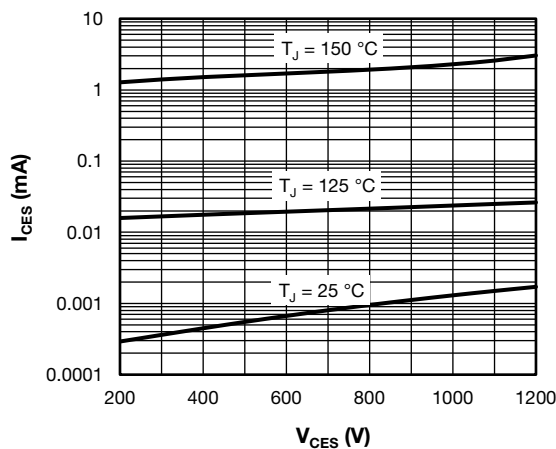
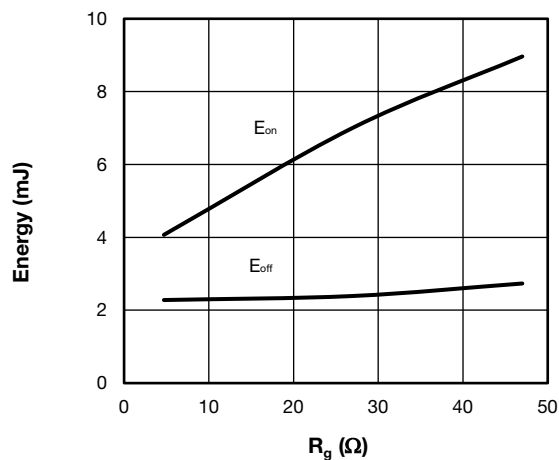
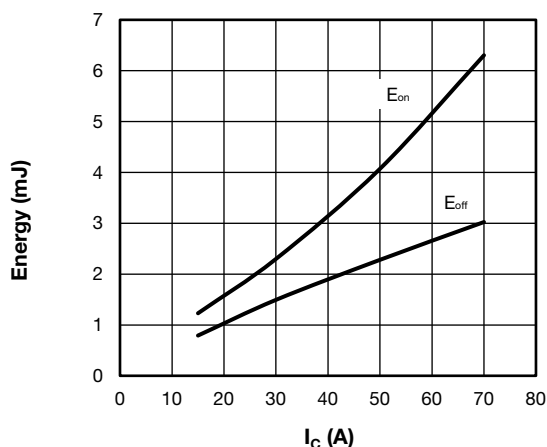
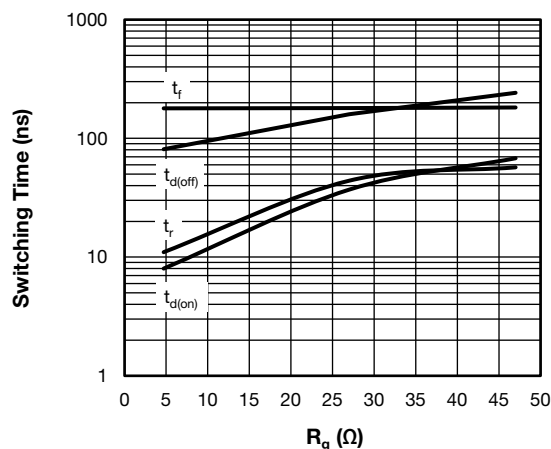

Fig. 8 - Typical Trench IGBT Switching Time vs. I_C
 $T_J = 125\text{ °C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$


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


Fig. 9 - Typical Trench IGBT Energy Losses vs. R_g
 $T_J = 125\text{ °C}$, $V_{CC} = 600\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

Fig. 7 - Typical Trench IGBT Energy Loss vs. I_C
 $T_J = 125\text{ °C}$, $V_{CC} = 600\text{ V}$, $R_g = 4.7\text{ }\Omega$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

