


## “Half Bridge” Low $V_{CE(on)}$ IGBT INT-A-PAK, 200 A


**INT-A-PAK IGBT**
**FEATURES**

- Trench IGBT technology
- Gen 4 FRED Pt® technology anti-parallel diodes with ultra soft reverse recovery characteristics
- Very low conduction 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 (AC TIG welding machines)
- Direct mounting to heatsink
- Very low junction to case thermal resistance
- Low EMI

**PRIMARY CHARACTERISTICS**

$V_{CES}$	650 V
$I_C$ DC, $T_C = 80\text{ °C}$	378 A
$V_{CE(on)}$ at 200 A, 25 °C	1.09 V
Chip level $V_{CE(on)}$ at 200 A, 25 °C	0.98 V
Speed	DC to 1 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	$I_C$	$T_C = 25\text{ °C}$	476	A
		$T_C = 80\text{ °C}$	378	
Pulsed collector current	$I_{CM}$	$T_C = 175\text{ °C}$ , $t_p = 6\text{ ms}$ , $V_{GE} = 15\text{ V}$	810	
Diode continuous forward current	$I_F$	$T_C = 25\text{ °C}$	57	
		$T_C = 80\text{ °C}$	43	
Maximum non-repetitive peak current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse	270	
Peak switching current	$I_{LM}$		320	
Gate to emitter voltage	$V_{GE}$		± 20	V
RMS isolation voltage	$V_{ISOL}$	Any terminal to case, $t = 1\text{ min}$	2500	
Maximum power dissipation	$P_D$	$T_C = 25\text{ °C}$	1000	W
		$T_C = 80\text{ °C}$	633	
Maximum power dissipation (Diode)	$P_D$	$T_C = 25\text{ °C}$	150	
		$T_C = 80\text{ °C}$	95	
Operating junction temperature range	$T_J$		-40 to +175	°C
Storage temperature range	$T_{Stg}$		-40 to +150	



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}, I_C = 800\text{ }\mu\text{A}$	650	-	-	
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 200\text{ A}$	-	1.09	1.32	V
		$V_{GE} = 15\text{ V}, I_C = 400\text{ A}$	-	1.32	-	
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.07	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 4.0\text{ mA}$	4.0	4.8	6.0	
Temperature coefficient of threshold voltage	$\Delta V_{GE(th)}/\Delta T_J$	$V_{CE} = V_{GE}, I_C = 4.0\text{ mA}, (25\text{ }^\circ\text{C to } 125\text{ }^\circ\text{C})$	-	-14.8	-	mV/°C
Forward transconductance	$g_{fe}$	$V_{CE} = 20\text{ V}, I_C = 100\text{ A}$	-	455	-	S
Transfer characteristics	$V_{GE}$	$V_{CE} = 20\text{ V}, I_C = 200\text{ A}$	-	6.65	-	V
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	-	0.5	200	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.17	-	mA
Diode forward voltage drop	$V_{FM}$	$I_C = 50\text{ A}, V_{GE} = 0\text{ V}$	-	2.0	2.9	V
		$I_C = 50\text{ A}, V_{GE} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.6	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 480$	nA

