Insulated Gate Bipolar Transistor (Trench IGBT), 650 V, 120 A

SOT-227

PRIMARY CHARACTERISTICS	
V_{CES}	650 V
I_C DC	120 A at 90 °C
$V_{CE(on)}$ typical at 100 A, 25 °C	1.71 V
I_F DC	76 A at 90 °C
Speed	8 kHz to 30 kHz
Package	SOT-227
Circuit configuration	Single switch with AP diode

FEATURES

- Trench IGBT technology with positive temperature coefficient
- Square RBSOA
- FRED Pt® antiparallel diodes with ultrasoft reverse recovery
- Fully isolated package
- Very low internal inductance (≤ 5 nH typical)
- Industry standard outline
- UL pending
- 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 to heatsink
- Plug-in compatible with other SOT-227 packages
- Lower conduction losses and switching losses
- Low EMI, requires less snubbing

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	V_{CES}		650	V
Continuous collector current	I_C	T_C = 25 °C	167	A
		T_C = 90 °C	120	
Pulsed collector current	I_{CM}		220	
Clamped inductive load current	I_{LM}		220	
Diode continuous forward current	I_F	T_C = 25 °C	110	
		T_C = 90 °C	76	
Single pulse forward current	I_{FSM}	10 ms sine or 6 ms rectangular pulse, T_J = 25 °C	550	A
Gate-to-emitter voltage	V_{GE}		± 20	V
Power dissipation, IGBT	P_D	T_C = 25 °C	577	W
		T_C = 90 °C	327	
Power dissipation, diode	P_D	T_C = 25 °C	238	
		T_C = 90 °C	135	
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 = 100 μA	650	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	V_{GE} = 15 V, I_C = 100 A	-	1.71	2.00	V
		V_{GE} = 15 V, I_C = 100 A, T_J = 125 °C	-	2.00	-	V
		V_{GE} = 15 V, I_C = 100 A, T_J = 175 °C	-	2.17	-	V
Gate threshold voltage	$V_{GE(th)}$	V_{CE} = V_{GE}, I_C = 3.3 mA	5.1	6.1	8.3	V
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	V_{CE} = V_{GE}, I_C = 1 mA (25 °C to 125 °C)	-	-20	-	mV/°C
Collector to emitter leakage current	I_{CES}	V_{GE} = 0 V, V_{CE} = 650 V	-	1.2	50	μA
		V_{GE} = 0 V, V_{CE} = 650 V, T_J = 125 °C	-	80	-	μA
		V_{GE} = 0 V, V_{CE} = 650 V, T_J = 175 °C	-	2.0	-	mA
Forward voltage drop, diode	V_{FM}	I_C = 100 A, V_{GE} = 0 V	-	2.00	2.53	V
		I_C = 100 A, V_{GE} = 0 V, T_J = 125 °C	-	1.69	-	V
		I_C = 100 A, V_{GE} = 0 V, T_J = 175 °C	-	1.55	-	V
Gate to emitter leakage current	I_{GES}	V_{GE} = ± 20 V	-	-	± 660	nA

