

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

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

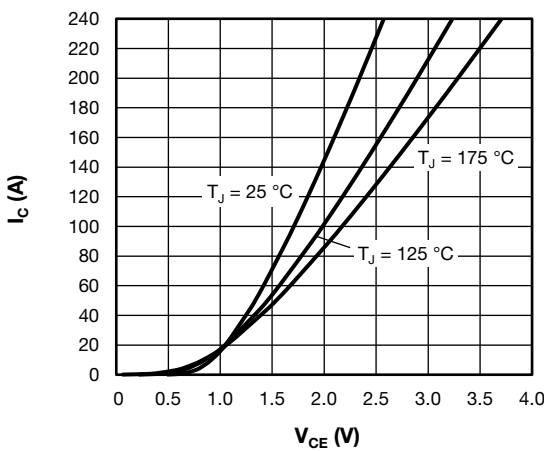


Fig. 1 - Typical IGBT Output Characteristics, $V_{GE} = 15\text{ V}$

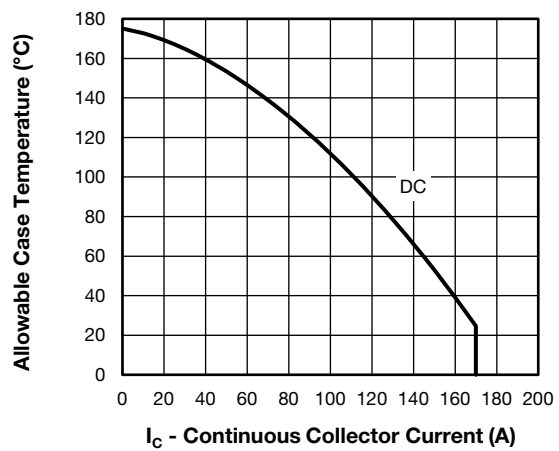


Fig. 3 - Maximum IGBT Continuous Collector Current vs. Case Temperature

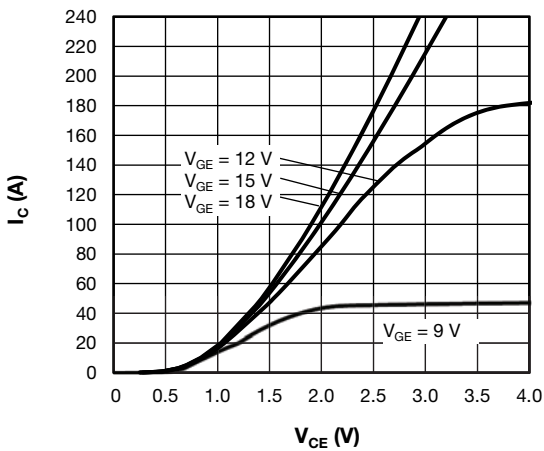


Fig. 2 - Typical IGBT Output Characteristics, $T_J = 125\text{ °C}$

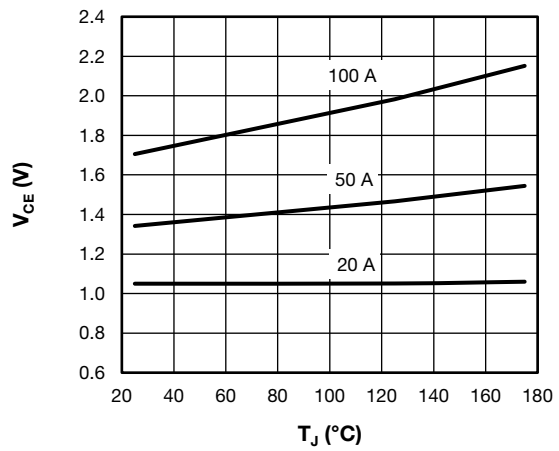


Fig. 4 - Collector to Emitter Voltage vs. Junction Temperature

