



## INT-A-PAK, Half Bridge - Trench IGBT, 200 A



INT-A-PAK

### FEATURES

- Trench IGBT
- Very low  $V_{CE(on)}$
- Positive  $V_{CE(on)}$  temperature coefficient
- FRED Pt<sup>®</sup> anti-parallel diode low  $Q_{rr}$  and low switching energy
- Industry and standard package
- $T_J = 175\text{ °C}$
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT

### BENEFITS

- Benchmark efficiency for UPS and welding application
- Rugged transient performance
- Direct mounting on heatsink
- Very low junction to case thermal resistance

PRIMARY CHARACTERISTICS	
$V_{CES}$	650 V
$I_C$ (DC) at $T_C = 59\text{ °C}$	150 A
$V_{CE(on)}$ (typical) at $I_C = 200\text{ A}$ , $T_J = 25\text{ °C}$	1.90 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	$I_C$	$T_C = 25\text{ °C}$	177	A
		$T_C = 80\text{ °C}$	132	
Pulsed collector current	$I_{CM}$	$T_J = 175\text{ °C}$ , $t_p = 6\text{ ms}$ , $V_{GE} = 15\text{ V}$	570	
Clamped inductive load current	$I_{LM}$		600	
Diode continuous forward current	$I_F$	$T_C = 25\text{ °C}$	138	
		$T_C = 80\text{ °C}$	103	
Maximum non-repetitive peak current	$I_{FSM}$	10 ms sine or 6 ms rectangular pulse, $T_J = 25\text{ °C}$	700	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation	IGBT	$T_C = 25\text{ °C}$	429	W
		$T_C = 80\text{ °C}$	271	
	Diode	$T_C = 25\text{ °C}$	288	
		$T_C = 80\text{ °C}$	183	
RMS isolation voltage	$V_{ISOL}$	$T_J = 25\text{ °C}$ , $f = 50\text{ Hz}$ , $t = 1\text{ s}$	3500	V
Operating junction temperature range	$T_J$		-40 to +175	$^{\circ}\text{C}$



<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	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.49	-	V
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}$	-	1.90	2.12	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.62	-	
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.20	-	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 2.0\text{ mA}$	2.9	4.0	5.3	
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	$g_{fe}$	$V_{CE} = 20\text{ V}, I_C = 200\text{ A}$	-	200	-	S
Transfer characteristics	$V_{GE}$	$V_{CE} = 20\text{ V}, I_C = 200\text{ A}$	-	6.6	-	V
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$	-	0.3	200	$\mu\text{A}$
		$V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	0.1	-	mA
Diode forward voltage drop	$V_{FM}$	$I_{FM} = 100\text{ A}$	-	1.75	-	V
		$I_{FM} = 200\text{ A}$	-	2.08	3.04	
		$I_{FM} = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.41	-	
		$I_{FM} = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.80	-	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	200	nA

<b>SWITCHING CHARACTERISTICS</b>							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS	
Total gate charge (turn-on)	$Q_g$	$I_C = 200\text{ A}$	-	476	-	nC	
Gate to emitter charge (turn-on)	$Q_{ge}$	$V_{CC} = 520\text{ V}$	-	61	-		
Gate to collector (turn-on)	$Q_{gc}$	$V_{GE} = 15\text{ V}$	-	128	-		
Turn-on switching loss	$E_{on}$	$V_{CC} = 325\text{ V}, I_C = 200\text{ A}, R_g = 4.7\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, V_{GE} = 15\text{ V}$	-	2.34	-	mJ	
Turn-off switching loss	$E_{off}$		-	3.77	-		
Total switching loss	$E_{tot}$		-	6.11	-		
Turn-on switching loss	$E_{on}$	$V_{CC} = 325\text{ V}, I_C = 200\text{ A}, R_g = 4.7\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, V_{GE} = 15\text{ V}$ $T_J = 125\text{ }^\circ\text{C}$	-	2.82	-	mJ	
Turn-off switching loss	$E_{off}$		-	3.86	-		
Total switching loss	$E_{tot}$		-	6.68	-		
Turn-on delay time	$t_{d(on)}$			-	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	$I_C = 600\text{ A}, R_g = 27\text{ }\Omega, V_{CC} = 400\text{ V},$ $V_p = 650\text{ V}, V_{GE} = 15\text{ V to } 0\text{ V}, T_J = 175\text{ }^\circ\text{C}$					
<b>ANTI-PARALLEL DIODE</b>							
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, di_F/dt = 500\text{ A}/\mu\text{s}$ $V_{rr} = 200\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	73	-	ns	
Diode peak reverse current	$I_{rr}$		-	13	-	A	
Diode recovery charge	$Q_{rr}$		-	465	-	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	-	125	
Junction to case per leg	IGBT		-	-	0.35	°C/W
	Diode					
Case to sink per module (conductive grease applied)	$R_{thCS}$		-	0.05	-	
Mounting torque	Power terminal screw: M5		2.5	-	5.0	
	Mounting screw: M6		3.0	-	5.0	
Weight			-	150	-	g

