


## INT-A-PAK "Half-Bridge" (Ultrafast Speed IGBT), 209 A


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

- Generation 5 Non Punch Through (NPT) technology
- Ultrafast: Optimized for hard switching speed 8 kHz to 60 kHz
- Low  $V_{CE(on)}$
- 10  $\mu$ s short circuit capability
- Square RBSOA
- Positive  $V_{CE(on)}$  temperature coefficient
- HEXFRED<sup>®</sup> antiparallel diode with ultrasoft reverse recovery characteristics
- Industry standard package
- $Al_2O_3$  DBC
- UL approved file E78996 
- Compliant to RoHS directive 2002/95/EC
- Designed for industrial level


**RoHS  
COMPLIANT**
**PRODUCT SUMMARY**

$V_{CES}$	600 V
$I_C$ DC	209 A
$V_{CE(on)}$ at 200 A, 25 °C	2.6 V

**BENEFITS**

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

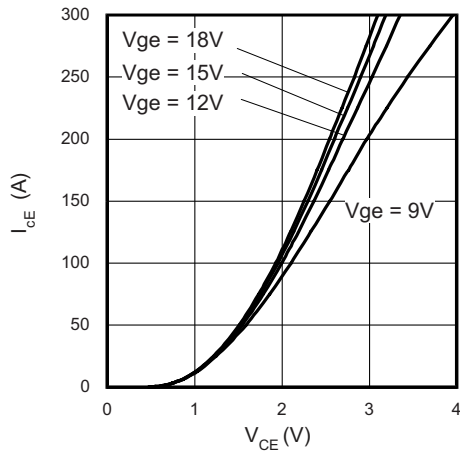
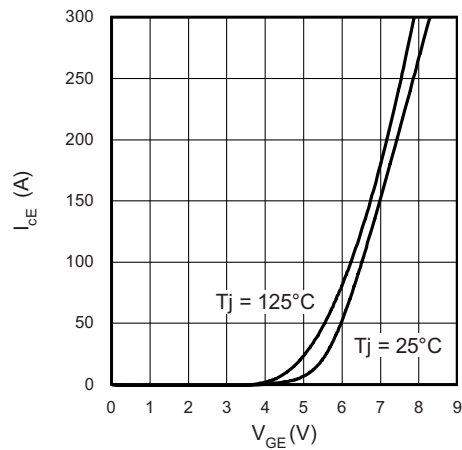
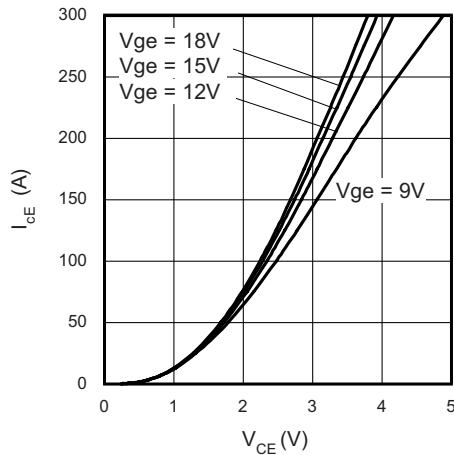
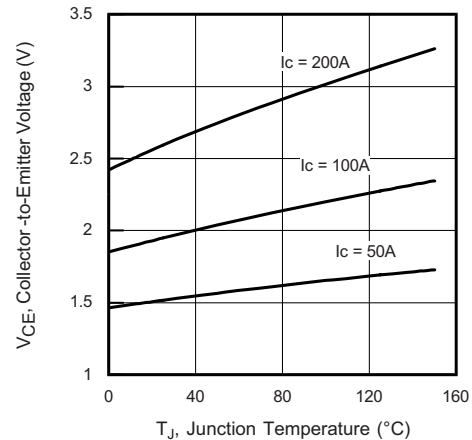
**ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		600	V
Continuous collector current	$I_C$	$T_C = 25\text{ °C}$	209	A
		$T_C = 80\text{ °C}$	142	
Pulsed collector current	$I_{CM}$		400	
Clamped inductive load current	$I_{LM}$		400	
Diode continuous forward current	$I_F$	$T_C = 25\text{ °C}$	178	
		$T_C = 80\text{ °C}$	121	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation	$P_D$	$T_C = 25\text{ °C}$	781	W
		$T_C = 80\text{ °C}$	438	
Isolation voltage	$V_{ISOL}$	Any terminal to case, t = 1 minute	2500	V

