


## “Half Bridge” High Speed IGBT INT-A-PAK, 200 A


**INT-A-PAK IGBT**

### FEATURES

- Trench IGBT technology
- Gen 4 FRED Pt<sup>®</sup> anti-parallel diodes with ultra soft reverse recovery characteristics
- Very low switching losses
- Al<sub>2</sub>O<sub>3</sub> DBC
- UL approved file E78996 
- Designed for industrial level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

### BENEFITS

- Optimized for high current inverter stages
- Direct mounting on heatsink
- Very low junction to case thermal resistance
- Low EMI

### PRIMARY CHARACTERISTICS

$V_{CES}$	650 V
$I_C$ (DC) at $T_C = 80\text{ }^\circ\text{C}$	144 A
$V_{CE(on)}$ (typical) at $I_C = 200\text{ A}$ , $T_J = 25\text{ }^\circ\text{C}$	1.83 V
Chip level $V_{CE(on)}$ at 200 A, 25 °C	1.70 V
Speed	8 kHz to 30 kHz
Package	INT-A-PAK
Circuit configuration	Half bridge

### ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		650	V
Continuous collector current	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	193	A
		$T_C = 80\text{ }^\circ\text{C}$	144	
Pulsed collector current	$I_{CM}$	$T_J = 175\text{ }^\circ\text{C}$ , $t_p = 6\text{ ms}$ , $V_{GE} = 15\text{ V}$	450	
Clamped inductive load current	$I_{LM}$		405	
Diode continuous forward current	$I_F$	$T_C = 25\text{ }^\circ\text{C}$	144	
		$T_C = 80\text{ }^\circ\text{C}$	108	
Maximum non-repetitive peak current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse	1080	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation (IGBT)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	517	W
		$T_C = 80\text{ }^\circ\text{C}$	328	
Maximum power dissipation (Diode)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	366	
		$T_C = 80\text{ }^\circ\text{C}$	232	
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1\text{ min}$	2500	V
Operating junction temperature range	$T_J$		-40 to +175	$^\circ\text{C}$
Storage temperature range	$T_{STG}$		-40 to +150	$^\circ\text{C}$



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{ V}, I_C = 400\text{ }\mu\text{A}$	650	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.46	-	V
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}$	-	1.83	2.3	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.59	-	
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.13	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 2.0\text{ mA}$	3	3.9	5	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 2.0\text{ mA}$ ( $25\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ )	-	-10	-	mV/ $^\circ\text{C}$
Forward transconductance	$g_{fe}$	$V_{CE} = 20\text{ V}, I_C = 200\text{ A}$	-	238	-	S
Transfer characteristics	$V_{GE}$	$V_{CE} = 20\text{ V}, I_C = 200\text{ A}$	-	6.3	-	V
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	-	0.2	100	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.1	-	mA
Diode forward voltage drop	$V_{FM}$	$I_{FM} = 100\text{ A}$	-	1.73	2.5	V
		$I_{FM} = 200\text{ A}$	-	2.05	-	
		$I_{FM} = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.37	-	
		$I_{FM} = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.75	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	240	nA