<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Total gate charge	$Q_g$	$I_C = 200\text{ A}, V_{CC} = 520\text{ V}, V_{GE} = 15\text{ V}$	-	1763	-	nC
Gate to emitter charge	$Q_{ge}$		-	301	-	
Gate to collector charge	$Q_{gc}$		-	509	-	
Turn-on switching energy	$E_{on}$	$I_C = 200\text{ A}, V_{CC} = 325\text{ V}, V_{GE} = 15\text{ V}, L = 500\text{ }\mu\text{H}, R_g = 4.7\text{ }\Omega, T_J = 25\text{ }^\circ\text{C}$	-	1.1	-	mJ
Turn-off switching energy	$E_{off}$		-	9.7	-	
Total switching energy	$E_{ts}$		-	10.8	-	
Turn-on delay time	$t_{d(on)}$		ns	-	60	-
Rise time	$t_r$			-	60	-
Turn-off delay time	$t_{d(off)}$			-	520	-
Fall time	$t_f$	-		57	-	
Turn-on switching energy	$E_{on}$	$I_C = 200\text{ A}, V_{CC} = 325\text{ V}, V_{GE} = 15\text{ V}, L = 500\text{ }\mu\text{H}, R_g = 4.7\text{ }\Omega, T_J = 125\text{ }^\circ\text{C}$	-	1.1	-	mJ
Turn-off switching energy	$E_{off}$		-	13.7	-	
Total switching energy	$E_{ts}$		-	14.8	-	
Turn-on delay time	$t_{d(on)}$		ns	-	60	-
Rise time	$t_r$			-	61	-
Turn-off delay time	$t_{d(off)}$			-	580	-
Fall time	$t_f$	-		137	-	
Reverse bias safe operating area	RBSOA	$T_J = 175\text{ }^\circ\text{C}, I_C = 320\text{ A}, V_{CC} = 325\text{ V}, V_p = 650\text{ V}, R_g = 4.7\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, L = 500\text{ }\mu\text{H}$	Fullsquare			
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 500\text{ A}/\mu\text{s}, V_{rr} = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	79	-	ns
Diode peak reverse current	$I_{rr}$		-	10.5	-	A
Diode recovery charge	$Q_{rr}$		-	409	-	nC
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 500\text{ A}/\mu\text{s}, V_{rr} = 200\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	141	-	ns
Diode peak reverse current	$I_{rr}$		-	19	-	A
Diode recovery charge	$Q_{rr}$		-	1336	-	nC

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	
Operating junction temperature range	$T_J$	-40	-	175	°C	
Storage temperature range	$T_{Stg}$	-40	-	150		
Junction to case	per switch per diode	$R_{thJC}$	-	-	0.15	°C/W
			-	-	1.0	
Case to sink per module	$R_{thCS}$	-	0.1	-		
Mounting torque	case to heatsink	-	-	4	Nm	
	case to terminal 1, 2, 3	-	-	3		
Weight		-	185	-	g	