<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	$V_{BR(CE)}$	$V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 100\text{ A}$	-	1.95	2.1	
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}$	-	2.6	2.84	
		$V_{GE} = 15\text{ V}, I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	2.28	2.5	
		$V_{GE} = 15\text{ V}, I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	3.14	3.48	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 500\text{ }\mu\text{A}$	3	4.2	6	
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	0.005	0.2	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	0.01	15	
Diode forward voltage drop	$V_{FM}$	$I_C = 100\text{ A}$	-	1.39	1.78	V
		$I_C = 200\text{ A}$	-	1.64	2.2	
		$I_C = 100\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.32	1.69	
		$I_C = 200\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.67	2.30	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	nA

<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Turn-on switching loss	$E_{on}$	$I_C = 200\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 10\text{ }\Omega, L = 200\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	3.65	-	mJ
Turn-off switching loss	$E_{off}$		-	6.9	-	
Total switching loss	$E_{tot}$		-	10.55	-	
Turn-on switching loss	$E_{on}$	$I_C = 200\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 10\text{ }\Omega, L = 200\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	3.8	-	ns
Turn-off switching loss	$E_{off}$		-	7.8	-	
Total switching loss	$E_{tot}$		-	11.6	-	
Turn-on delay time	$t_{d(on)}$		-	507	-	
Rise time	$t_r$		-	133	-	
Turn-off delay time	$t_{d(off)}$	-	538	-	ns	
Fall time	$t_f$	-	92	-		
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 400\text{ A}, R_g = 27\text{ }\Omega, V_{GE} = 15\text{ V to }0$	Fullsquare			
Short circuit safe operating area	SCSOA	$T_J = 150\text{ }^\circ\text{C}, V_{CC} = 400\text{ V}, V_P = 600\text{ V}, R_g = 27\text{ }\Omega, V_{GE} = 15\text{ V to }0$	10	-	-	
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}, V_{CC} = 400\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	226	260	ns
Diode peak reverse current	$I_{rr}$		-	17	20	A
Diode recovery charge	$Q_{rr}$		-	1900	2600	nC
Diode reverse recovery time	$t_{rr}$	$I_F = 50\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}, V_{CC} = 400\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	290	330	ns
Diode peak reverse current	$I_{rr}$		-	25	30	A
Diode recovery charge	$Q_{rr}$		-	3600	5000	nC

THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Operating junction and storage temperature range	$T_J, T_{Stg}$	- 40	-	150	$^{\circ}\text{C}$
Junction to case per leg	IGBT	-	0.13	0.16	$^{\circ}\text{C}/\text{W}$
	Diode	-	0.19	0.32	
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 IGBT Output Characteristics  
 $T_J = 25^{\circ}\text{C}$ ,  $t_p = 500 \mu\text{s}$ 

 Fig. 3 - Typical Transfer Characteristics  
 $V_{CE} = 20 \text{ V}$ ,  $t_p = 500 \mu\text{s}$ 

 Fig. 2 - Typical IGBT Output Characteristics  
 $T_J = 125^{\circ}\text{C}$ ,  $t_p = 500 \mu\text{s}$ 