SWITCHING CHARACTERISTICS (T_J = 25 °C unless otherwise specified)							
PARAMETER	**SYMBOL**	**TEST CONDITIONS**		**MIN.**	**TYP.**	**MAX.**	**UNITS**
Input capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 30 V, f = 1.0 MHz		-	6600	-	pF
Output capacitance	C_{oss}			-	340	-	pF
Reverse transfer capacitance	C_{rss}			-	180	-	pF
Total gate charge (turn-on)	Q_g	I_C = 100 A, V_{CC} = 400 V, V_{GE} = 15 V		-	190	-	nC
Gate to emitter charge (turn-on)	Q_{ge}			-	65	-	nC
Gate to collector charge (turn-on)	Q_{gc}			-	80	-	nC
Turn-on switching loss	E_{on}	I_C = 100 A, V_{CC} = 325 V, V_{GE} = 15 V, R_g = 4.7 Ω, L = 500 μH	Energy losses include tail and diode recovery.	-	0.32	-	mJ
Turn-off switching loss	E_{off}			-	1.5	-	mJ
Total switching loss	E_{tot}			-	1.82	-	mJ
Turn-on delay time	$t_{d(on)}$			-	114	-	ns
Rise time	t_r			-	73	-	ns
Turn-off delay time	$t_{d(off)}$			-	107	-	ns
Fall time	t_f			-	68	-	ns
Turn-on switching loss	E_{on}	I_C = 100 A, V_{CC} = 325 V, V_{GE} = 15 V, R_g = 4.7 Ω, L = 500 μH, T_J = 125 °C		-	0.52	-	mJ
Turn-off switching loss	E_{off}			-	1.85	-	mJ
Total switching loss	E_{tot}			-	2.37	-	mJ
Turn-on delay time	$t_{d(on)}$			-	115	-	ns
Rise time	t_r			-	74	-	ns
Turn-off delay time	$t_{d(off)}$			-	114	-	ns
Fall time	t_f			-	89	-	ns
Reverse bias safe operating area	RBSOA	T_J = 175 °C, I_C = 220 A, R_g = 10 Ω, V_{GE} = 15 V to 0 V, V_{CC} = 325 V, V_P = 650 V, L = 500 μH		Fullsquare			
Short circuit safe operating area	SCSOA	V_{GE} = 15 V, V_{CC} = 400 V, R_g = 4.7 Ω, $V_P \leq$ 650 V, T_J = 150 °C		-	-	5.5	μs
Diode reverse recovery time	t_{rr}	I_F = 50 A, dI_F/dt = 200 A/μs, V_R = 200 V		-	72	-	ns
Diode peak reverse current	I_{rr}			-	5.3	-	A
Diode recovery charge	Q_{rr}			-	192	-	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		-	149	-	ns
Diode peak reverse current	I_{rr}			-	13	-	A
Diode recovery charge	Q_{rr}			-	974	-	nC

THERMAL AND MECHANICAL SPECIFICATIONS							
PARAMETER		SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range		T_J, T_{Stg}		-40	-	175	°C
Junction to case	IGBT	R_{thJC}		-	-	0.26	°C/W
	Diode			-	-	0.63	
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	-	-	1.8 (15.9)	Nm (lbf.in)
Case style		SOT-227					