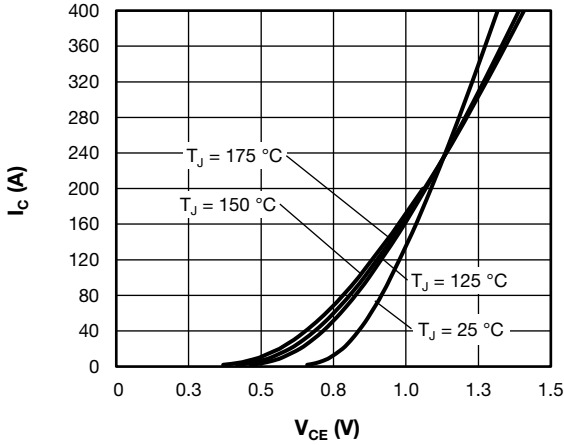


Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

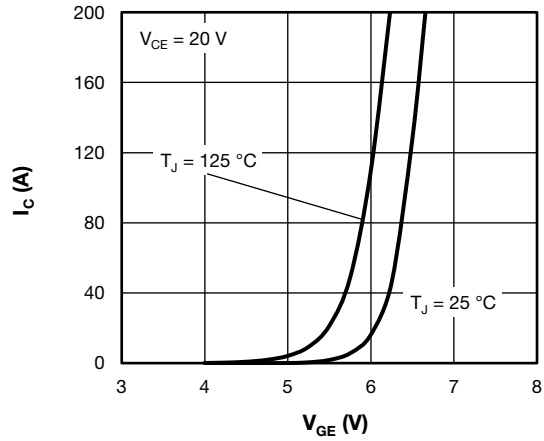


Fig. 4 - Typical Trench IGBT Transfer Characteristics

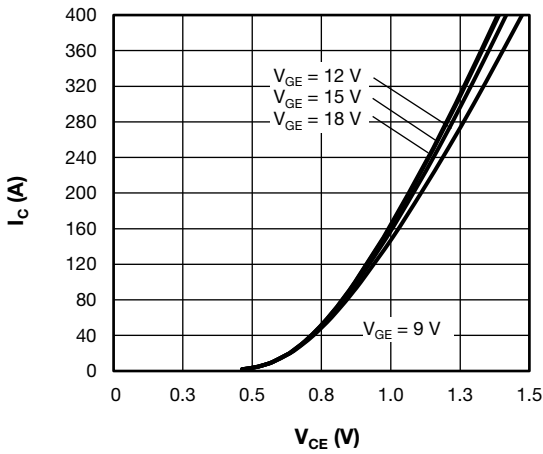


Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$

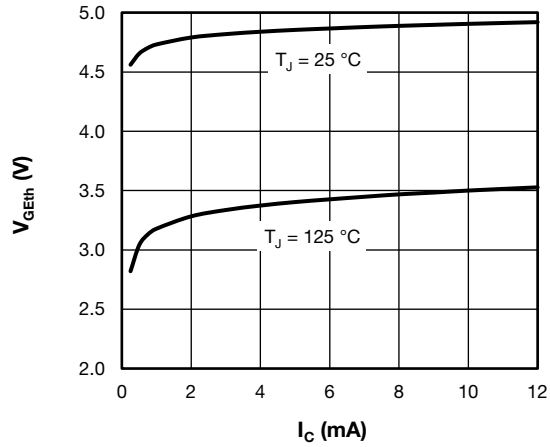


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

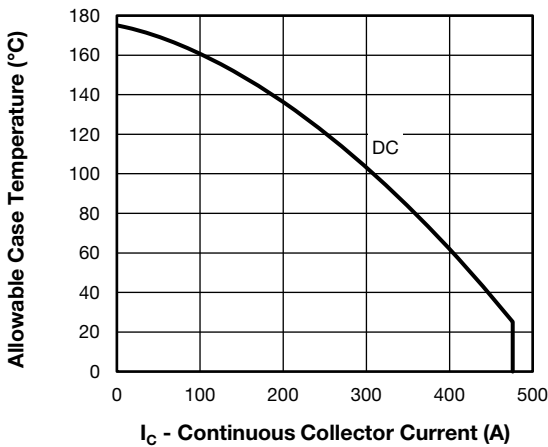


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

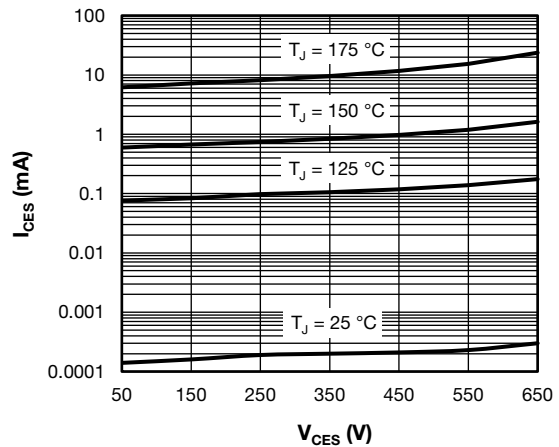


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

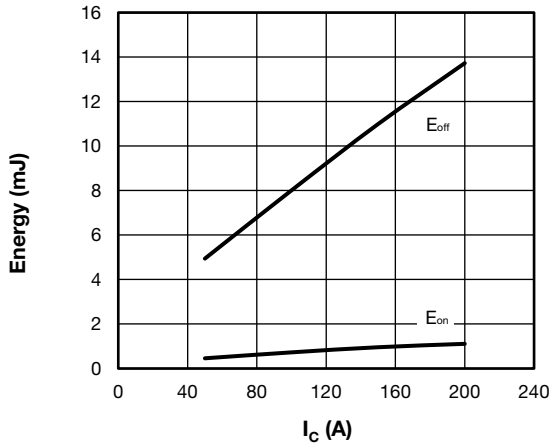