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

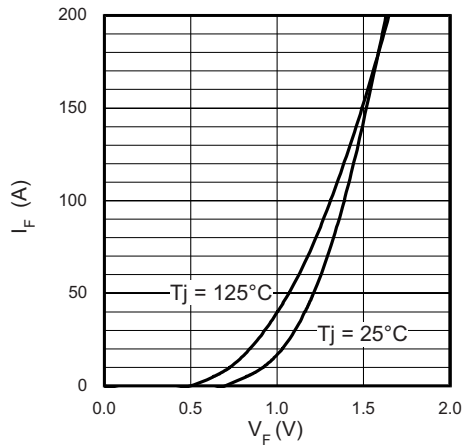


Fig. 5 - Diode Forward Characteristics,  
 $t_p = 500 \mu s$

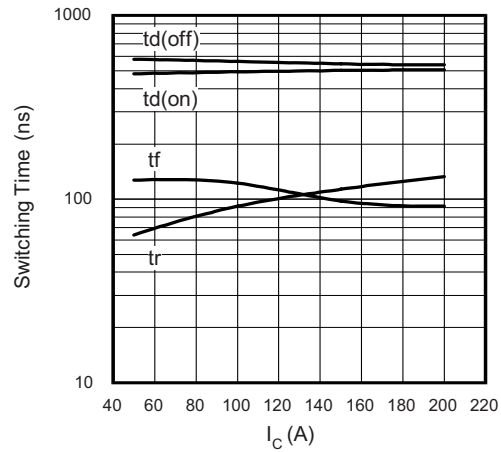


Fig. 8 - Typical Switching Time vs.  $I_C$   
 $T_J = 125^\circ C$ ,  $L = 200 \mu H$ ,  $V_{CC} = 360 V$ ,  
 $R_g = 10 \Omega$ ,  $V_{GE} = 15 V$

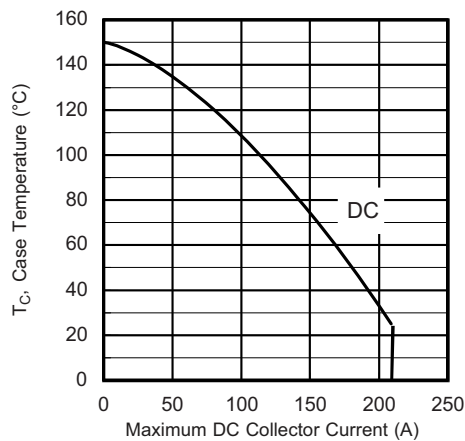


Fig. 6 - Maximum Collector Current vs.  
Case Temperature

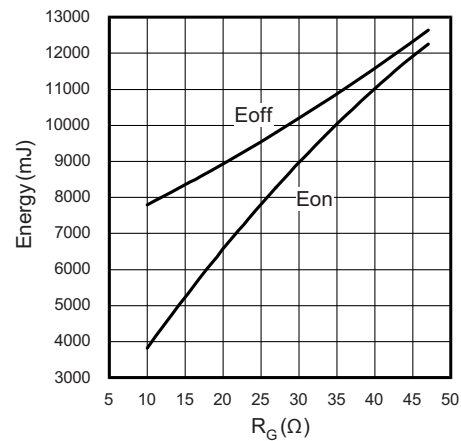


Fig. 9 - Typical Energy Loss vs.  $R_g$   
 $T_J = 125^\circ C$ ,  $L = 200 \mu H$ ,  $V_{CC} = 360 V$ ,  
 $I_{CE} = 200 A$ ,  $V_{GE} = 15 V$

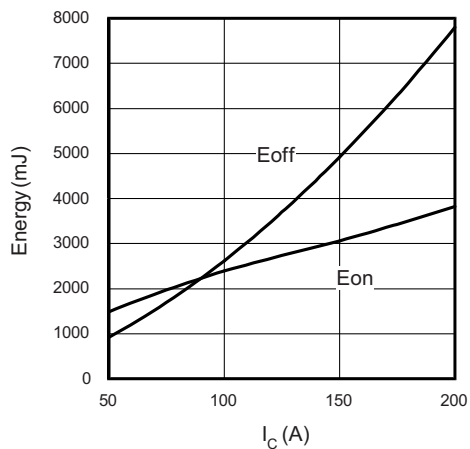


Fig. 7 - Typical Energy Loss vs.  $I_C$   
 $T_J = 125^\circ C$ ,  $L = 200 \mu H$ ,  $V_{CC} = 360 V$ ,  
 $R_g = 10 \Omega$ ,  $V_{GE} = 15 V$

