

SOT-227 Power Module

Low Side Chopper - Silicon Carbide Power MOSFET 50 A


SOT-227

FEATURES

- High blocking voltage with low on-resistance
- High speed switching with low capacitance
- Soft body diode with low reverse recovery
- Maximum 175 °C junction temperature
- UL approved file E78996 
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

APPLICATIONS

- EV chargers
- Server and telecom PSU
- UPS
- Solar Inverters
- SMPS
- DC/DC converters

PRIMARY CHARACTERISTICS

V_{DSS}	1200 V
$R_{DS(on)}$ at 50 A	43 mΩ
I_D	30 A at 90 °C
I_F	29 A at 90 °C
Type	Low side chopper - SiC MOSFET Modules
Package	SOT-227

DESCRIPTION

This is an high performance silicon carbide MOSFET. The high blocking voltage with low on-resistance, high speed switching with low capacitance make this MOSFET ideal for high frequency switching application including solar inverters and EV chargers.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
MOSFET				
Drain to source voltage	V_{DSS}		1200	V
Continuous drain current, V_{GS} at 15 V	I_D	$T_C = 25\text{ °C}$	38	A
		$T_C = 90\text{ °C}$	30	
Pulsed drain current	$I_{DM}^{(1)}$		100	
Diode continuous forward current	I_F	$T_C = 25\text{ °C}$	40	A
		$T_C = 90\text{ °C}$	29	
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, $T_J = 25\text{ °C}$	130	A
Power dissipation per MOSFET	P_D	$T_C = 25\text{ °C}$	136	W
Power dissipation per diode	P_D	$T_C = 25\text{ °C}$	125	W
Gate to source voltage	V_{GS}		-8 / +19	V
MODULE				
Operating junction temperature range	T_J		-55 to +175	°C
Operating storage temperature range	T_{Stg}		-40 to +150	
Insulation voltage (RMS)	V_{ISOL}	any terminal to case, $t = 1\text{ min}$	2500	V

Note

⁽¹⁾ Limited at max. junction temperature

**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	SYMBOL	RATING	UNITS
Recommended operating gate - source voltage	$V_{GS(op)}$	-4 / +15	V

THERMAL AND MECHANICAL SPECIFICATIONS

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating junction temperature range	T_J		-55	-	175	°C
Operating storage temperature range	T_{Stg}		-40	-	150	
Junction to case	MOSFET	R_{thJC}	-	-	1.1	°C/W
	diode	R_{thJC}	-	-	1.2	
Case to heatsink	Module	R_{thCS}	Flat, greased surface	0.1	-	
Weight			-	30	-	g
Mounting torque		Torque to terminal	-	-	1.1 (9.7)	Nm (lb. in)
		Torque to heatsink	-	-	1.8 (15.9)	Nm (lb. in)
Case style			SOT-227			

ELECTRICAL CHARACTERISTICS ($T_J = 25\text{ °C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Drain to source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}$, $I_D = 100\text{ }\mu\text{A}$	1200	-	-	V
Breakdown voltage temperature coefficient	$\Delta V_{(BR)DSS}/\Delta T_J$	$I_D = 100\text{ }\mu\text{A}$ (25 °C to 125 °C)	-	0.45	-	mV/°C
Static drain to source on-resistance	$R_{DS(on)}$	$V_{GS} = 15\text{ V}$, $I_D = 50\text{ A}$	-	43	63	mΩ
		$V_{GS} = 15\text{ V}$, $I_D = 50\text{ A}$, $T_J = 175\text{ °C}$	-	85	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$, $I_D = 7.11\text{ mA}$	1.7	2.4	3.7	V
		$V_{DS} = V_{GS}$, $I_D = 7.11\text{ mA}$, $T_J = 150\text{ °C}$	-	2.1	-	
Temperature coefficient of threshold voltage	$\Delta V_{GS(th)}/\Delta T_J$	$V_{DS} = V_{GS}$, $I_D = 7.11\text{ mA}$ (25 °C to 125 °C)	-	-2.2	-	mV/°C
Forward transconductance	g_{fs}	$V_{DS} = 20\text{ V}$, $I_D = 50\text{ A}$	-	32	-	S
Drain to source leakage current	I_{DSS}	$V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$	-	0.4	50	μA
		$V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ °C}$	-	1.5	-	
Gate to source leakage	I_{GSS}	$V_{GS} = 15\text{ V}$	-	-	250	nA
Diode reverse breakdown voltage	V_{BR}	$I_R = 100\text{ }\mu\text{A}$	1200	-	-	V
Diode forward voltage drop	V_{FM}	$I_F = 50\text{ A}$	-	1.96	3.05	V
Diode reverse leakage current	I_R	$V_R = 1200\text{ V}$	-	3.43	50	μA
Total gate charge	Q_g	$I_D = 30\text{ A}$, $V_{DS} = 800\text{ V}$, $V_{GS} = -4\text{ V} / +15\text{ V}$	-	87	-	nC
Gate to source charge	Q_{gs}		-	19	-	
Gate to drain ("Miller") charge	Q_{gd}		-	36	-	
Turn-on switching energy	E_{on}	$V_{DD} = 800\text{ V}$, $I_D = 50\text{ A}$, $R_g = 2.2\text{ }\Omega$, $V_{GS} = -4\text{ V} / +15\text{ V}$	-	0.649	-	mJ
Turn-off switching energy	E_{off}		-	0.346	-	
Turn-on delay time	$t_{d(on)}$		-	13.44	-	ns
Rise time	t_r		-	29.44	-	
Turn-off delay time	$t_{d(off)}$		-	27.52	-	
Fall time	t_f	$V_{DD} = 800\text{ V}$, $I_D = 50\text{ A}$, $R_g = 2.2\text{ }\Omega$, $V_{GS} = -4\text{ V} / +15\text{ V}$, $T_J = 125\text{ °C}$	-	9.28	-	mJ
Turn-on switching energy	E_{on}		-	0.507	-	
Turn-off switching energy	E_{off}		-	0.408	-	ns
Turn-on delay time	$t_{d(on)}$		-	14.24	-	
Rise time	t_r		-	23.52	-	
Turn-off delay time	$t_{d(off)}$	$V_{GS} = 0\text{ V}$, $V_{DS} = 1000\text{ V}$, $f = 100\text{ kHz}$	-	30.24	-	pF
Fall time	t_f		-	9.28	-	
Input capacitance	C_{iss}		-	2317	-	
Output capacitance	C_{oss}		-	49	-	pF
Reverse transfer capacitance	C_{rss}		-	13	-	