Fig. 10 - Typical Trench IGBT Switching Time vs. R_g
 $T_J = 125\text{ °C}$, $V_{CC} = 600\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = +15\text{ V}/-15\text{ V}$, $L = 500\text{ }\mu\text{H}$

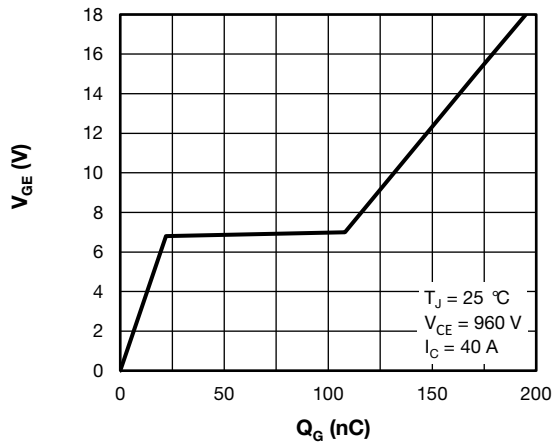


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

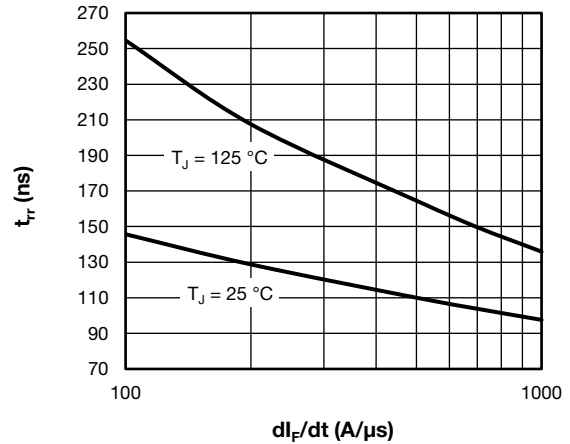


Fig. 14 - Typical Diode Reverse Recovery Time vs. dI_F/dt

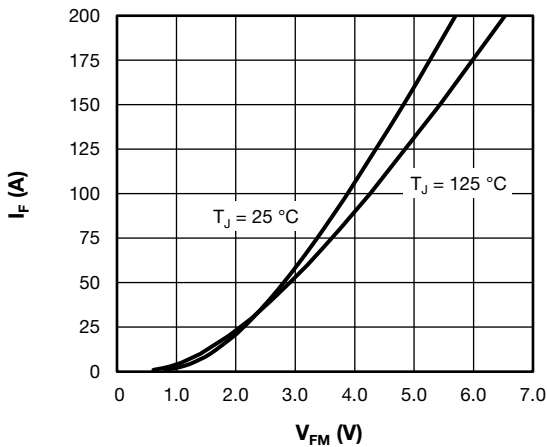


Fig. 12 - Typical Diode Forward Characteristic