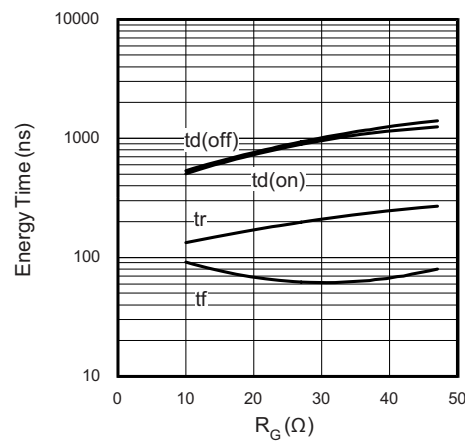


Fig. 10 - Typical Switching Time vs.  $R_g$   
 $T_J = 125^\circ C$ ,  $L = 200 \mu H$ ,  $V_{CC} = 360 V$ ,  
 $I_{CE} = 200 A$ ,  $V_{GE} = 15 V$

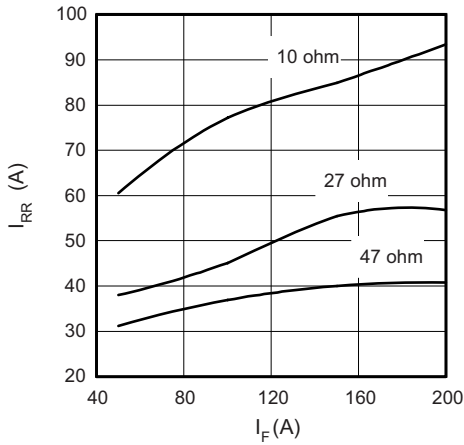


Fig. 11 - Typical Diode  $I_{rr}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$

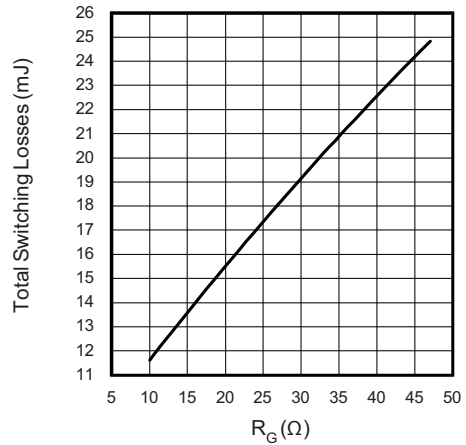


Fig. 14 - Typical Switching Losses vs. Gate Resistance  
 $T_J = 125^\circ\text{C}$ ,  $L = 200\ \mu\text{H}$ ,  $R_g = 10\ \Omega$ ,  
 $V_{CC} = 360\ \text{V}$ ,  $V_{GE} = 15\ \text{V}$

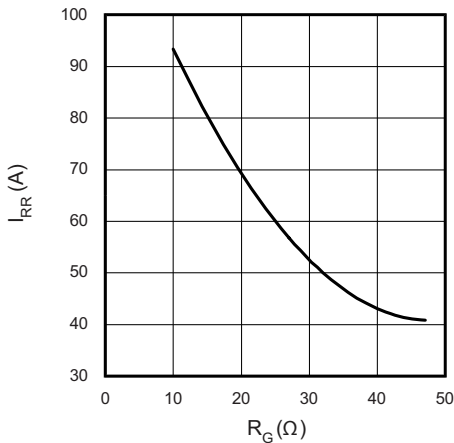


Fig. 12 - Typical Diode  $I_{rr}$  vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $I_F = 200\ \text{A}$

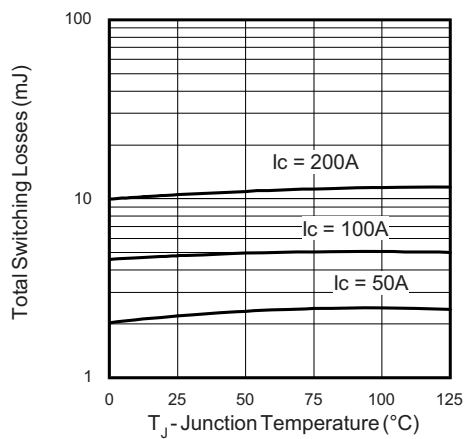


Fig. 15 - Typical Switching Losses vs. Junction Temperature;  
 $L = 200\ \mu\text{H}$ ,  $R_g = 10\ \Omega$ ,  $V_{CC} = 360\ \text{V}$ ,  $V_{GE} = 15\ \text{V}$