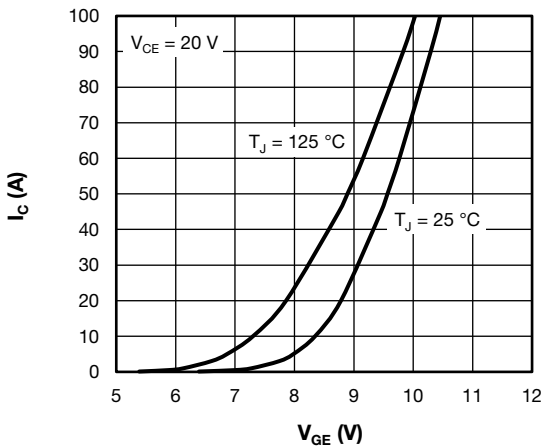


Fig. 5 - Typical IGBT Transfer Characteristics

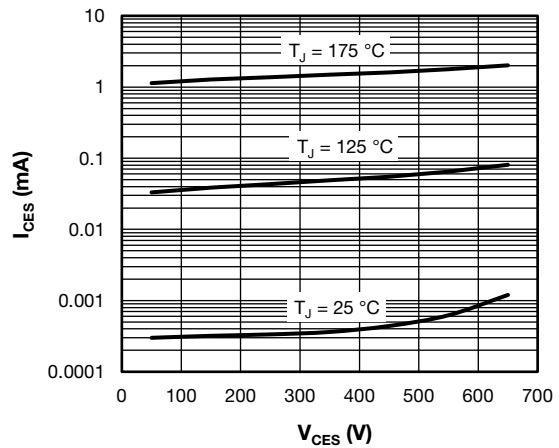


Fig. 8 - Typical IGBT Zero Gate Voltage Collector Current

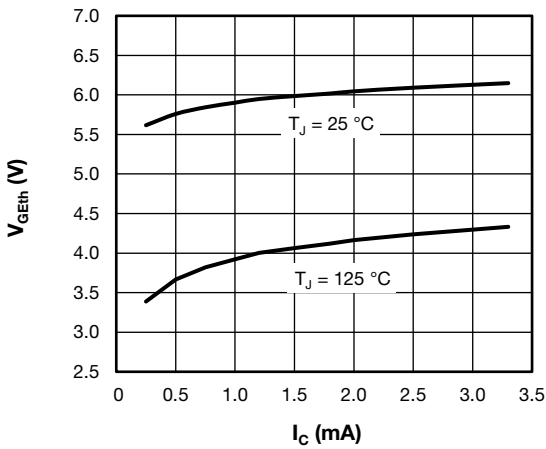


Fig. 6 - Typical IGBT Gate Threshold Voltage

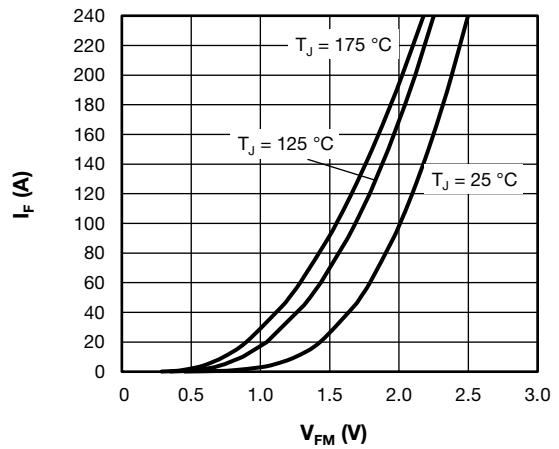


Fig. 9 - Typical Diode Forward Characteristics

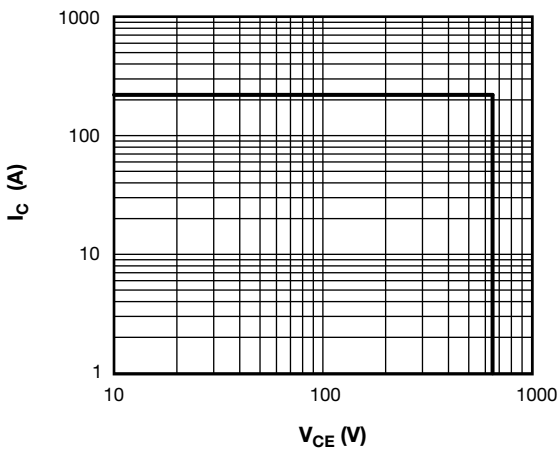


Fig. 7 - IGBT Reverse BIAS SOA $T_J = 175\text{ }^\circ\text{C}$, $V_{GE} = 15\text{ V}$