<b>SWITCHING CHARACTERISTICS</b>								
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS		
Total gate charge (turn-on)	$Q_g$	$I_C = 200\text{ A}$ $V_{CC} = 520\text{ V}$ $V_{GE} = 15\text{ V}$	-	488	-	nC		
Gate to emitter charge (turn-on)	$Q_{ge}$		-	58	-			
Gate to collector (turn-on)	$Q_{gc}$		-	137	-			
Turn-on switching loss	$E_{on}$	$V_{CC} = 325\text{ V}, I_C = 200\text{ A}, R_g = 27\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, V_{GE} = \pm 15\text{ V}$	-	2.34	-	mJ		
Turn-off switching loss	$E_{off}$		-	3.77	-			
Total switching loss	$E_{tot}$		-	6.11	-			
Turn-on delay time	$t_{d(on)}$		$V_{CC} = 325\text{ V}, I_C = 200\text{ A}, R_g = 27\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, V_{GE} = \pm 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	111	-	ns	
Rise time	$t_r$			-	120	-		
Turn-off delay time	$t_{d(off)}$			-	454	-		
Fall time	$t_f$			-	64	-		
Turn-on switching loss	$E_{on}$			-	2.82	-		mJ
Turn-off switching loss	$E_{off}$			-	3.86	-		
Total switching loss	$E_{tot}$			-	6.68	-		
Turn-on delay time	$t_{d(on)}$	$V_{CC} = 325\text{ V}, I_C = 200\text{ A}, R_g = 27\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, V_{GE} = \pm 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	79	-	ns		
Rise time	$t_r$		-	82	-			
Turn-off delay time	$t_{d(off)}$		-	306	-			
Fall time	$t_f$		-	34	-			
Reverse bias safe operating area	RBSOA	$I_C = 405\text{ A}, R_g = 27\text{ }\Omega, V_{CC} = 325\text{ V},$ $V_p = 650\text{ V}, V_{GE} = 15\text{ V to } -5\text{ V}, T_J = 175\text{ }^\circ\text{C}$	Fullsquare					
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 500\text{ A}/\mu\text{s}$ $V_{rr} = 200\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	72	-	ns		
Diode peak reverse current	$I_{rr}$		-	13	-	A		
Diode recovery charge	$Q_{rr}$		-	466	-	nC		
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 500\text{ A}/\mu\text{s}$ $V_{rr} = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	146	-	ns		
Diode peak reverse current	$I_{rr}$		-	28	-	A		
Diode recovery charge	$Q_{rr}$		-	2064	-	nC		



THERMAL AND MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating junction temperature range	$T_J$		-40	-	175	°C
Storage temperature range	$T_{Stg}$		-40	-	150	
Junction to case per leg	IGBT		-	-	0.29	°C/W
	Diode					
Case to sink per module (conductive grease applied)	$R_{thCS}$		-	0.05	-	
Mounting torque	case to heatsink		-	-	4	
	case to terminal 1, 2, 3		-	-	3	
Weight			-	150	-	g