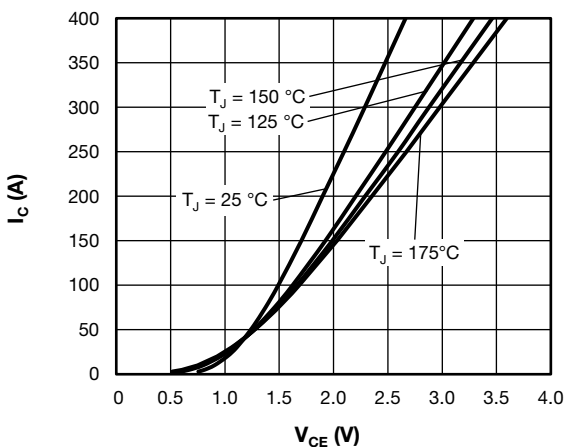


Fig. 1 - Typical IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$

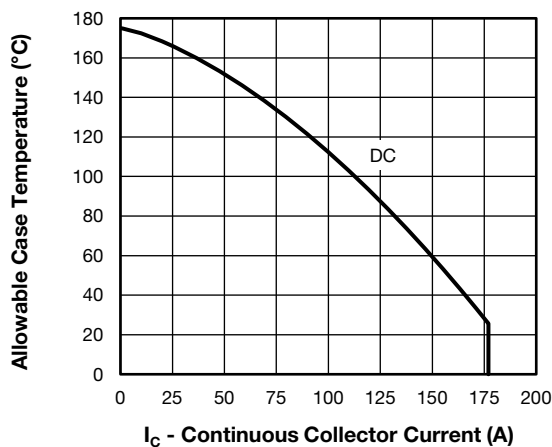


Fig. 3 - Maximum IGBT Continuous Collector Current vs. Case Temperature

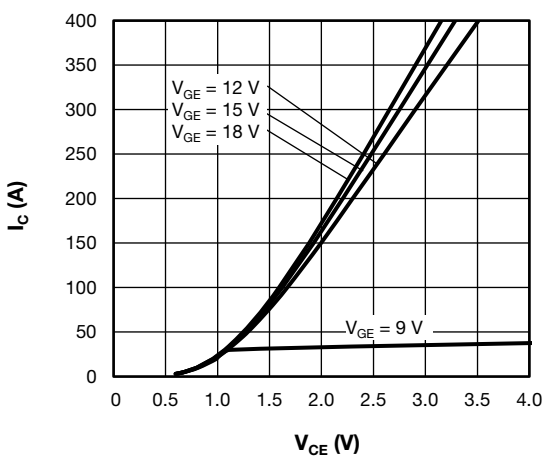


Fig. 2 - Typical IGBT Output Characteristics,  $T_J = 125\text{ °C}$

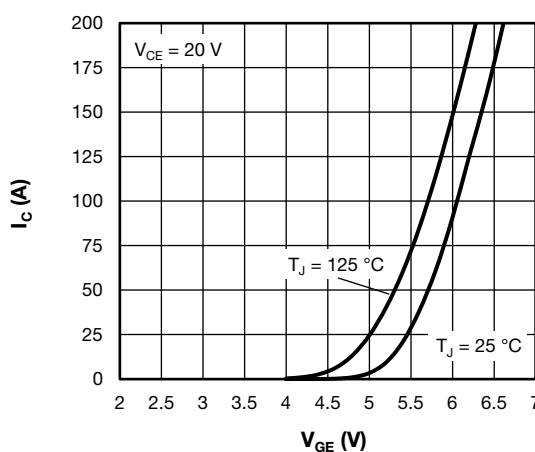


Fig. 4 - Typical IGBT Transfer Characteristics

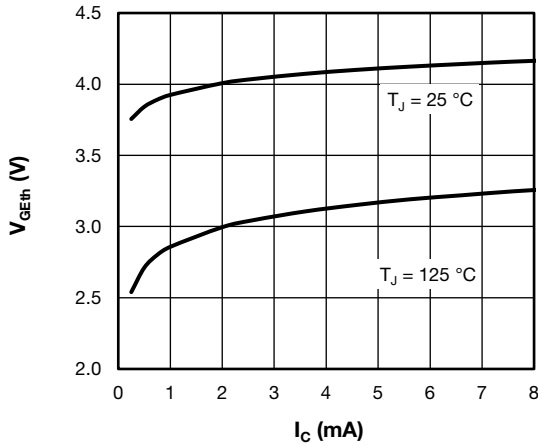


Fig. 5 - Typical IGBT Threshold Voltage