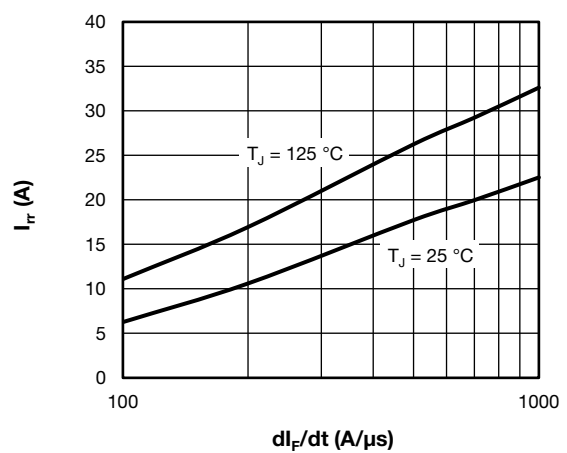


Fig. 15 - Typical Diode Reverse Recovery Current vs. dI_F/dt

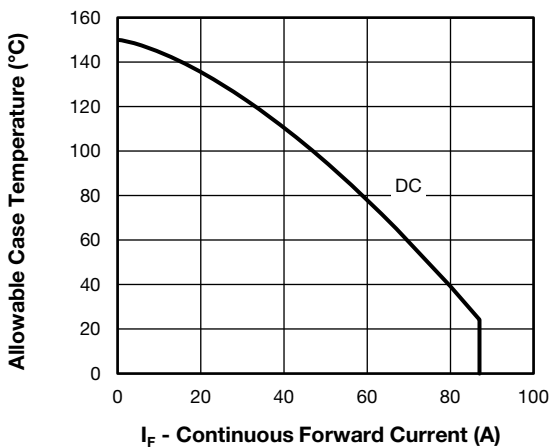


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

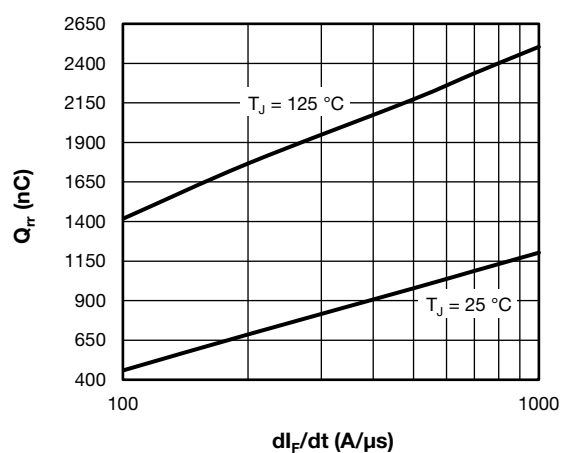


Fig. 16 - Typical Diode Reverse Recovery Charge vs. dI_F/dt

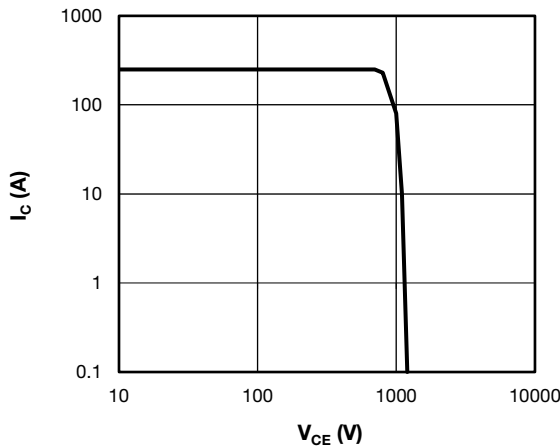


Fig. 17 - Trench IGBT Reverse BIAS SOA
 $T_J = 150^\circ\text{C}$, $I_C = 250\text{ A}$, $R_g = 4.7\ \Omega$, $V_{GE} = +15\text{ V/0 V}$,
 $V_{CC} = 700\text{ V}$, $V_p = 1200\text{ V}$