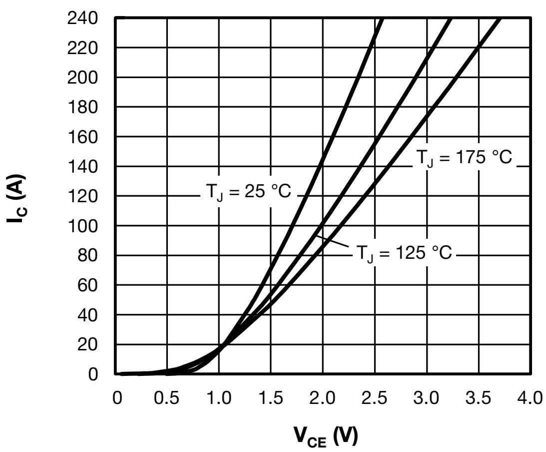


Fig. 1 - Typical IGBT Output Characteristics, V_{GE} = 15 V

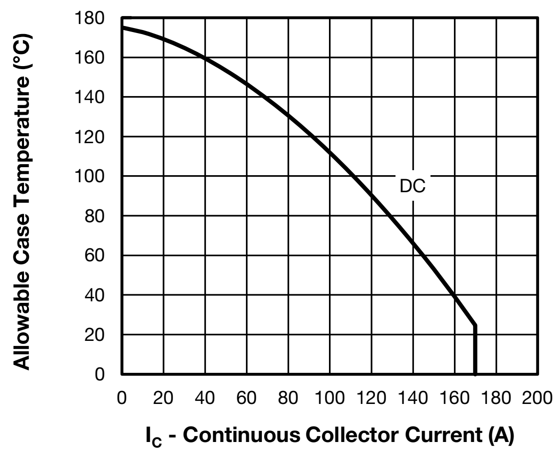


Fig. 3 - Maximum IGBT Continuous Collector Current vs. Case Temperature

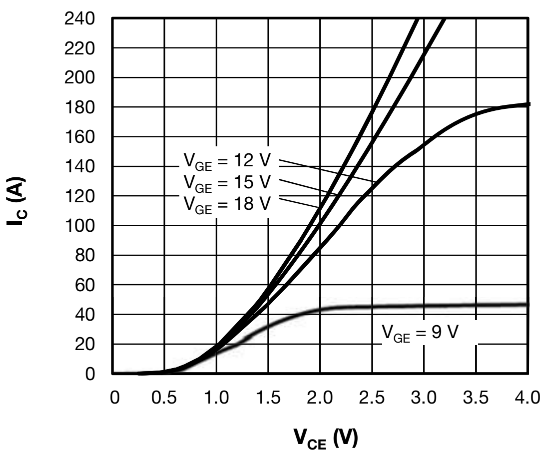


Fig. 2 - Typical IGBT Output Characteristics, T_J = 125 °C

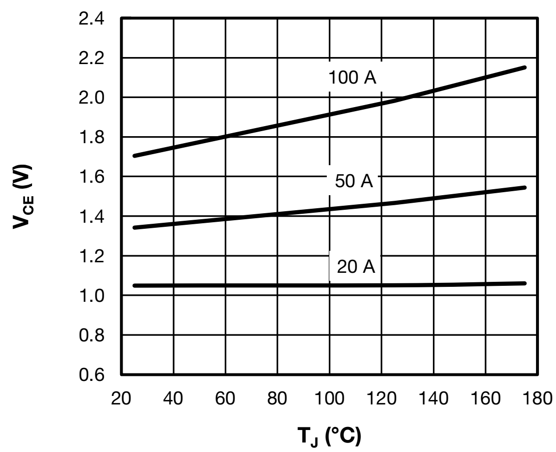


Fig. 4 - Collector to Emitter Voltage vs. Junction Temperature

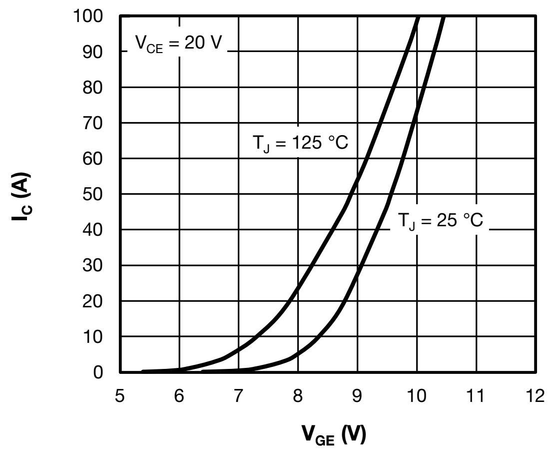


Fig. 5 - Typical IGBT Transfer Characteristics