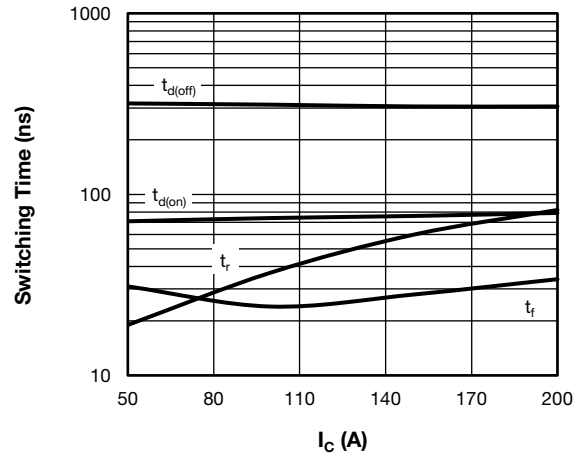


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$  (with Antiparallel Diode)  
 $T_J = 125\text{ °C}$ ,  $V_{CC} = 300\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

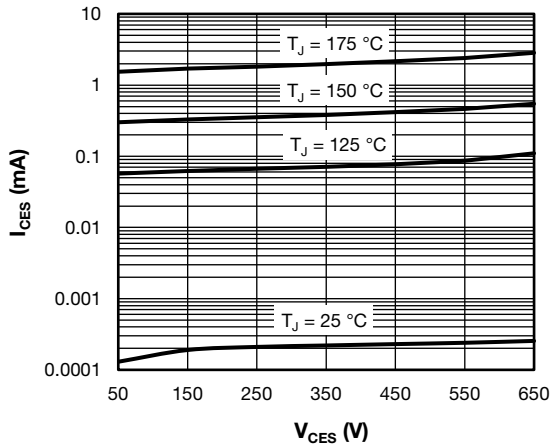


Fig. 6 - Typical IGBT Zero Gate Voltage Collector Current

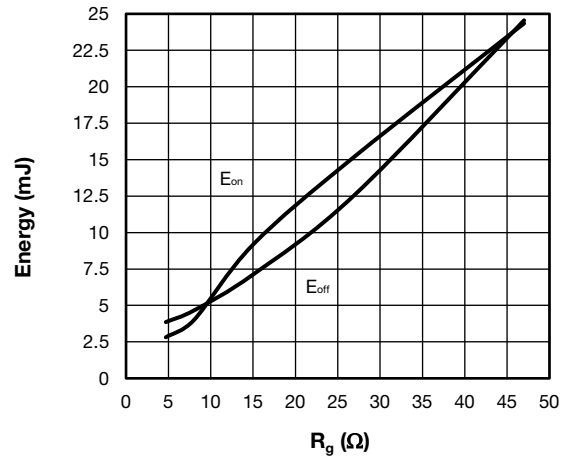


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$  (with Antiparallel Diode)  
 $T_J = 125\text{ °C}$ ,  $V_{CC} = 300\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