**SOURCE-DRAIN RATINGS AND CHARACTERISTICS** ($T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Pulsed source current (body diode)	I_{SM}	10 ms sine or 6 ms rectangular pulse, $T_J = 175\text{ }^{\circ}\text{C}$	-	-	110	A
Diode forward voltage	V_{SD}	$I_S = 50\text{ A}$, $V_{GS} = 0\text{ V}$	-	5.67	6.0	V
Reverse recovery time	t_{rr}	$T_J = 25\text{ }^{\circ}\text{C}$, $I_F = I_S = 50\text{ A}$, $di/dt = 6400\text{ A}/\mu\text{s}$, $V_R = 800\text{ V}$	-	13	-	ns
Reverse recovery charge	Q_{rr}		-	121	-	nC
Reverse recovery current	I_{RRM}		-	18	-	A

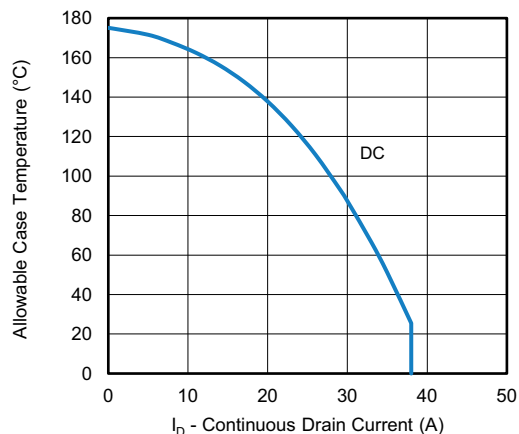


Fig. 1 - Max. Continuous Drain Current vs. Case Temperature

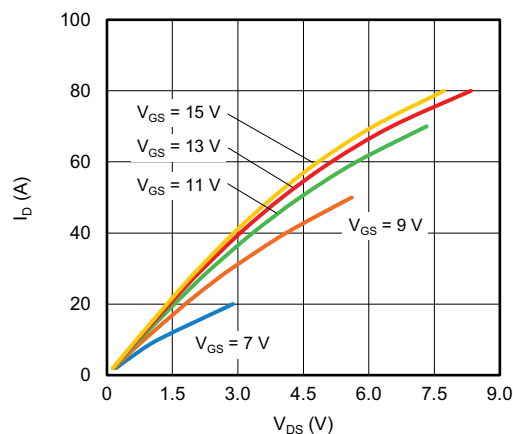
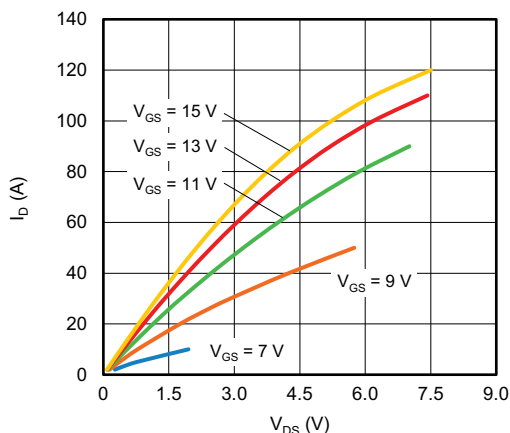
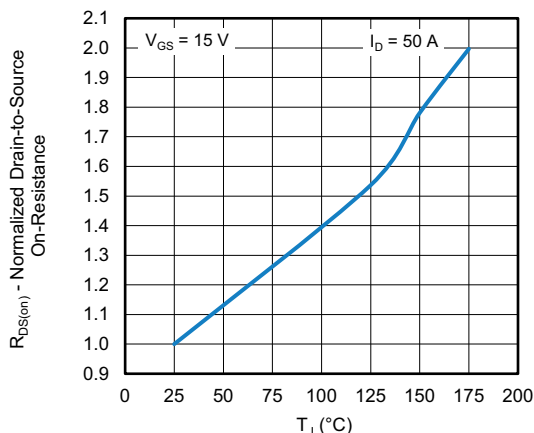
Fig. 3 - Typical Drain to Source Current Output Characteristics at $T_J = 150\text{ }^{\circ}\text{C}$ Fig. 2 - Typical Drain to Source Current Output Characteristics at $T_J = 25\text{ }^{\circ}\text{C}$ 