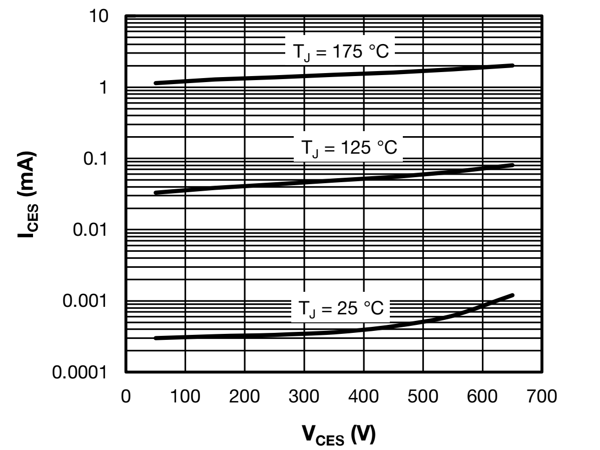


Fig. 8 - Typical IGBT Zero Gate Voltage Collector Current

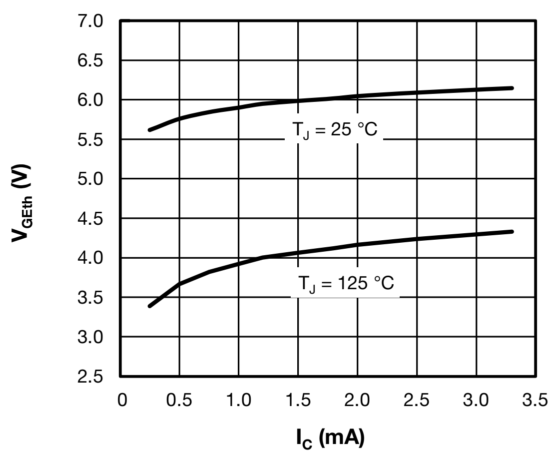


Fig. 6 - Typical IGBT Gate Threshold Voltage

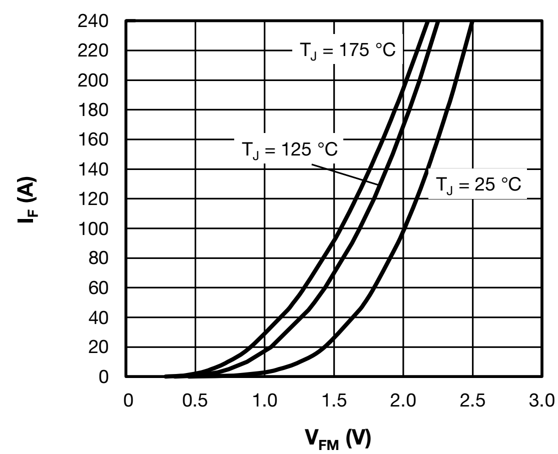


Fig. 9 - Typical Diode Forward Characteristics

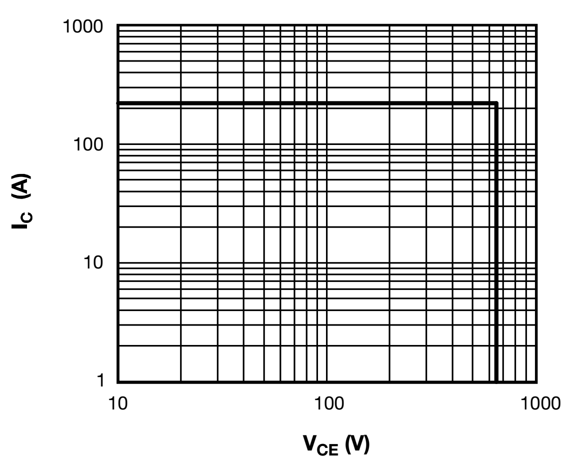


Fig. 7 - IGBT Reverse BIAS SOA T_J = 175 °C, V_{GE} = 15 V

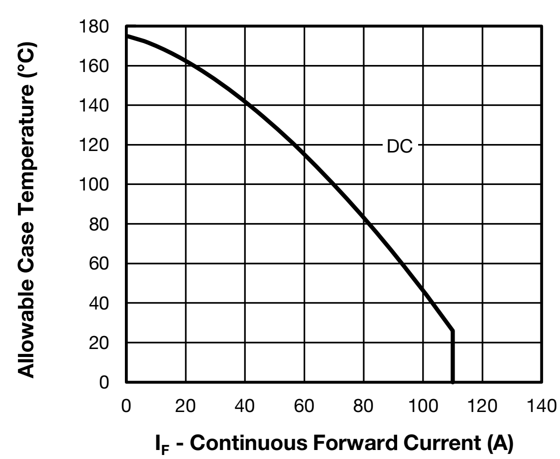


Fig. 10 - Maximum Diode Continuous Forward Current vs. Case Temperature