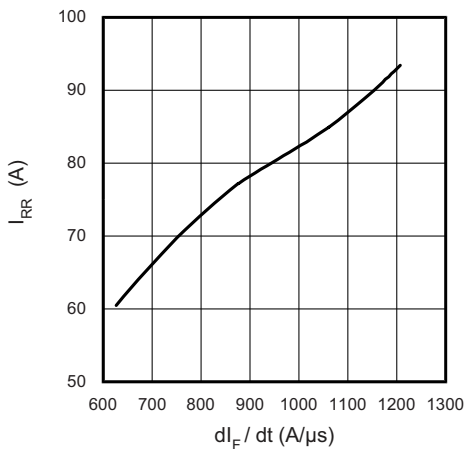


Fig. 13 - Typical Diode  $I_{rr}$  vs.  $di_F/dt$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 360\ \text{V}$ ,  $I_F = 200\ \text{A}$ ,  $V_{GE} = 15\ \text{V}$

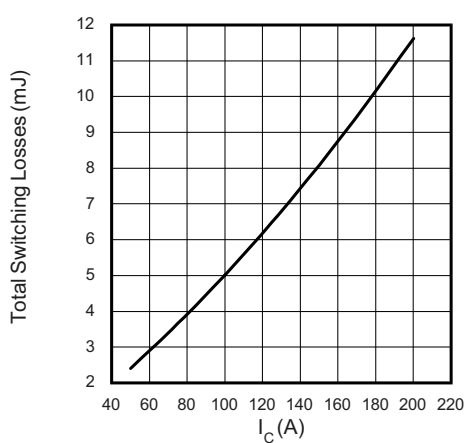


Fig. 16 - Typical Switching Losses vs. Collector to Emitter Current;  
 $T_J = 125^\circ\text{C}$ ,  $R_{g1} = 10\ \Omega$ ,  $R_{g2} = 0\ \Omega$ ,  $V_{CC} = 360\ \text{V}$ ,  $V_{GE} = 15\ \text{V}$

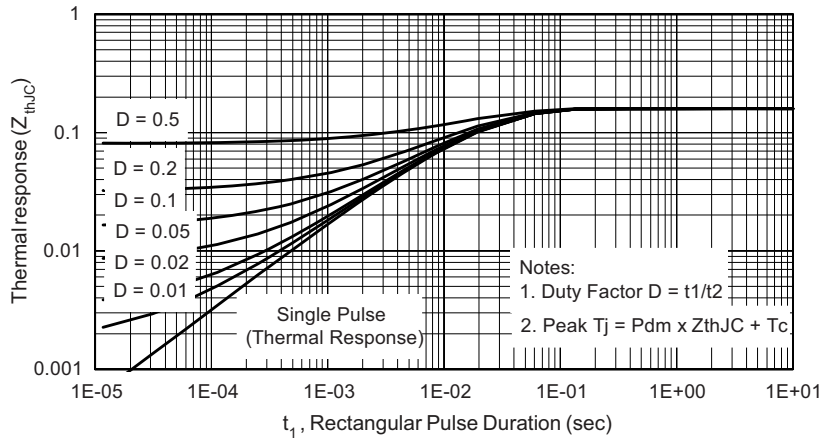


Fig. 17 - Maximum Transient Thermal Impedance, Junction to Case (IGBT)

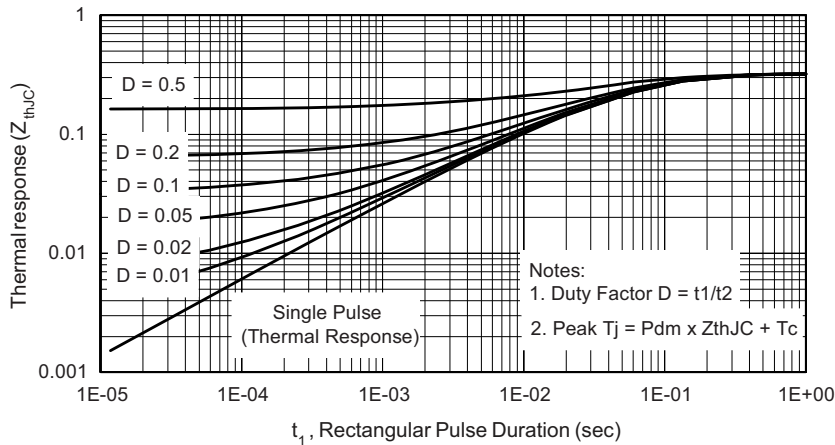
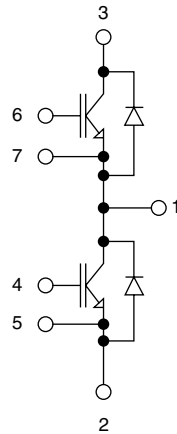