Fig. 4 - Normalized Drain-to-Source On-Resistance vs. Temperature

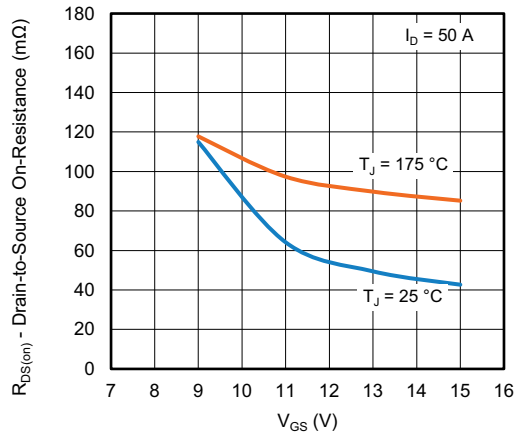


Fig. 5 - Typical Drain-to-Source On-Resistance vs. Gate to Source Voltage

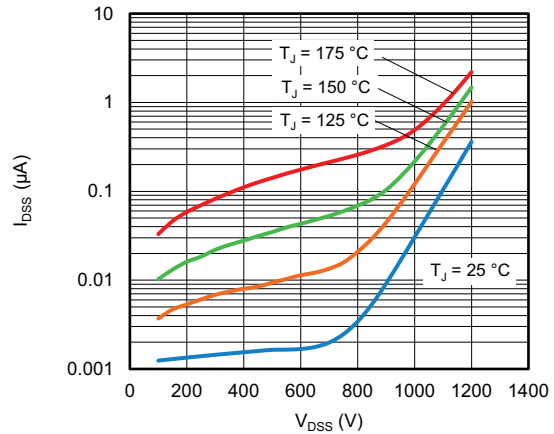


Fig. 8 - Typical Zero Gate Voltage Drain Current

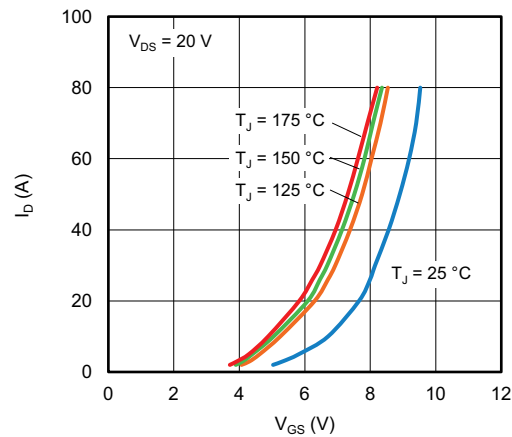


Fig. 6 - Typical Transfer Characteristics

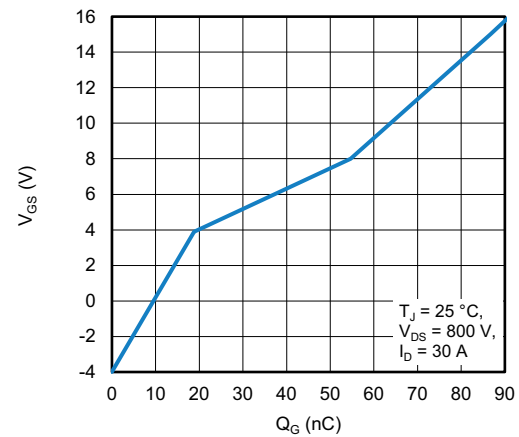