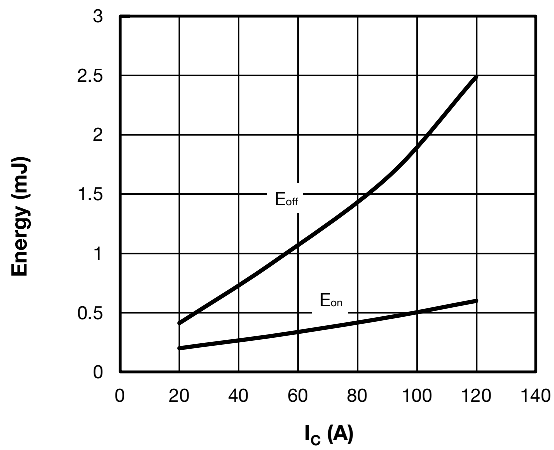


Fig. 11 - Typical IGBT Energy Loss vs. I_C
T_J = 125 °C, V_{CC} = 325 V, R_g = 4.7 Ω, V_{GE} = 15 V, L = 500 μH

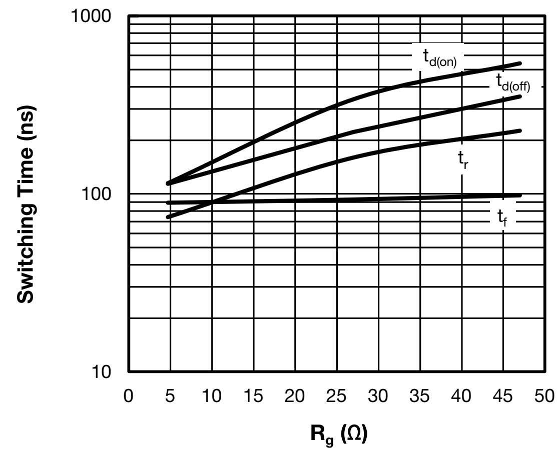


Fig. 14 - Typical IGBT Switching Time vs. R_g
T_J = 125 °C, V_{CC} = 600 V, I_C = 100 A, V_{GE} = 15 V, L = 500 μH

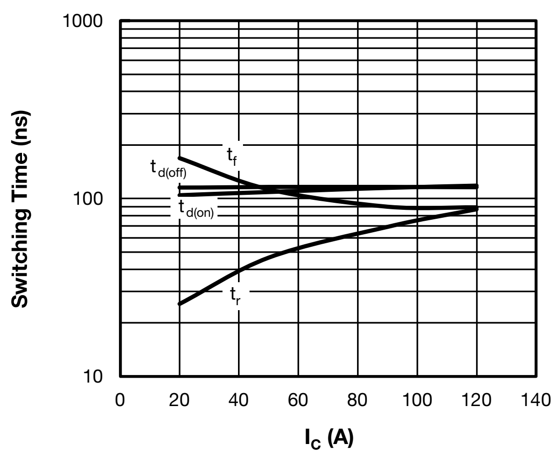


Fig. 12 - Typical IGBT Switching Time vs. I_C
T_J = 125 °C, V_{CC} = 325 V, R_g = 4.7 Ω, V_{GE} = 15 V, L = 500 μH