Fig. 18 - Maximum Transient Thermal Impedance, Junction to Case (HEXFRED®)

**ORDERING INFORMATION TABLE**

Device code	<b>G</b>	<b>B</b>	<b>200</b>	<b>T</b>	<b>S</b>	<b>60</b>	<b>N</b>	<b>PbF</b>
	①	②	③	④	⑤	⑥	⑦	⑧

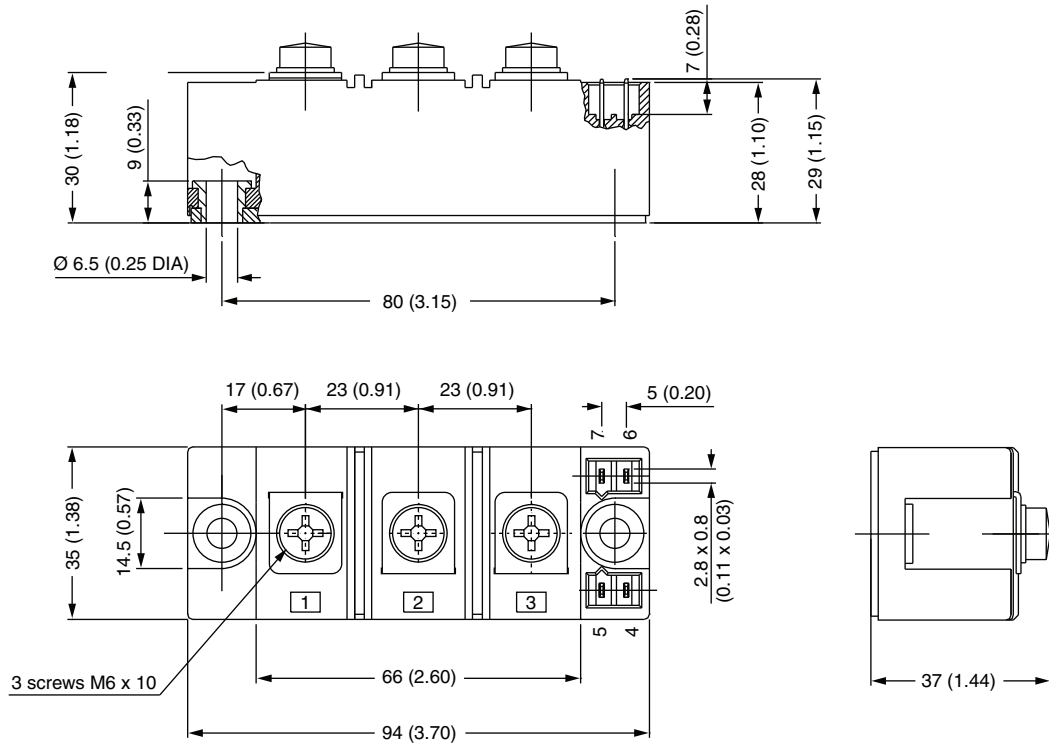
- 1** - Insulated Gate Bipolar Transistor (IGBT)
- 2** - B = IGBT Generation 5 NPT
- 3** - Current rating (200 = 200 A)
- 4** - Circuit configuration (T = Half-bridge)
- 5** - Package indicator (S = INT-A-PAK)
- 6** - Voltage rating (60 = 600 V)
- 7** - Speed/type (N = Ultrafast IGBT)
- 8** - Lead (Pb)-free

**CIRCUIT CONFIGURATION**

**LINKS TO RELATED DOCUMENTS**

Dimensions	<a href="http://www.vishay.com/doc?95173">www.vishay.com/doc?95173</a>
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## INT-A-PAK IGBT/Thyristor

**DIMENSIONS** in millimeters (inches)







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