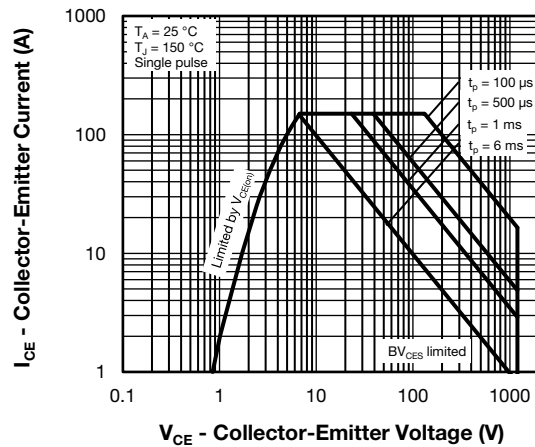


Fig. 18 - Trench IGBT Safe Operating Area

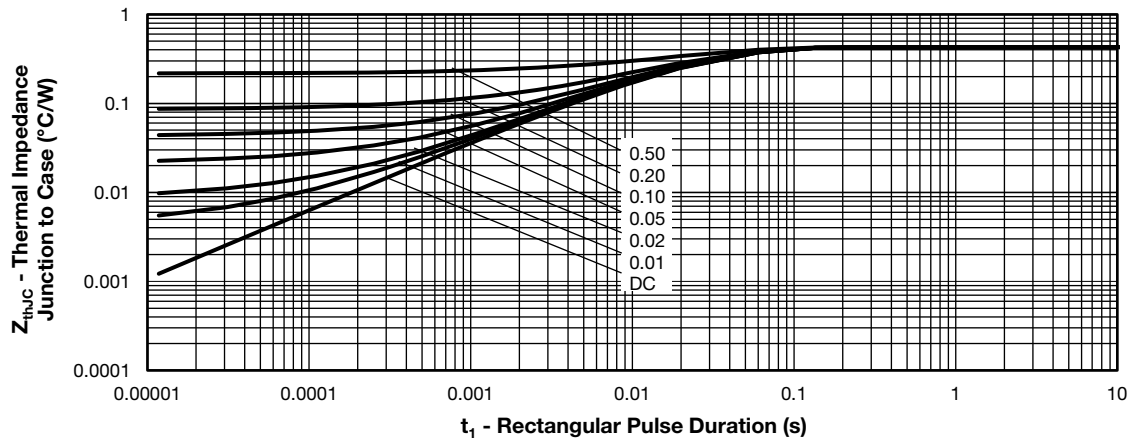


Fig. 19 - Maximum Trench IGBT Thermal Impedance Z_{thJC} Characteristics

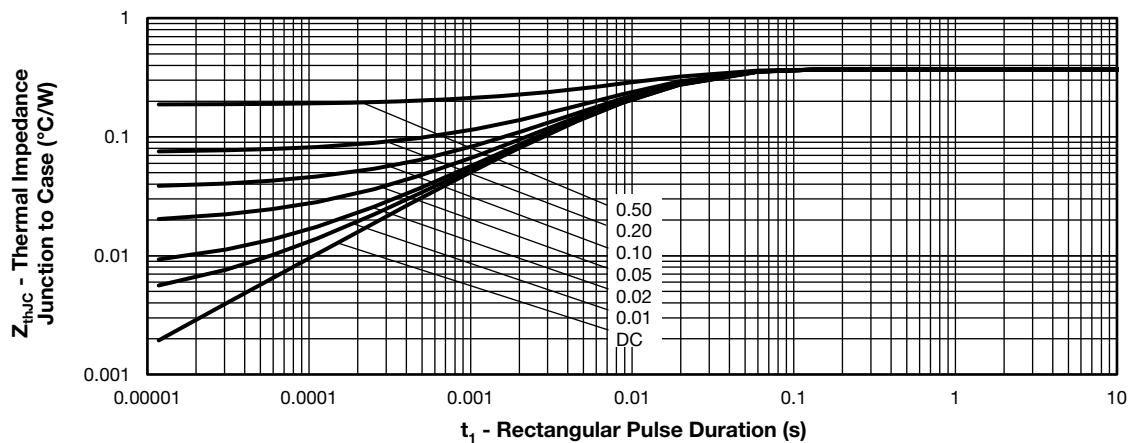
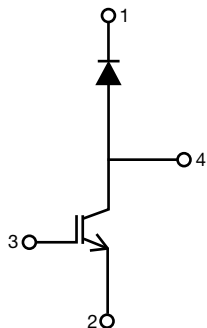
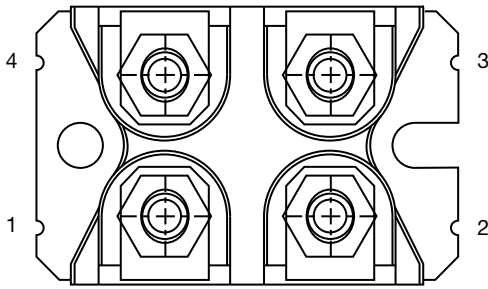