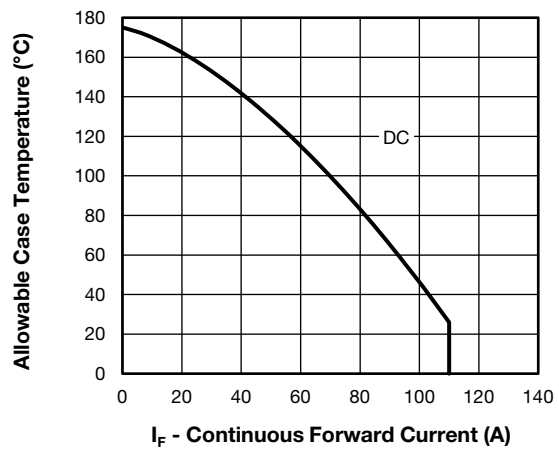


Fig. 10 - Maximum Diode Continuous Forward Current vs. Case Temperature

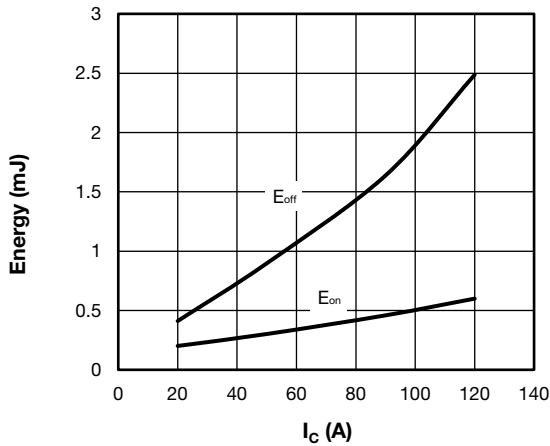


Fig. 11 - Typical IGBT Energy Loss vs. I_C
 $T_J = 125\text{ }^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$, $L = 500\ \mu\text{H}$

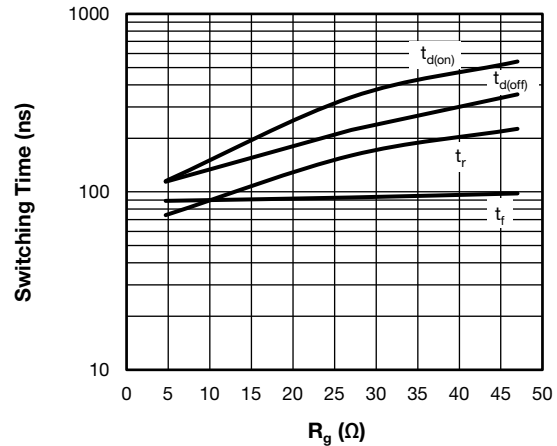


Fig. 14 - Typical IGBT Switching Time vs. R_g
 $T_J = 125\text{ }^\circ\text{C}$, $V_{CC} = 600\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\ \mu\text{H}$

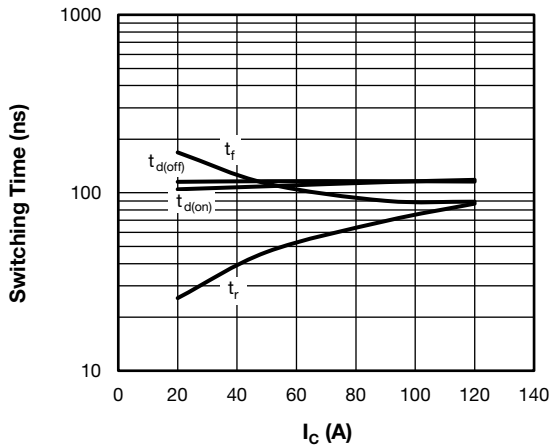


Fig. 12 - Typical IGBT Switching Time vs. I_C
 $T_J = 125\text{ }^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $R_g = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$, $L = 500\ \mu\text{H}$