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

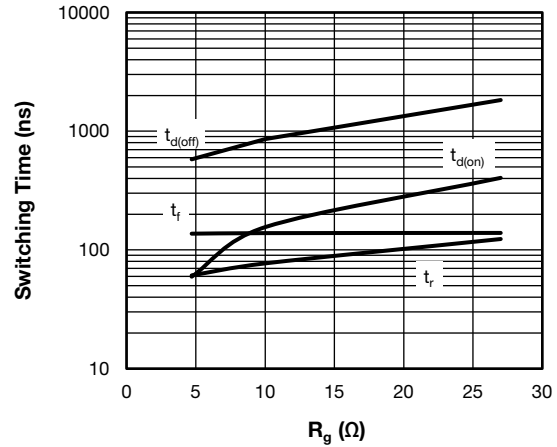


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

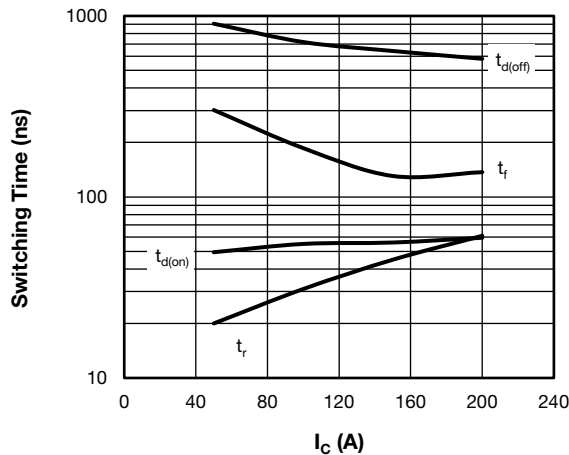


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

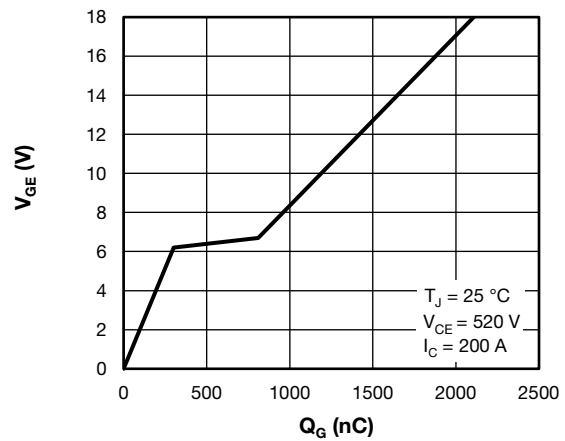


Fig. 11 - Typical Trench IGBT Gate Charge vs.  
Gate to Collector Voltage

$T_J = 25^\circ\text{C}$   
 $V_{CE} = 520\text{ V}$   
 $I_C = 200\text{ A}$

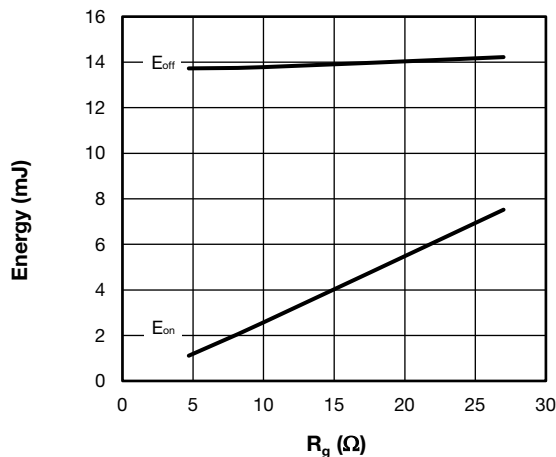


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$   
(with Antiparallel Diode)

$T_J = 125^\circ\text{C}$ ,  $V_{CC} = 325\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