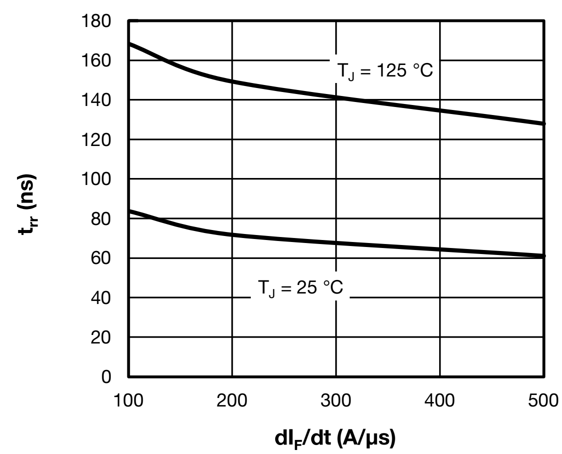


Fig. 15 - Typical t_{rr} Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 50 A

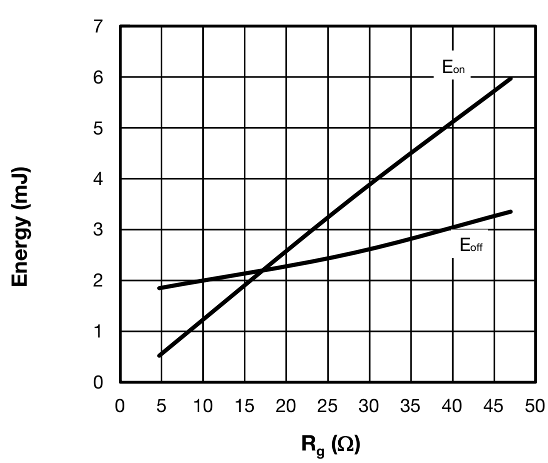


Fig. 13 - Typical IGBT Energy Loss vs. R_g
T_J = 125 °C, V_{CC} = 325 V, I_C = 100 A, V_{GE} = 15 V, L = 500 μH

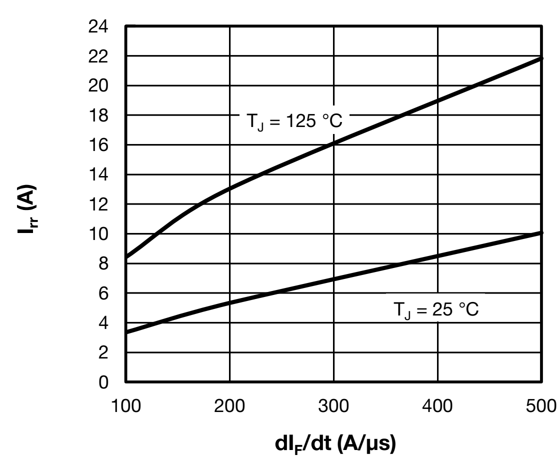


Fig. 16 - Typical I_{rr} Diode vs. dI_F/dt
V_{rr} = 200 V, I_F = 50 A

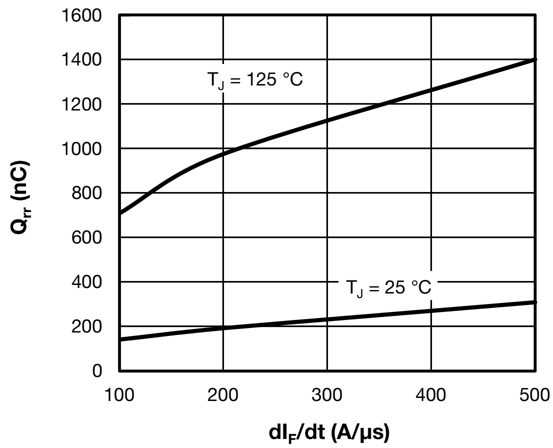


Fig. 17 - Typical Diode Reverse Recovery Charge vs. dI_F/dt
V_{rr} = 200 V, I_F = 50 A