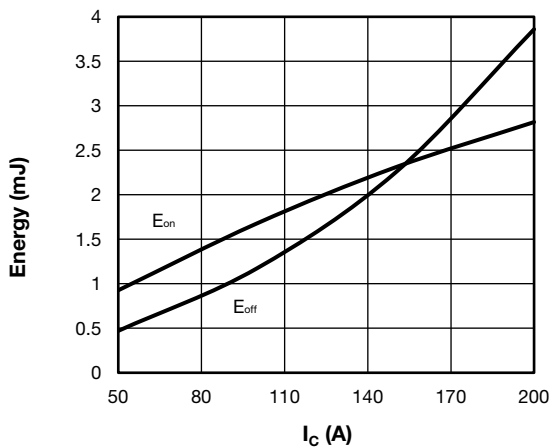


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$  (with Antiparallel Diode)  
 $T_J = 125\text{ °C}$ ,  $V_{CC} = 300\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

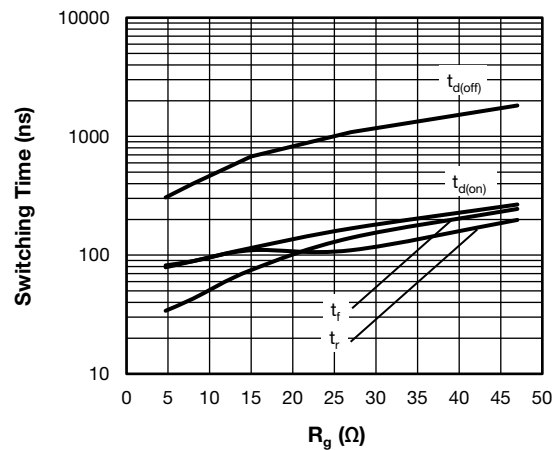


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$  (with Antiparallel Diode)  
 $T_J = 125\text{ °C}$ ,  $V_{CC} = 300\text{ V}$ ,  $I_C = 200\text{ A}$ ,  $V_{GE} = +15\text{ V} / -15\text{ V}$ ,  $L = 500\ \mu\text{H}$

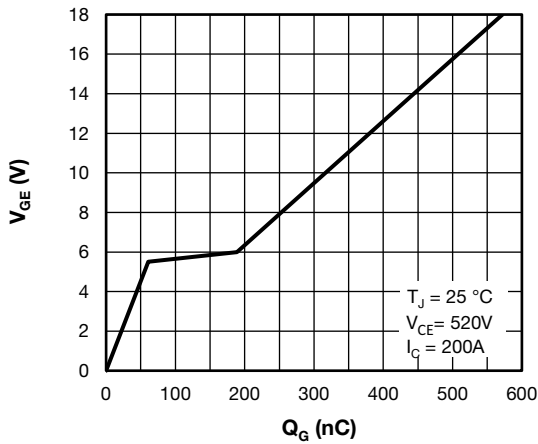


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

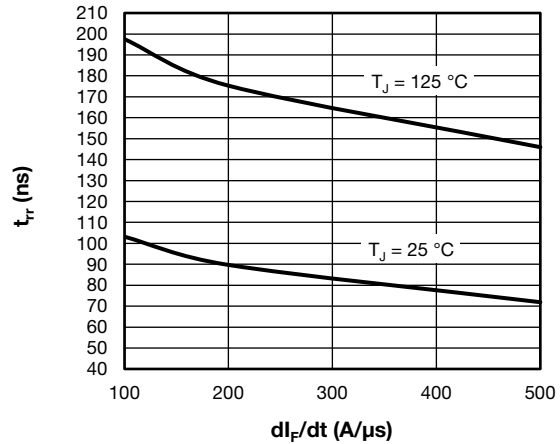


Fig. 14 - Typical Diode Reverse Recovery Time vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 50\text{ A}$