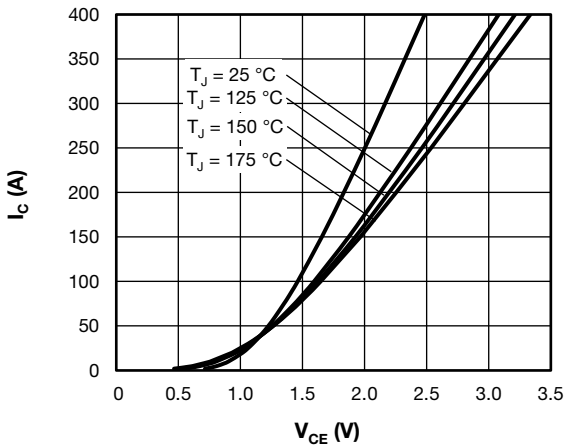


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

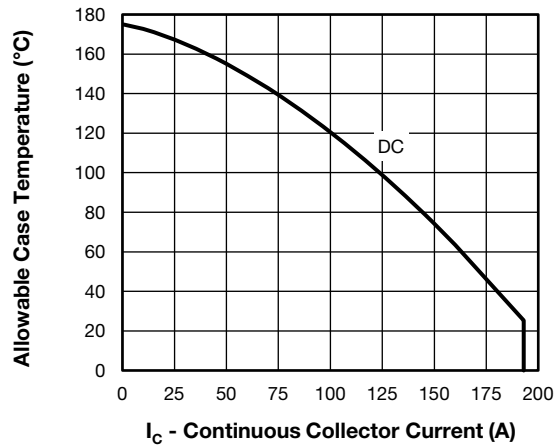


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

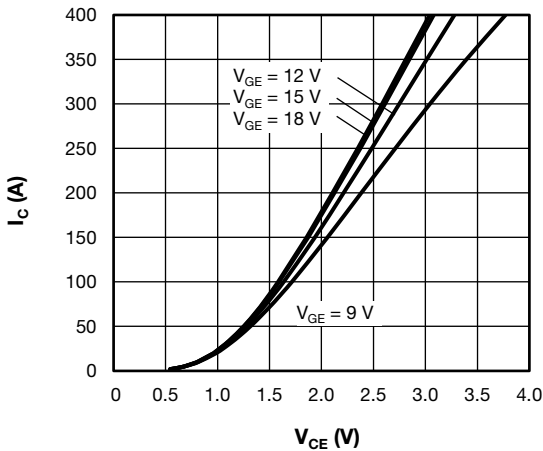


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$

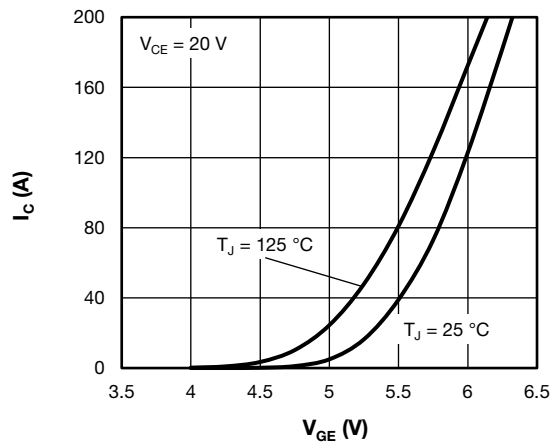


Fig. 4 - Typical Trench IGBT Transfer Characteristics

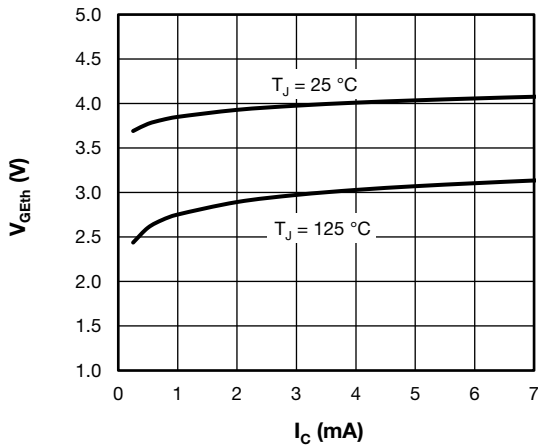


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

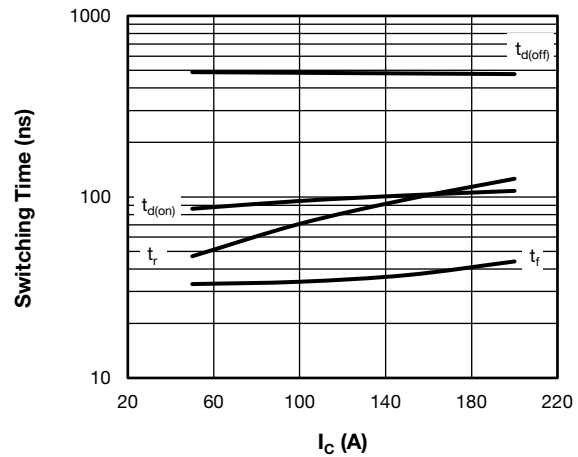


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
(with Antiparallel Diode)  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 27\text{ }\Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