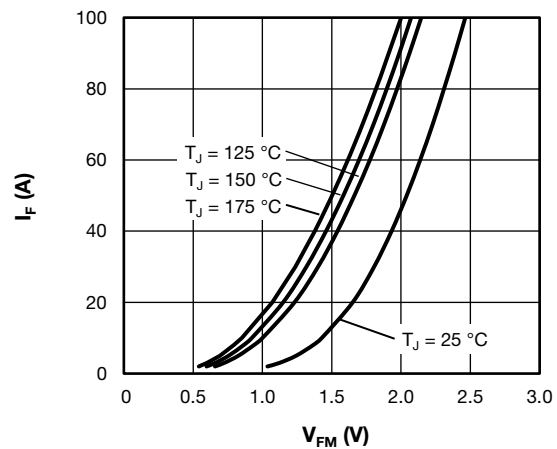


Fig. 12 - Typical Antiparallel Diode Forward Characteristics

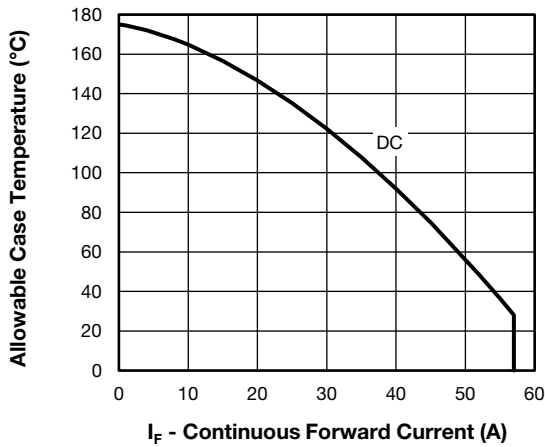


Fig. 13 - Maximum Antiparallel Diode Continuous Forward Current vs. Case Temperature

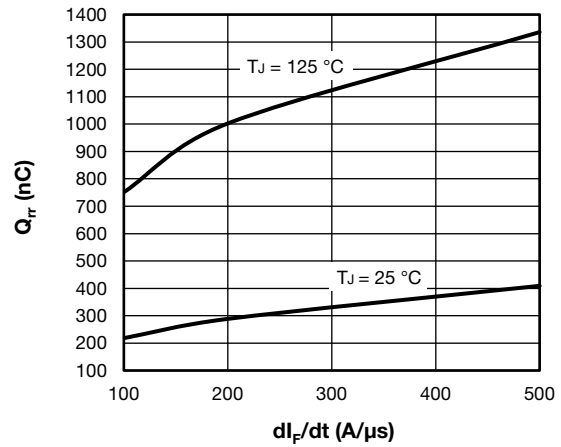


Fig. 16 - Typical Antiparallel Diode Reverse Recovery Charge vs.  $dI_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

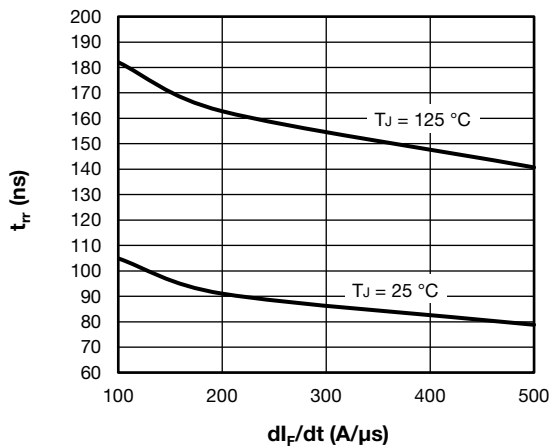


Fig. 14 - Typical Antiparallel Diode Reverse Recovery Time vs.  $dI_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

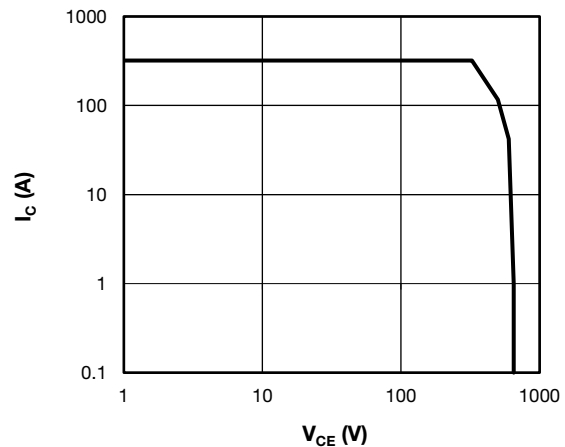


Fig. 17 - Trench IGBT Reverse BIAS SOA  
 $T_J = 175 \text{ °C}, I_C = 320 \text{ A}, R_g = 4.7 \text{ } \Omega, V_{GE} = +15 \text{ V} / 0 \text{ V}, V_{CC} = 325 \text{ V}, V_p = 650 \text{ V}$