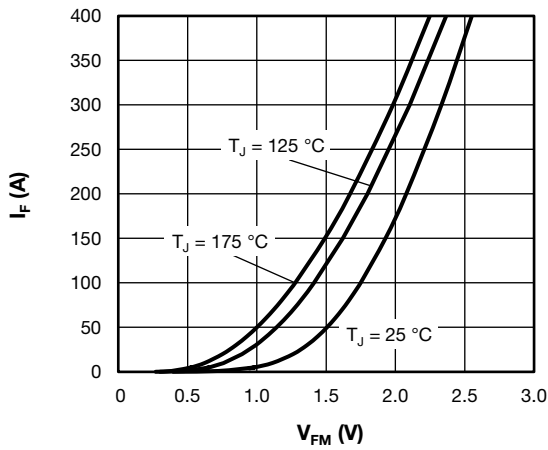


Fig. 12 - Typical IGBT Switching Time vs.  $I_C$

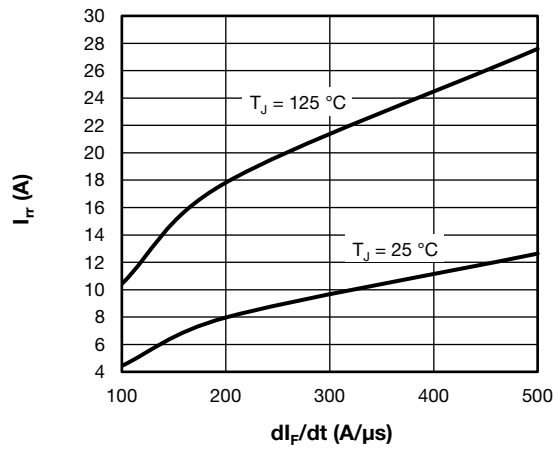


Fig. 15 - Typical Diode Reverse Recovery Current vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 50\text{ A}$

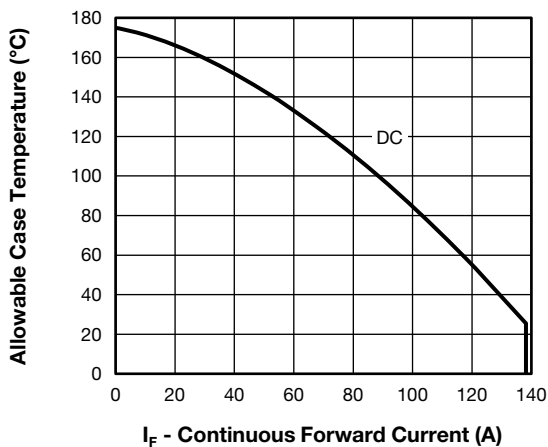


Fig. 13 - Maximum Diode Continuous Forward Current vs. Case Temperature

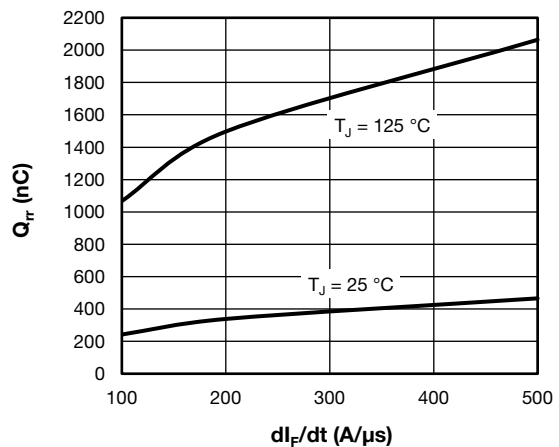


Fig. 16 - Typical Diode Reverse Recovery Current vs.  $dI_F/dt$   
 $V_{rr} = 200\text{ V}$ ,  $I_F = 50\text{ A}$

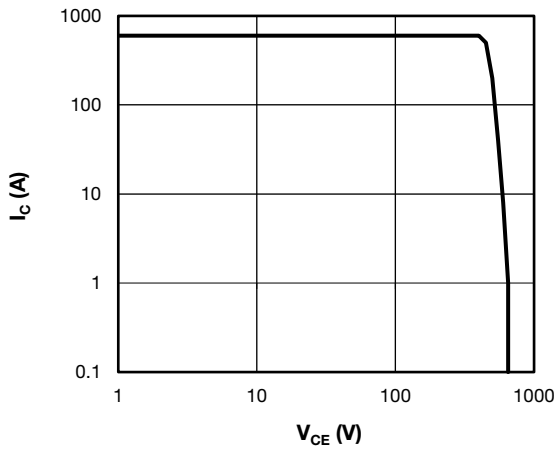


Fig. 17 - Typical Trench IGBT Reverse BIAS SOA  
 $T_J = 175\text{ }^\circ\text{C}$ ,  $I_C = 600\text{ A}$ ,  $R_g = 27\ \Omega$ ,  $V_{GE} = +15\text{ V} / 0\text{ V}$ ,  $V_{CC} = 400\text{ V}$ ,  
 $V_p = 650\text{ V}$