Fig. 9 - Typical Gate Charge vs. Gate to Source Voltage

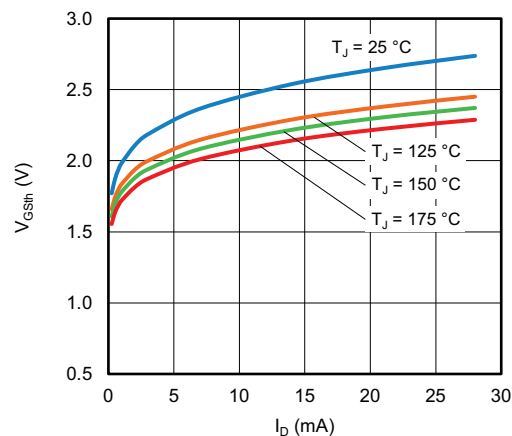


Fig. 7 - Typical Gate Threshold Voltage Characteristics

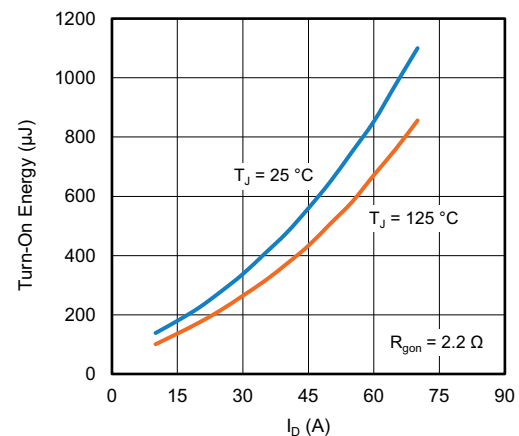
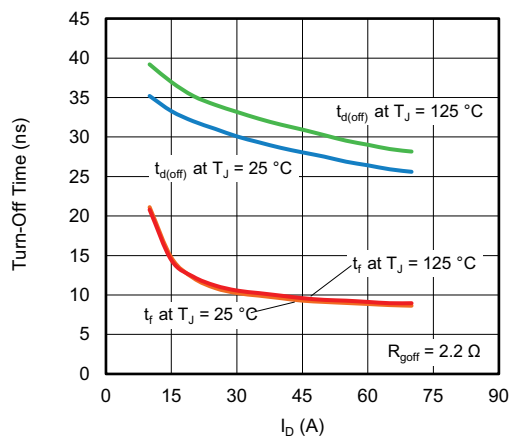
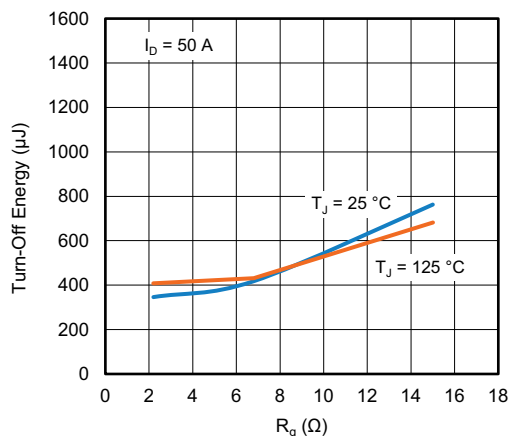
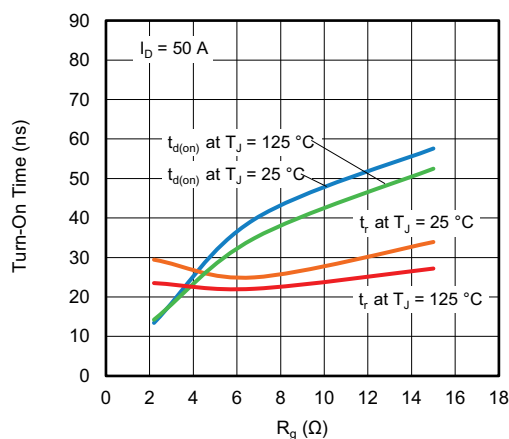
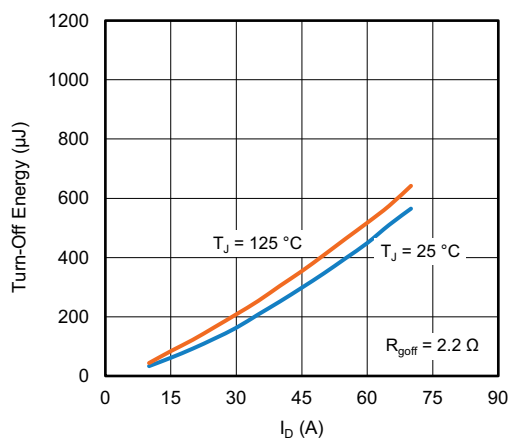
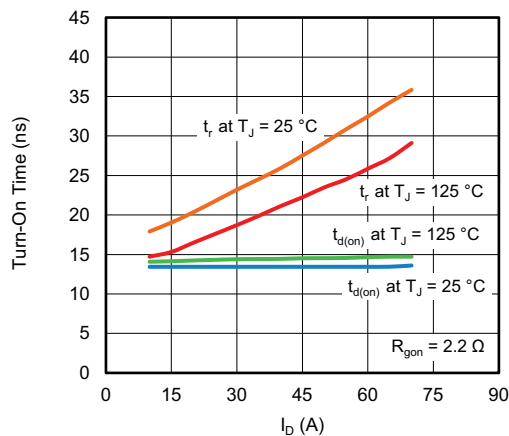
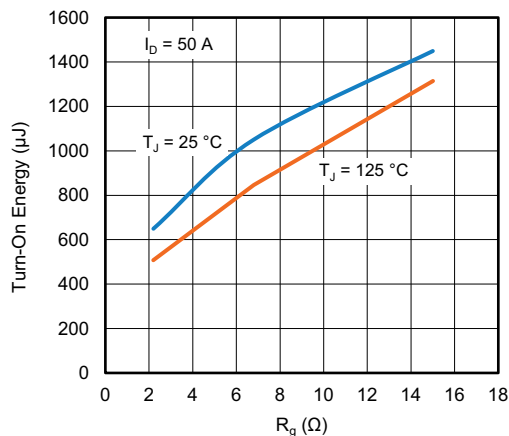