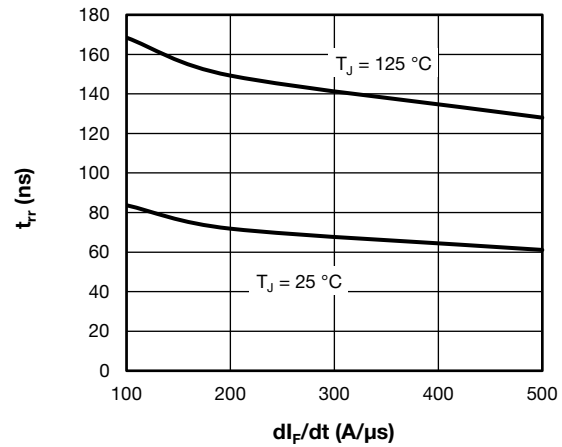


Fig. 15 - Typical t_{rr} Diode vs. dI_F/dt
 $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

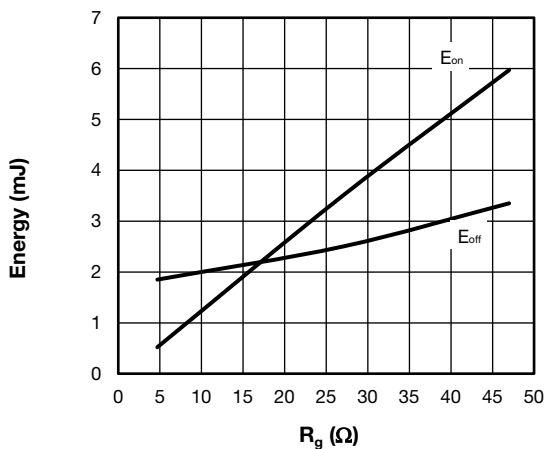


Fig. 13 - Typical IGBT Energy Loss vs. R_g
 $T_J = 125\text{ }^\circ\text{C}$, $V_{CC} = 325\text{ V}$, $I_C = 100\text{ A}$, $V_{GE} = 15\text{ V}$, $L = 500\ \mu\text{H}$

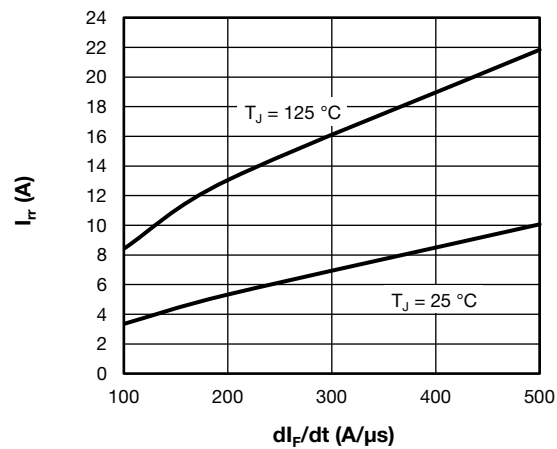


Fig. 16 - Typical I_{rr} Diode vs. dI_F/dt
 $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

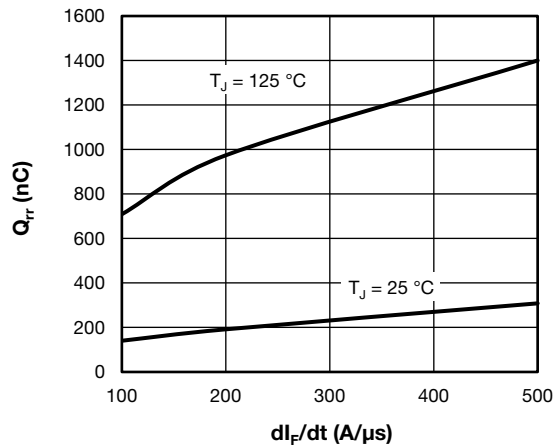


Fig. 17 - Typical Diode Reverse Recovery Charge vs. di_F/dt
 $V_{rr} = 200\text{ V}$, $I_F = 50\text{ A}$