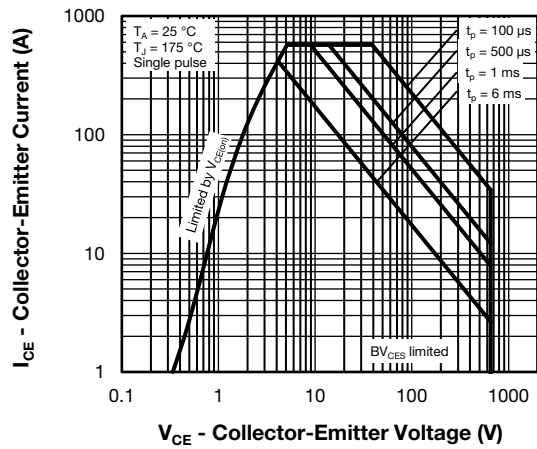


Fig. 18 - Trench IGBT safe Operating Area

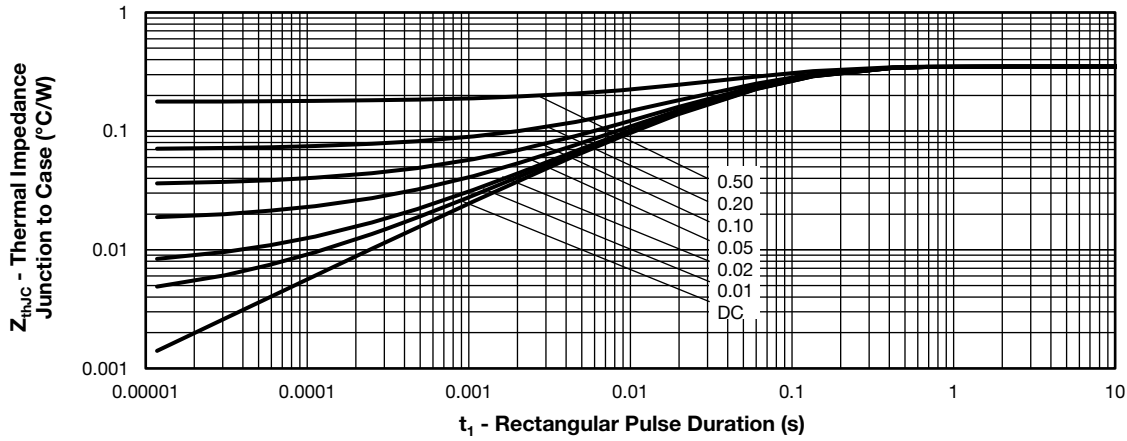


Fig. 19 - Maximum Trench IGBT Thermal Impedance  $Z_{thJC}$  Characteristics

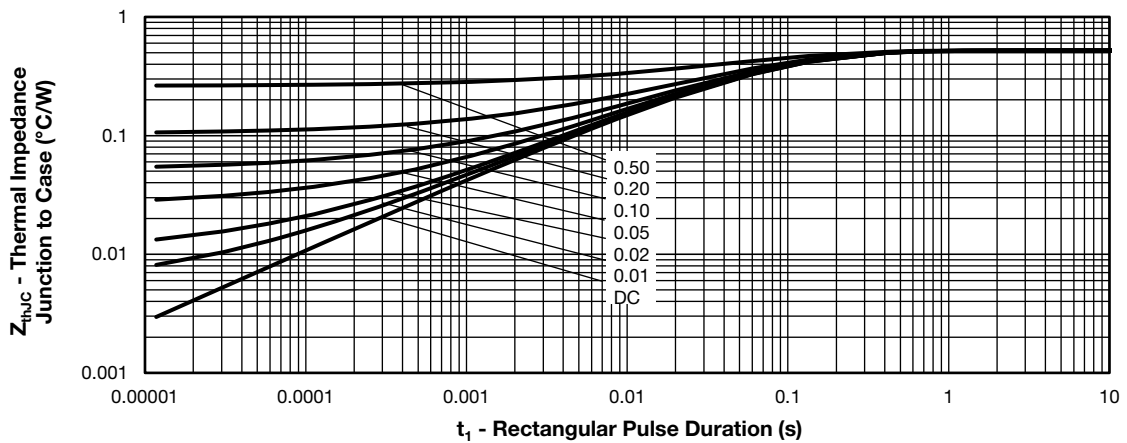
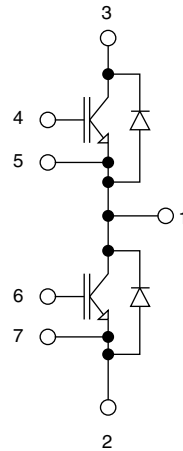