Fig. 10 - Typical Turn-On Energy Loss vs. I_D



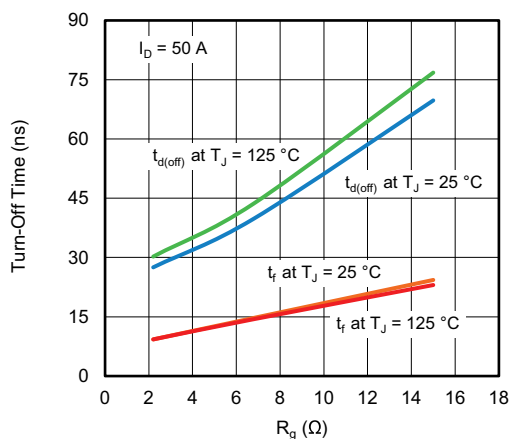
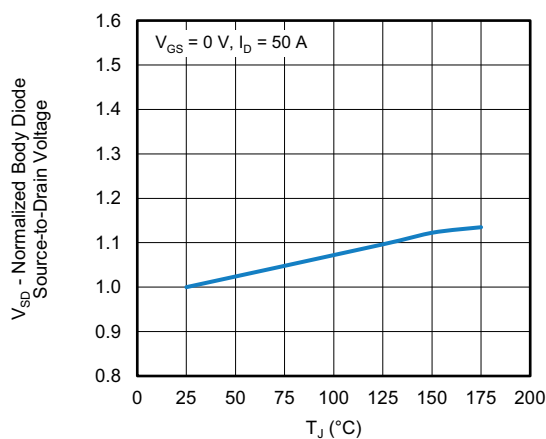