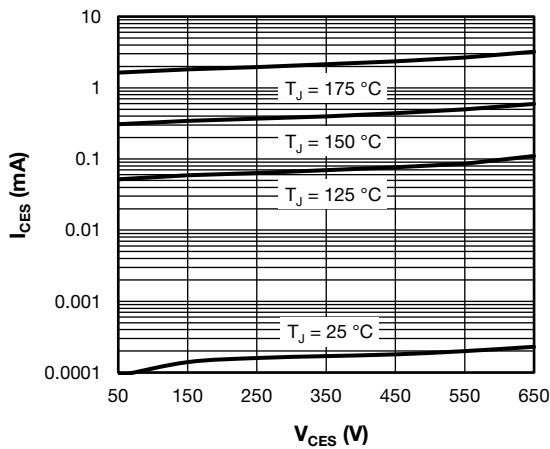


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

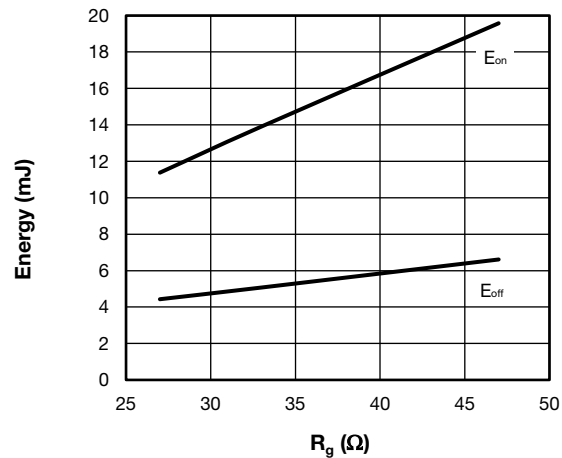


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$   
(with Antiparallel Diode)  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

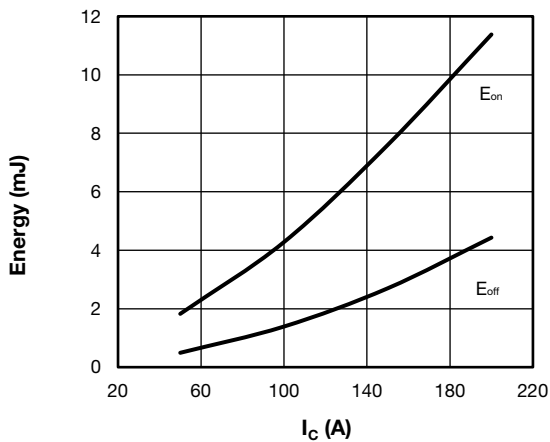


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
(with Antiparallel Diode)  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 27\text{ }\Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

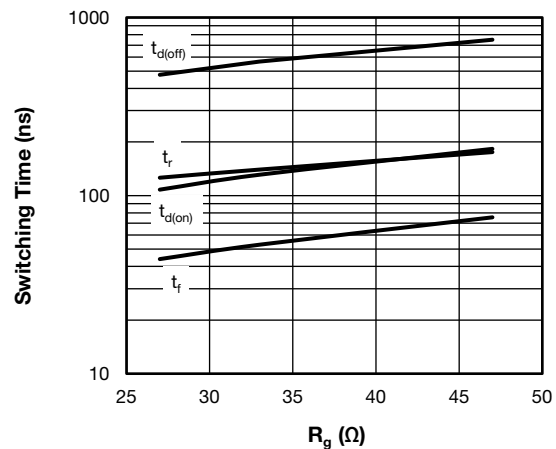


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
(with Antiparallel Diode)  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\text{ }\mu\text{H}$

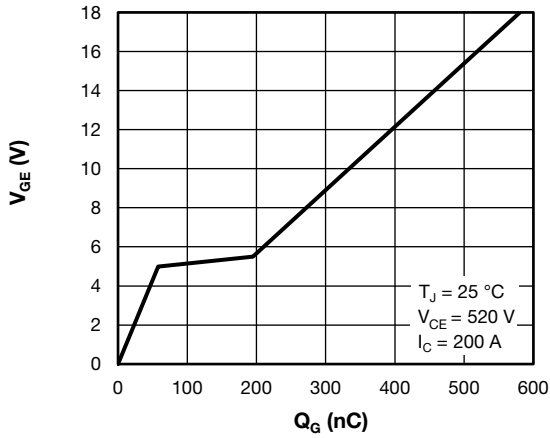


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Collector Voltage

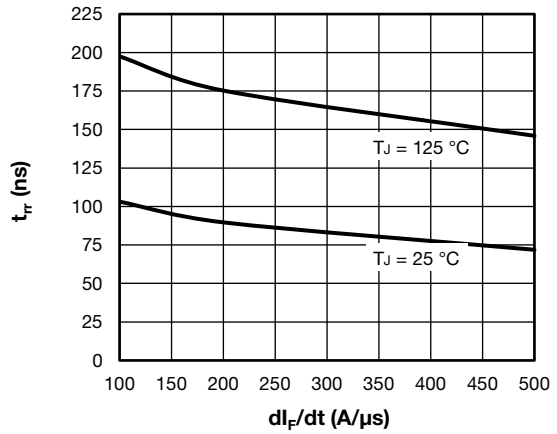


Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs.  $di_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