Fig. 20 - Maximum Diode Thermal Impedance  $Z_{thJC}$  Characteristics



**CIRCUIT CONFIGURATION**



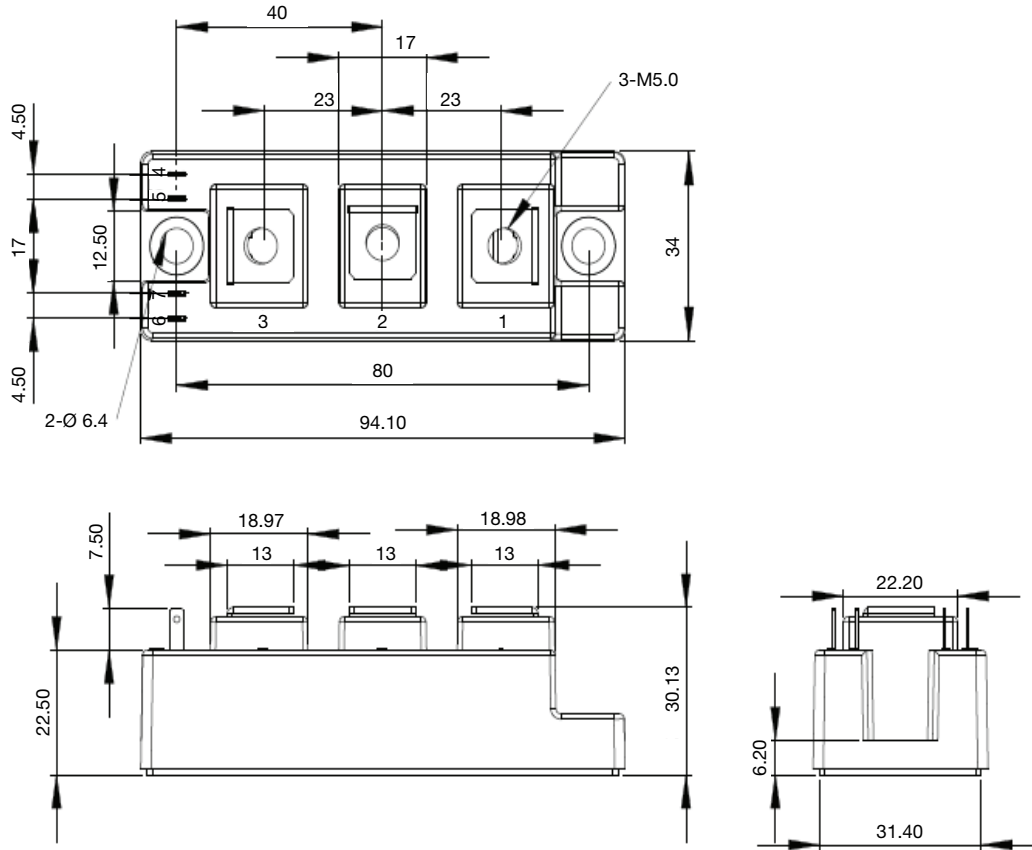
**ORDERING INFORMATION TABLE**

Device code	<b>VS-</b>	<b>G</b>	<b>T</b>	<b>200</b>	<b>T</b>	<b>P</b>	<b>065</b>	<b>U</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 (P = INT-A-PAK IGBT)
- 7** - Voltage rating (065 = 650 V)
- 8** - Speed/type (U = ultrafast)