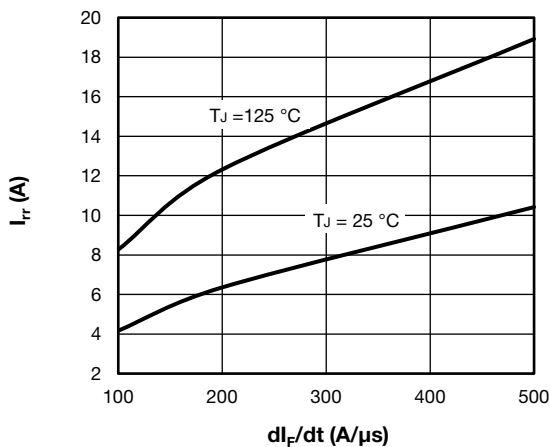


Fig. 15 - Typical Antiparallel Diode Reverse Recovery Current vs.  $dI_F/dt$   
 $I_F = 50 \text{ A}, V_{CC} = 200 \text{ V}$

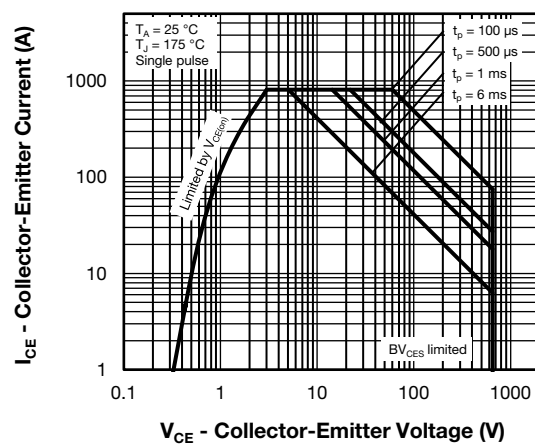


Fig. 18 - Trench IGBT Safe Operating Area

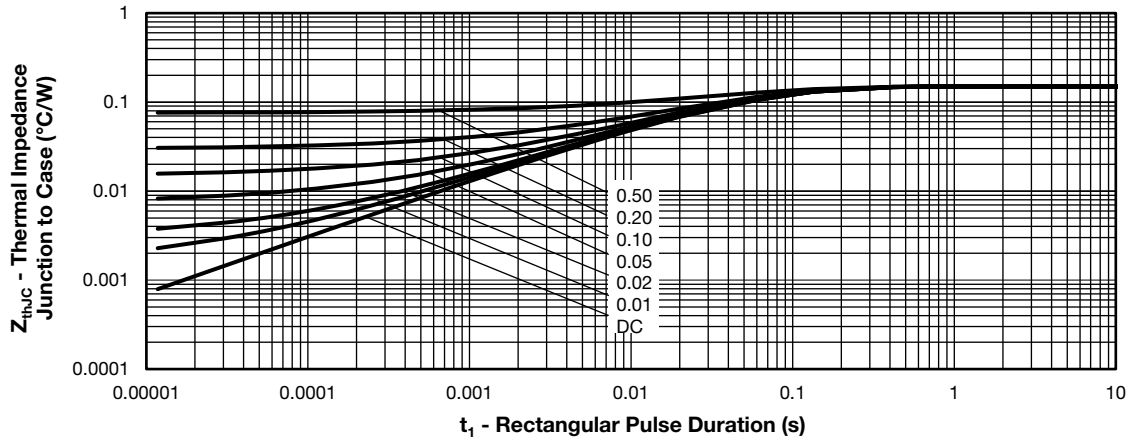


Fig. 19 - Maximum Trench IGBT Thermal Impedance  $Z_{thJC}$  Characteristics

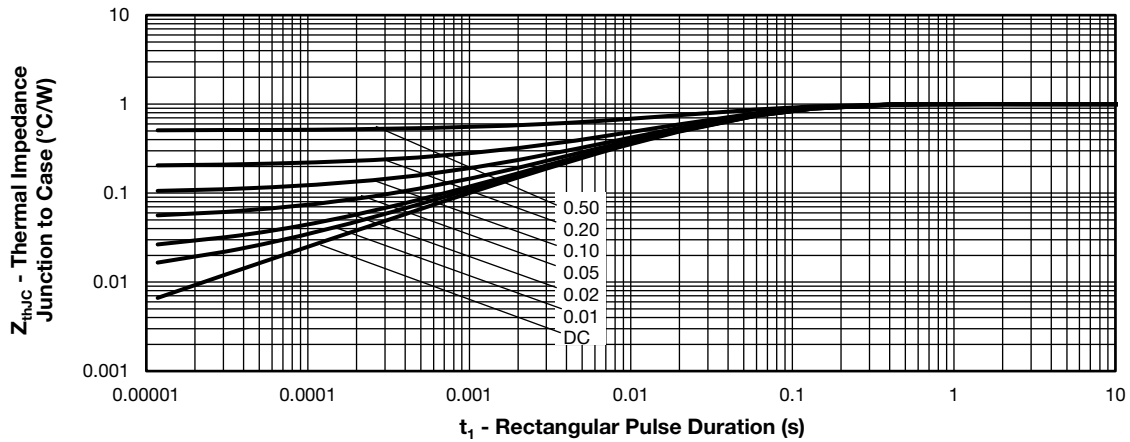
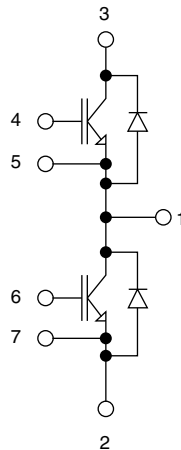


Fig. 20 - Maximum Antiparallel Diode Thermal Impedance  $Z_{thJC}$  Characteristics