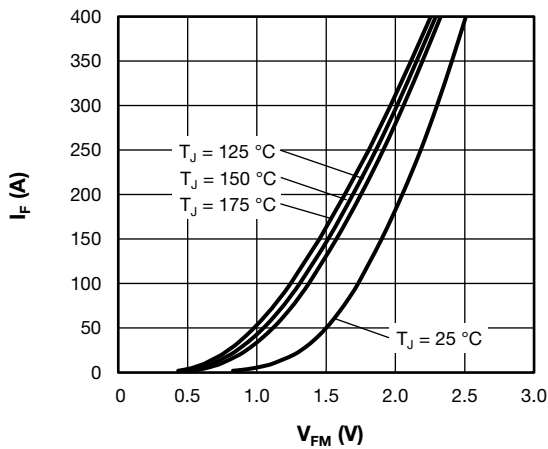


Fig. 12 - Typical Antiparallel Diode Forward Characteristics

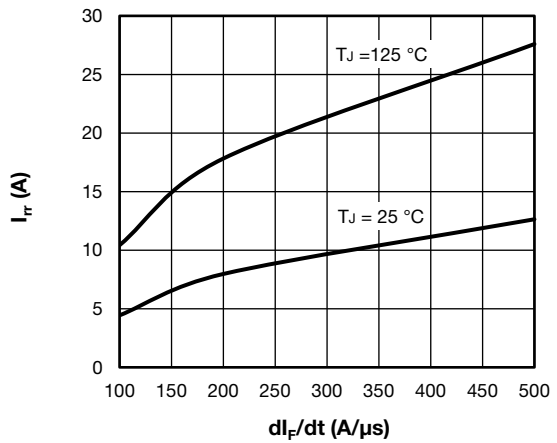


Fig. 15 - Typical Antiparallel Diode Reverse Recovery Current vs.  $di_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

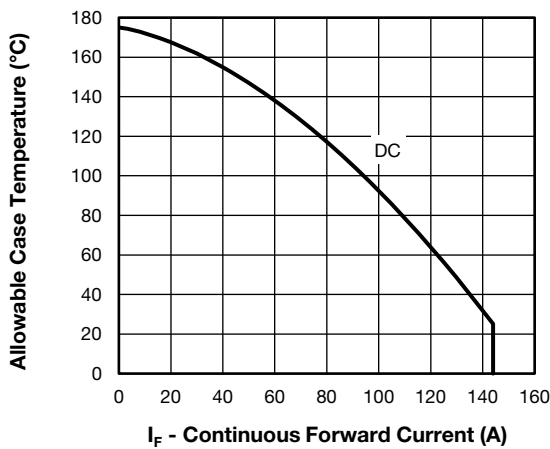


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

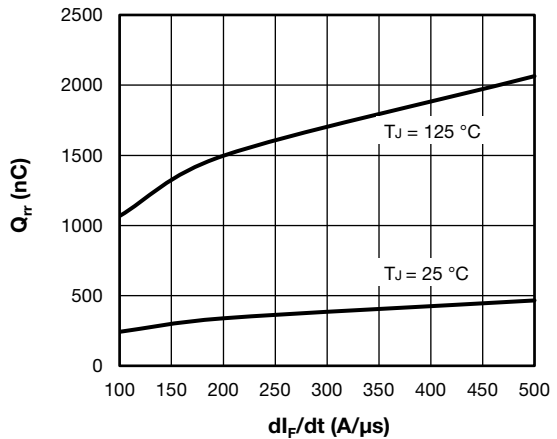


Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs.  $di_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