**DIMENSIONS** in millimeters

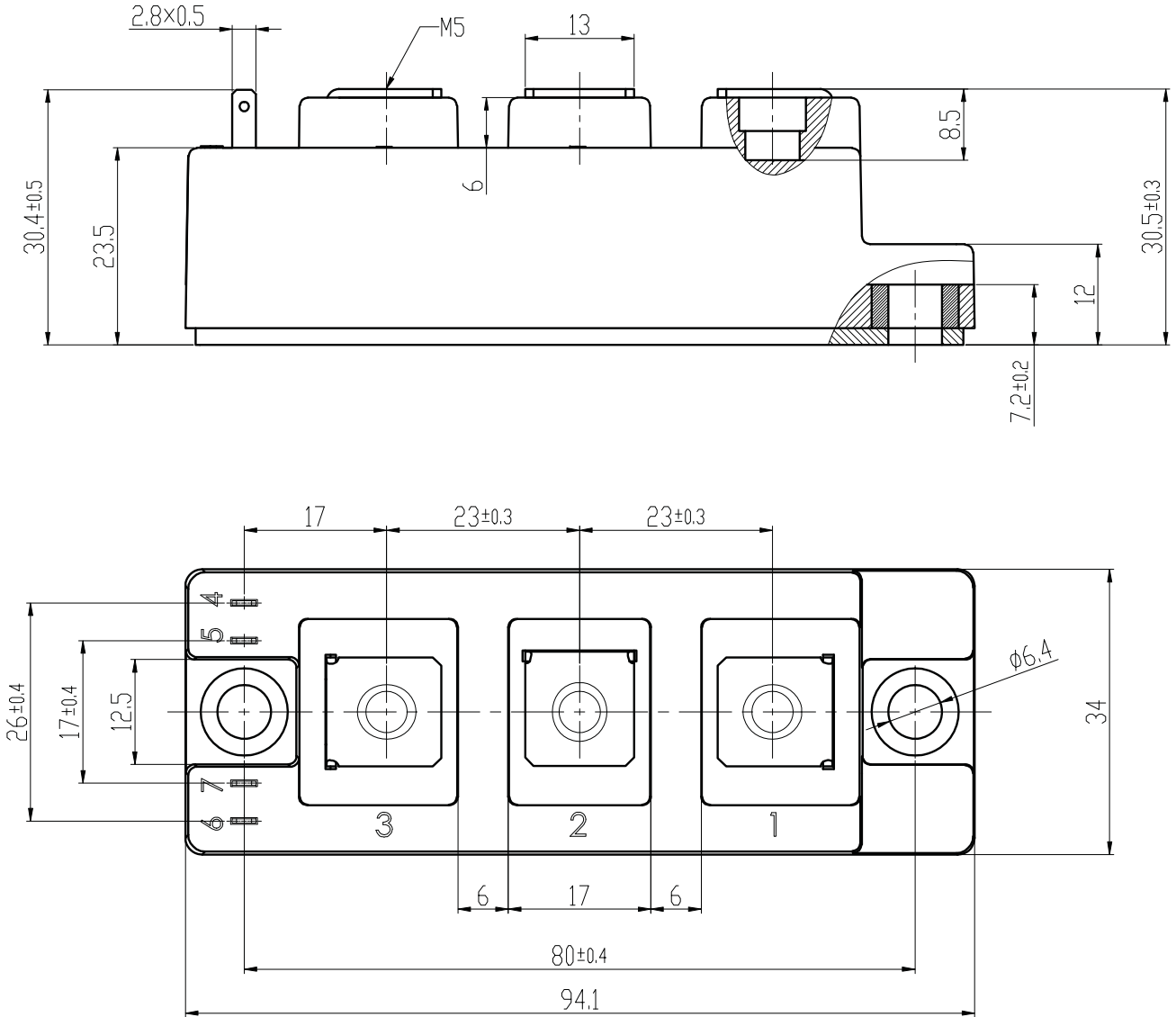






## INT-A-PAK

**DIMENSIONS** in millimeters (inches)





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