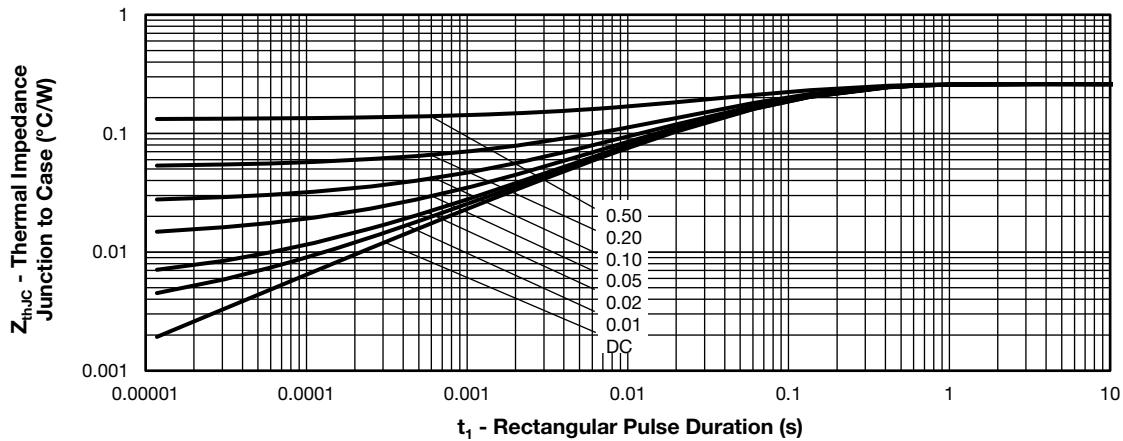


Fig. 18 - Maximum Thermal Impedance Z_{thJC} Characteristics, IGBT

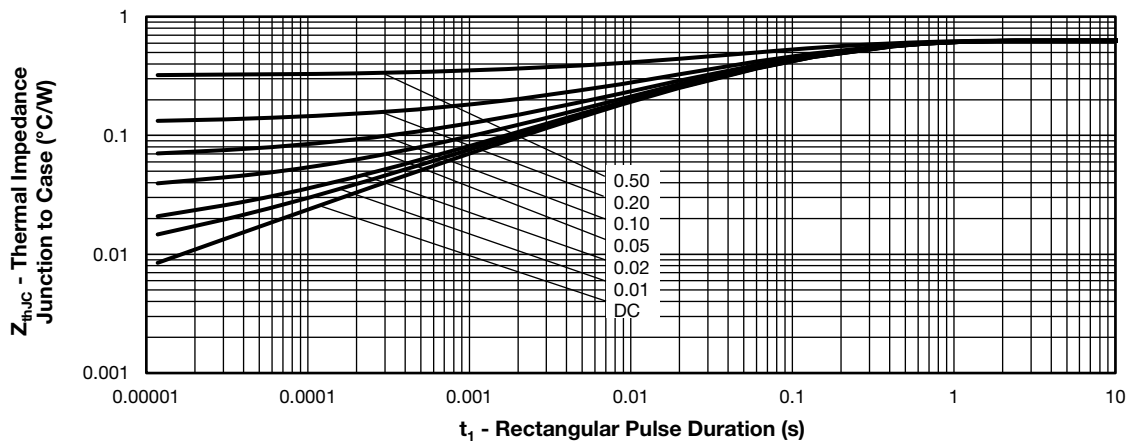


Fig. 19 - Maximum Thermal Impedance Z_{thJC} Characteristics, Diode

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



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