Fig. 17 - Typical Turn-Off Switching Time vs. R_g


Fig. 20 - Normalized Body Diode Source-to-Drain vs. Temperature

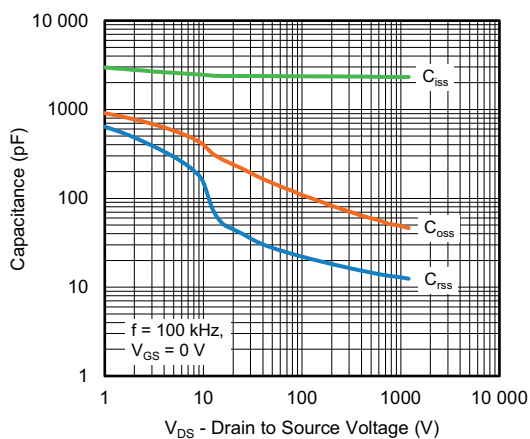


Fig. 18 - Capacitance vs. Drain-to-Source Voltage

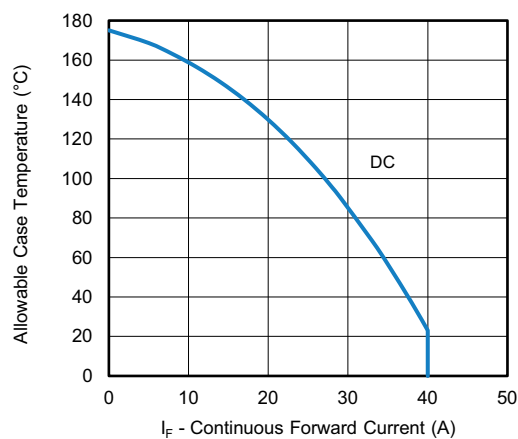


Fig. 21 - Allowable Case Temperature vs. Continuous Forward Current

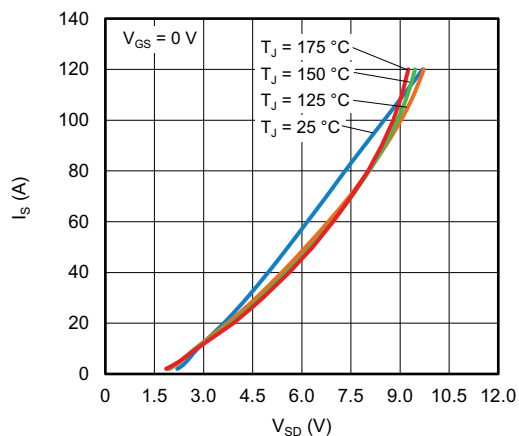