Fig. 20 - Maximum Diode Thermal Impedance Z_{thJC} Characteristics

ORDERING INFORMATION TABLE

Device code	VS-	G	T	55	L	A	120	U	X
	1	2	3	4	5	6	7	8	9

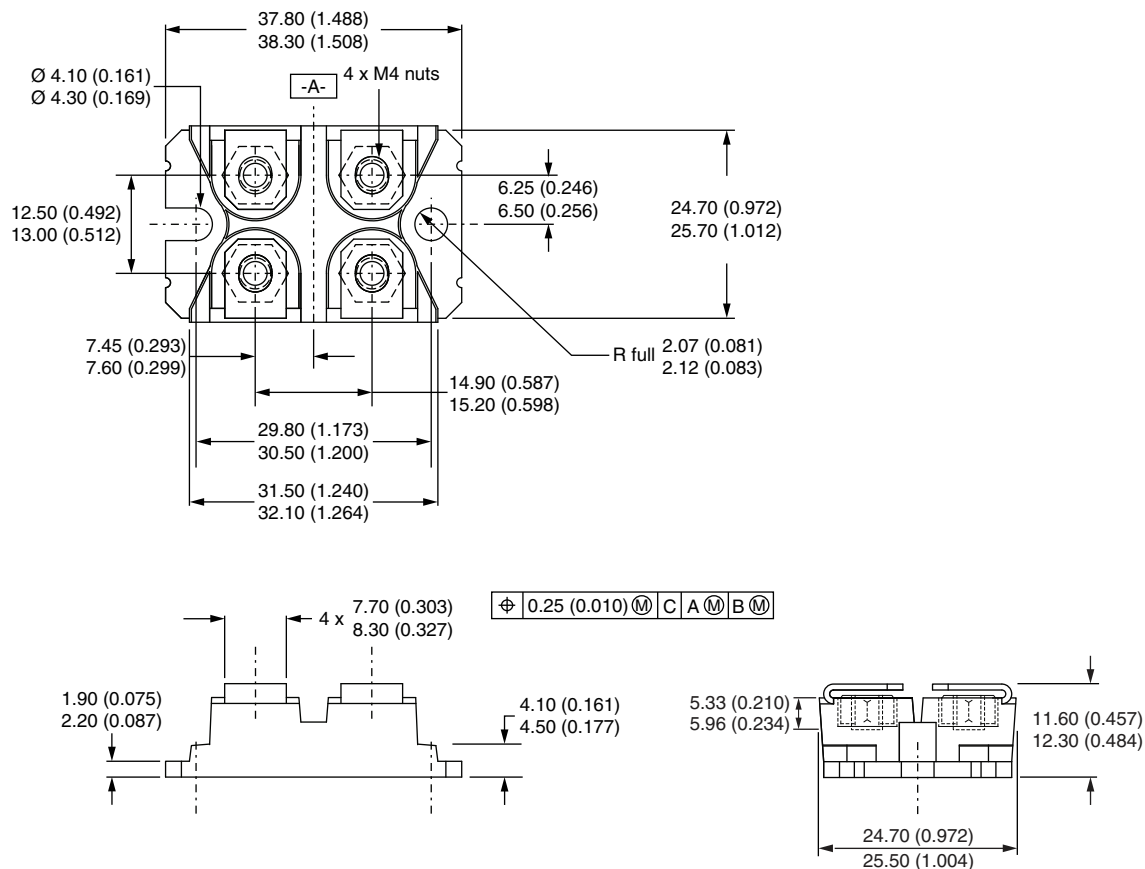
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|----------|---|--|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated gate bipolar transistor (IGBT) |
| 3 | - | T = trench IGBT |
| 4 | - | Current rating (55 = 55 A) |
| 5 | - | Circuit configuration (L = low side chopper) |
| 6 | - | Package indicator (A = SOT-227) |
| 7 | - | Voltage rating (120 = 1200 V) |
| 8 | - | Speed/type (U = ultrafast IGBT) |
| 9 | - | Diode (X = HEXFRED® diode) |

CIRCUIT CONFIGURATION			
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING	
Low side chopper	L		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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