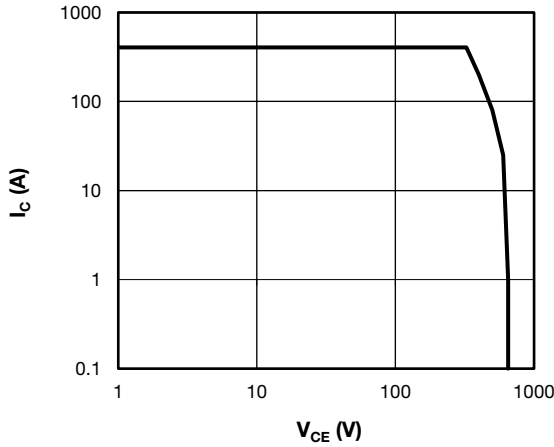


Fig. 17 - Trench IGBT Reverse BIAS SOA  
 $T_J = 175\text{ }^\circ\text{C}$ ,  $I_C = 405\text{ A}$ ,  $R_g = 27\text{ }\Omega$ ,  $V_{GE} = +15\text{ V}/-5\text{ V}$ ,  $V_{CC} = 325\text{ V}$ ,  
 $V_p = 650\text{ V}$

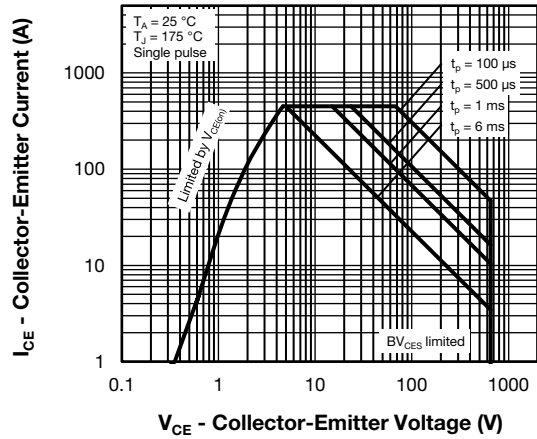


Fig. 18 - Trench IGBT Safe Operating Area

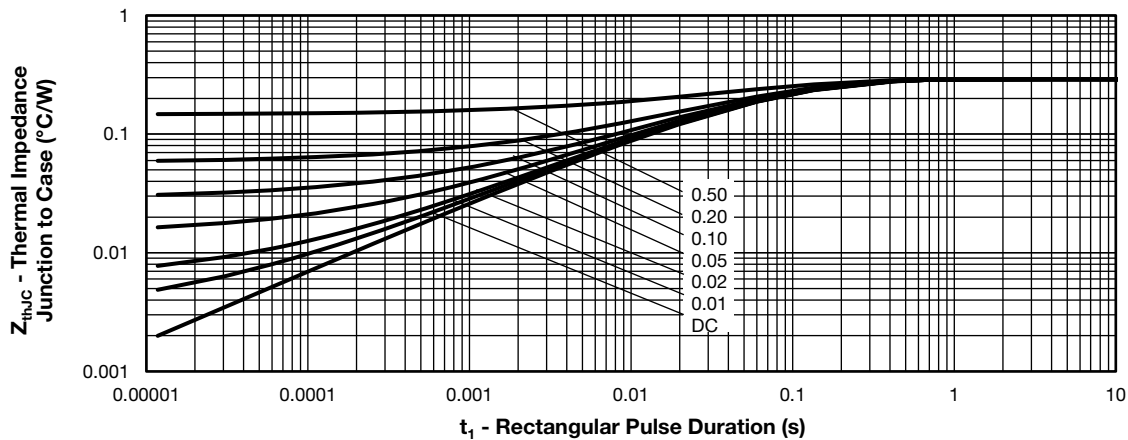


Fig. 19 - Maximum Trench IGBT Thermal Impedance  $Z_{thJC}$  Characteristics

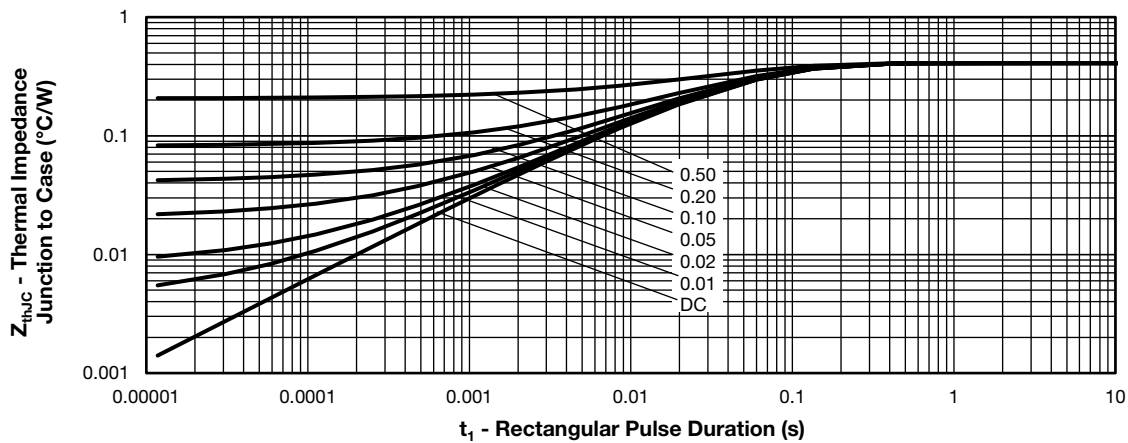
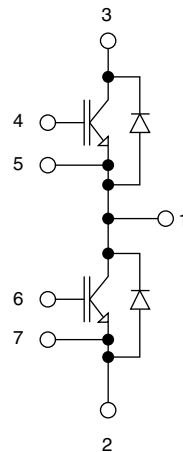


Fig. 20 - Maximum Antiparallel Diode Thermal Impedance  $Z_{thJC}$  Characteristics