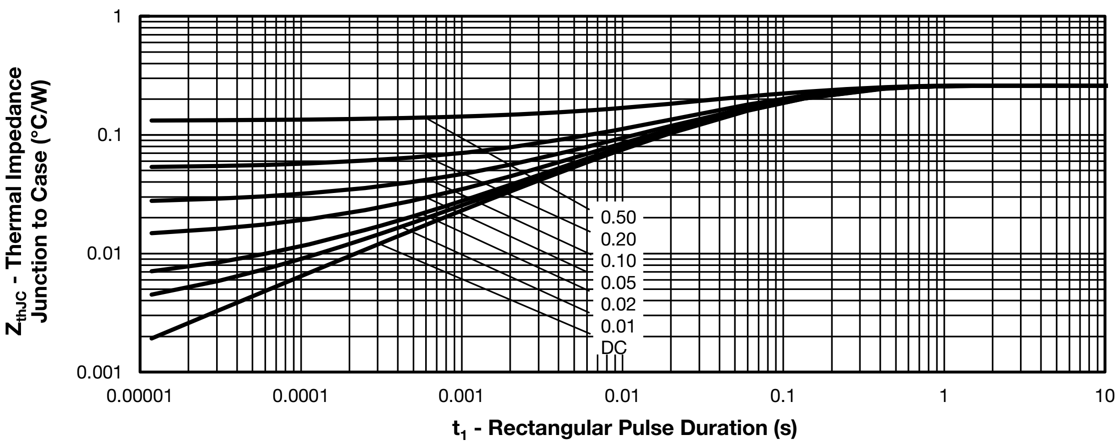


Fig. 18 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

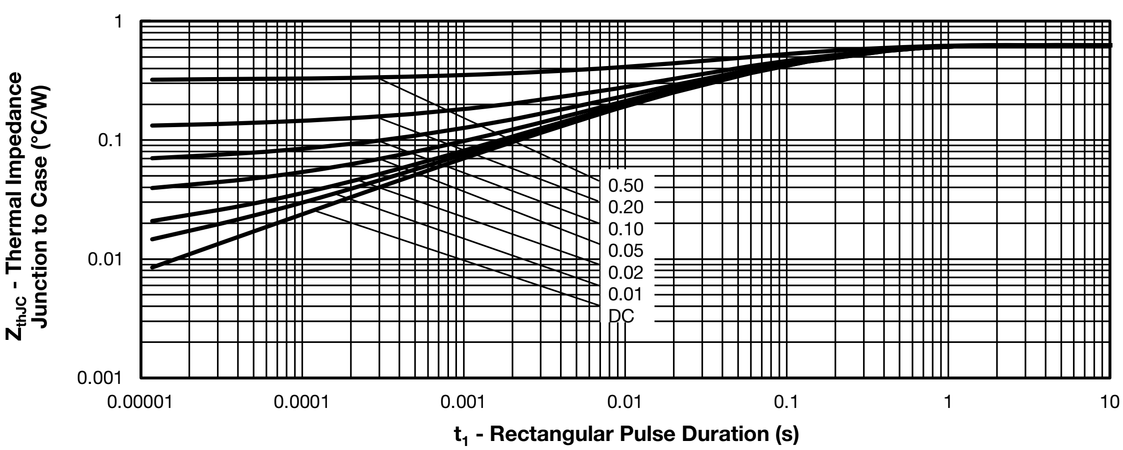
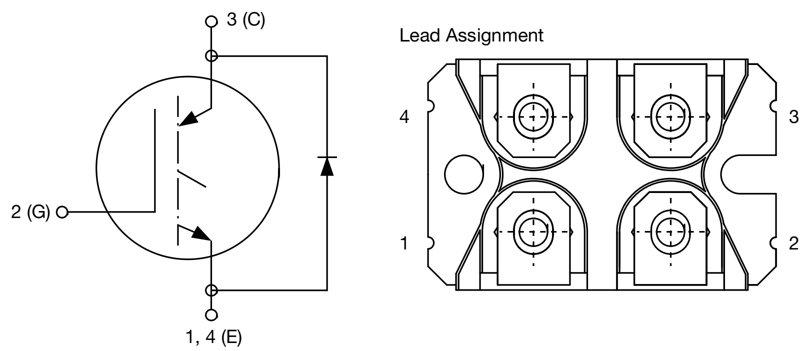