Fig. 19 - Typical Body Diode Source-to-Drain Current Characteristics

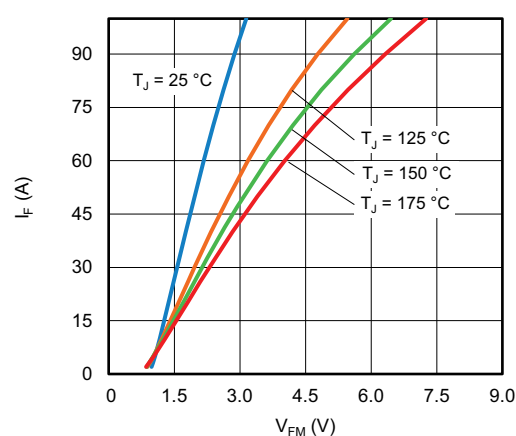


Fig. 22 - Diode Forward Characteristics

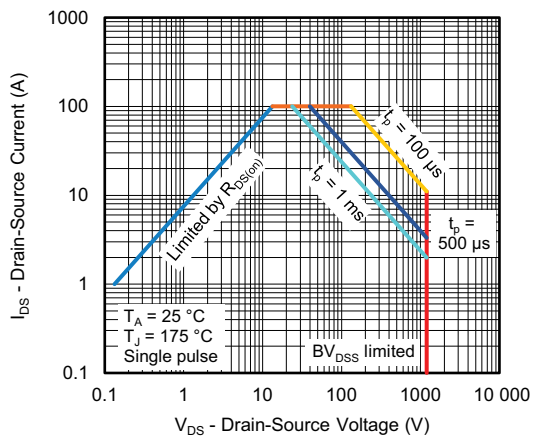


Fig. 23 - Safe Operating Area

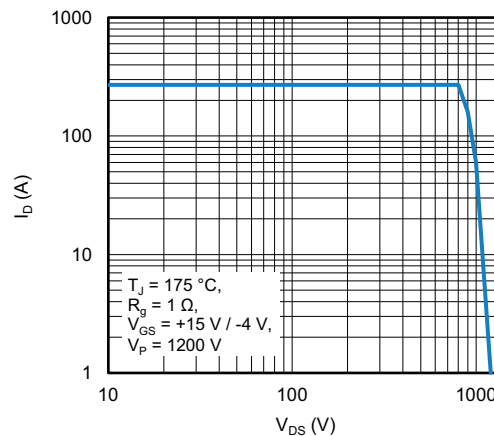
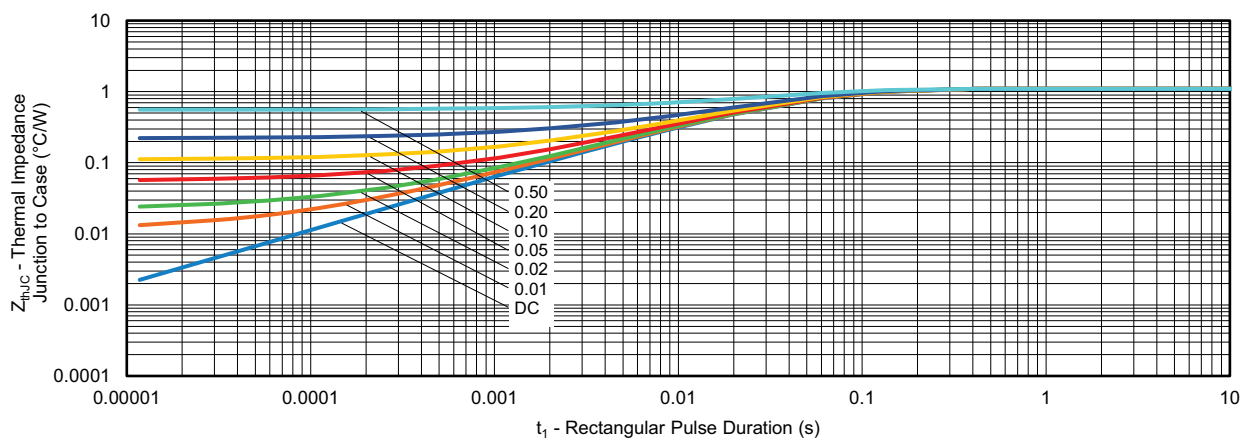
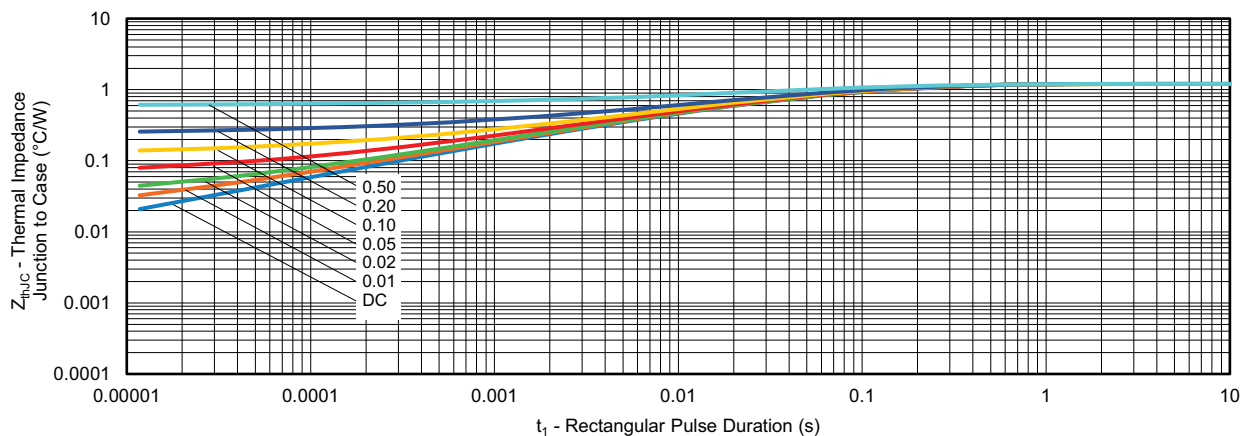