**ORDERING INFORMATION TABLE**

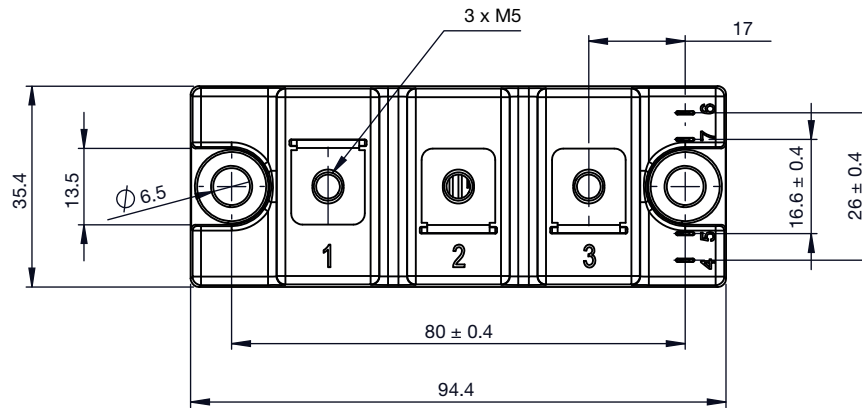
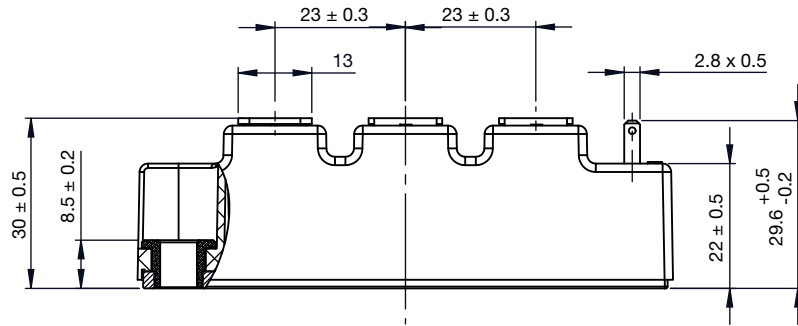
Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>200</b>	<b>T</b>	<b>S</b>	<b>065</b>	<b>S</b>
	①	②	③	④	⑤	⑥	⑦	⑧

- 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 = (S = standard speed IGBT)

**CIRCUIT CONFIGURATION**




**DIMENSIONS** in millimeters (inches)



General tolerance  $\pm 0.5$  mm





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