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

ORDERING INFORMATION TABLE

Device code	VS-	G	T	120	D	A	65	U
	1	2	3	4	5	6	7	8

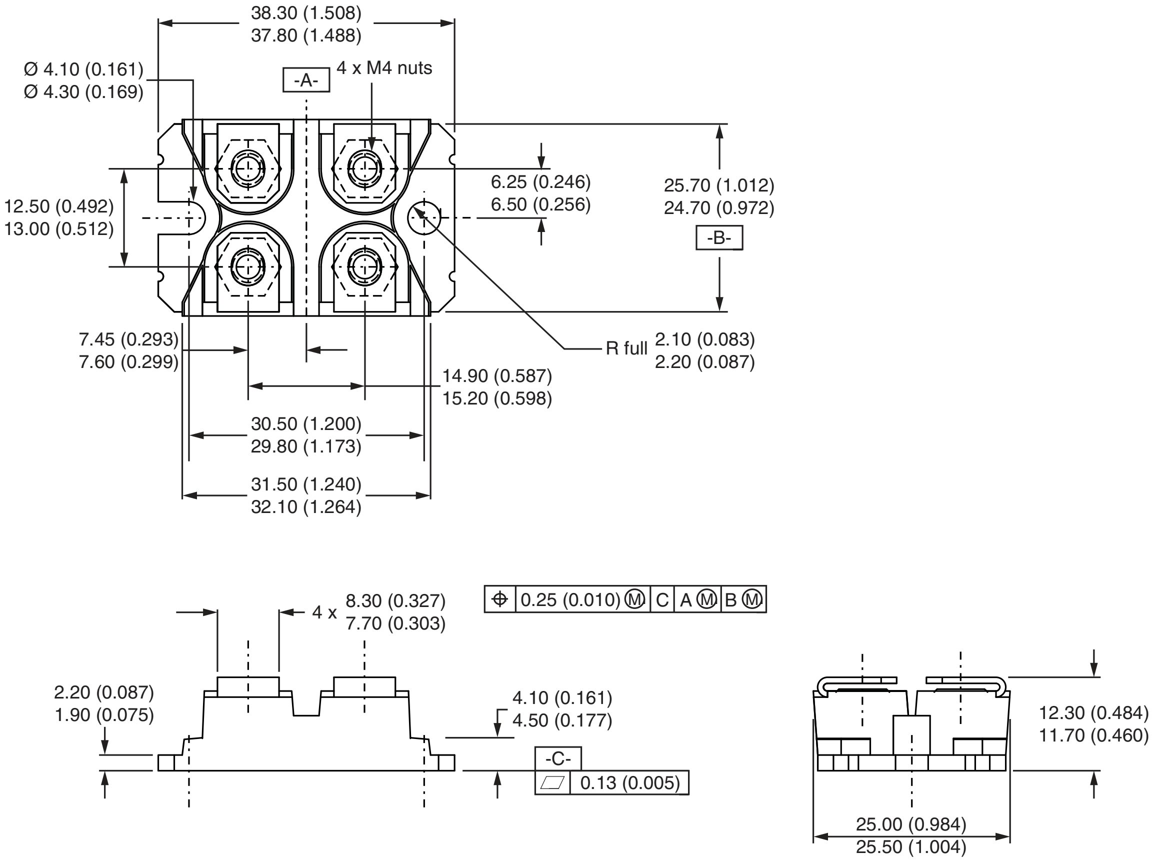
- **1** - Vishay Semiconductors product
- **2** - Insulated gate bipolar transistor (IGBT)
- **3** - T = trench IGBT
- **4** - Current rating (120 = 120 A)
- **5** - Circuit configuration (D = single switch with antiparallel diode)
- **6** - Package indicator (A = SOT-227)
- **7** - Voltage rating (65 = 650 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 II

DIMENSIONS in millimeters (inches)



Note

- Controlling dimension: millimeter

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