Fig. 24 - Reverse BIAS Safe Operating Area


Fig. 25 - Maximum Thermal Impedance Z_{thJC} Characteristics - MOSFET

Fig. 26 - Maximum Thermal Impedance Z_{thJC} Characteristics - Diode

ORDERING INFORMATION TABLE

Device code: VS-SF-50-L-A-120

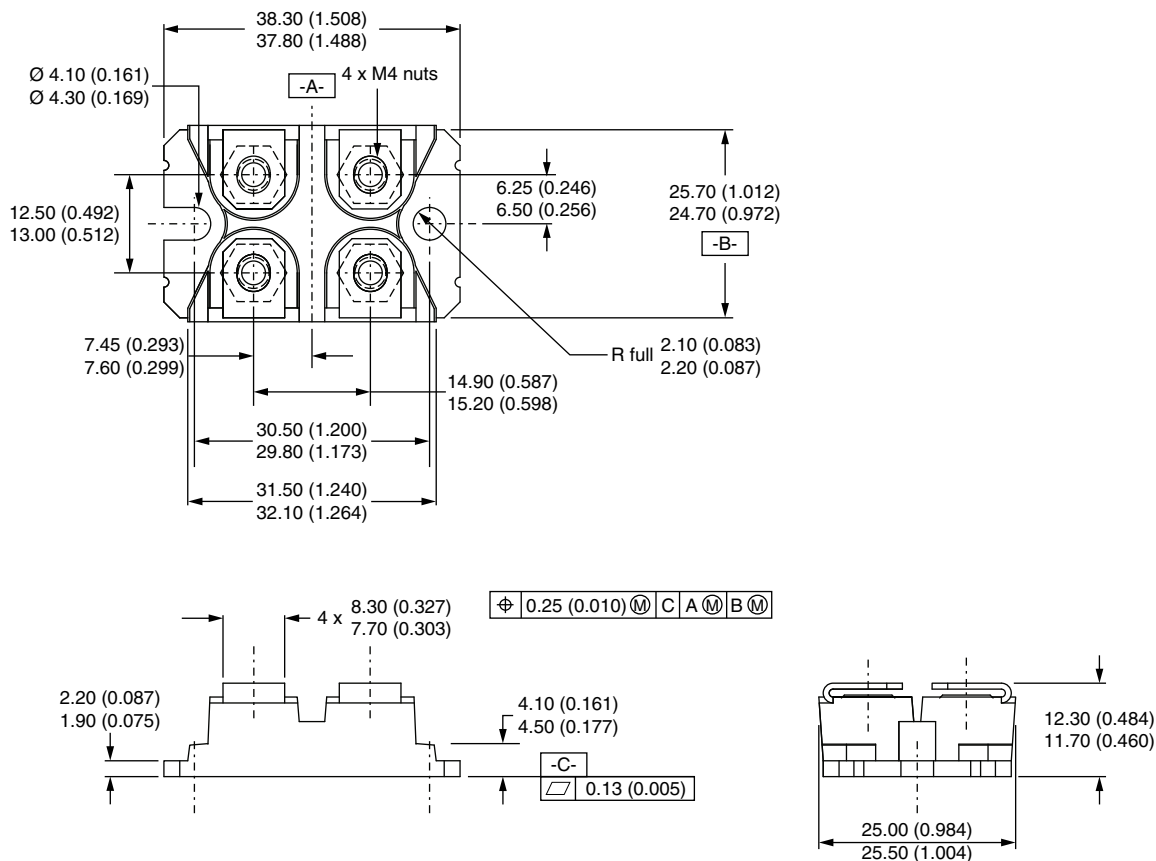
1 2 3 4 5 6

- 1** - Vishay Semiconductors product
- 2** - SF = SiC MOSFET module
- 3** - Current rating (50 = 50 A)
- 4** - Circuit configuration (L = low side chopper)
- 5** - Package indicator (SOT-227)
- 6** - Voltage rating (120 = 1200 V)

CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Low side chopper	L	The circuit drawing for the low side chopper module includes three parts: Schematic: A MOSFET with a diode in parallel. The MOSFET's gate is connected to terminal 3, its drain to terminal 1, and its source to terminal 2. The diode's anode is connected to terminal 2 and its cathode to terminal 4. Lead Assignment: A diagram showing four terminals: 1 (top), 2 (bottom), 3 (left), and 4 (right). Physical Layout: A diagram of the module's physical layout with four mounting holes. The top-left hole is labeled (D), the top-right (G), the bottom-left (D), and the bottom-right (S).



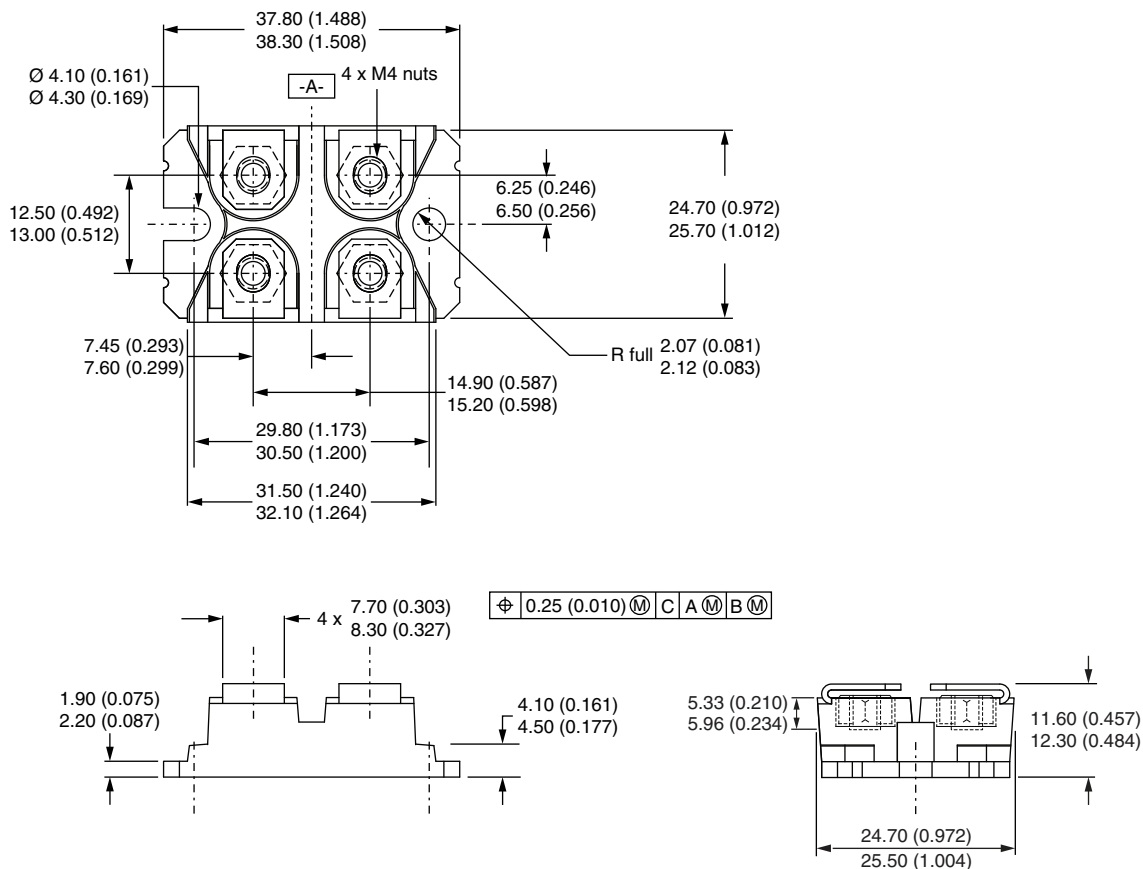
DIMENSIONS in millimeters





SOT-227 Generation 2

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter



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