**ORDERING INFORMATION TABLE**

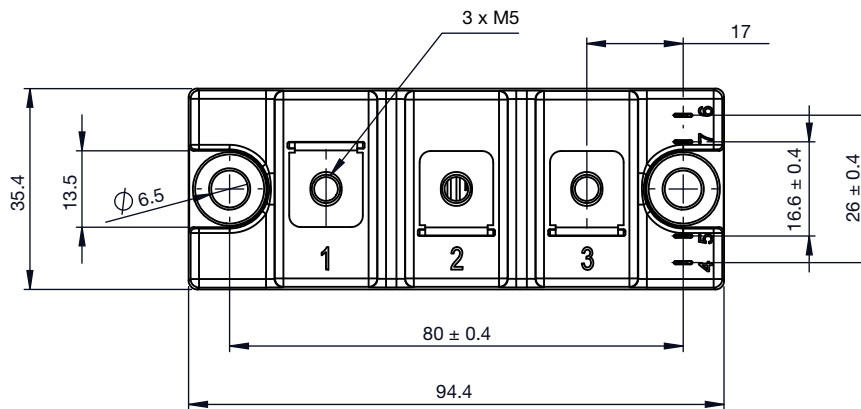
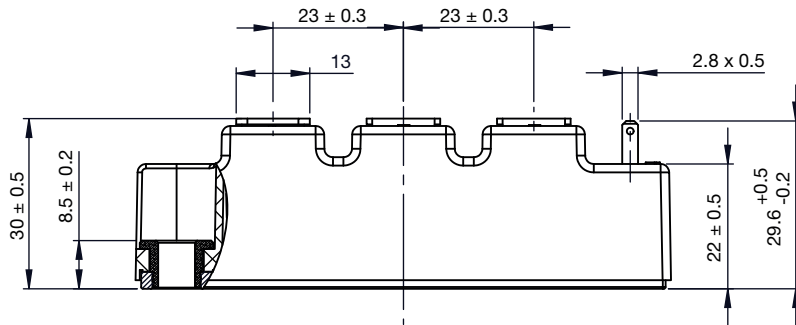
Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>200</b>	<b>T</b>	<b>S</b>	<b>065</b>	<b>N</b>
	1	2	3	4	5	6	7	8

- 1** - Vishay Semiconductors product
- 2** - Insulated gate bipolar transistor (IGBT)
- 3** - T = trench IGBT
- 4** - Current rating (200 = 200 A)
- 5** - Circuit configuration (T = half bridge)
- 6** - Package indicator (S = INT-A-PAK IGBT)
- 7** - Voltage rating (065 = 650 V)
- 8** - Speed/type (N = ultrafast IGBT)

**CIRCUIT CONFIGURATION**




**DIMENSIONS** in millimeters



General tolerance  $\pm 0.5$  mm





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