

## Thyristor/Diode and Thyristor/Thyristor, 135 A to 160 A (New INT-A-PAK Power Modules)



New INT-A-PAK

### FEATURES

- High voltage
- Electrically isolated by DBC ceramic ( $Al_2O_3$ )
- 3500  $V_{RMS}$  isolating voltage
- Industrial standard package
- High surge capability
- Glass passivated chips
- Modules uses high voltage power thyristor/diodes in three basic configurations
- Simple mounting
- UL approved file E78996
- Compliant to RoHS directive 2002/95/EC
- Designed and qualified for multiple level



**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

$I_{T(AV)}$	135 A to 160 A
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### APPLICATIONS

- DC motor control and drives
- Battery charges
- Welders
- Power converters
- Lighting control
- Heat and temperature control

### MAJOR RATINGS AND CHARACTERISTICS

SYMBOL	CHARACTERISTICS	VSK.136..	VSK.142..	VSK.162..	UNITS
$I_{T(AV)}$	85 °C	135	140	160	A
$I_{T(RMS)}$		300	310	355	A
$I_{TSM}$	50 Hz	3200	4500	4870	
	60 Hz	3360	4712	5100	
$I^2t$	50 Hz	51.5	102	119	$kA^2s$
	60 Hz	47	92.5	108	
$I^2\sqrt{t}$		515.5	1013	1190	$kA^2\sqrt{s}$
$V_{RRM}$	Range	400 to 1600			V
$T_J$	Range	- 40 to 125			°C

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

TYPE NUMBER	VOLTAGE CODE	$V_{RRM}/V_{DRM}$ , MAXIMUM REPETITIVE PEAK REVERSE VOLTAGE V	$V_{RSM}/V_{DSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE V	$I_{RRM}/I_{DRM}$ AT 125 °C mA
VSK.136 VSK.142 VSK.162	04	400	500	50
	08	800	900	
	12	1200	1300	
	14	1400	1500	
	16	1600	1700	

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FORWARD CONDUCTION								
PARAMETER	SYMBOL	TEST CONDITIONS		VSK.136	VSK.142	VSK.162	UNITS	
Maximum average on-state current at case temperature	$I_{T(AV)}$	180° conduction, half sine wave		135	140	160	A	
				85	85	85	°C	
Maximum RMS on-state current	$I_{T(RMS)}$	As AC switch		300	310	355	A	
Maximum peak, one-cycle on-state, non-repetitive surge current	$I_{TSM}$	t = 10 ms	No voltage reapplied	3200	4500	4870		
		t = 8.3 ms	No voltage reapplied	3360	4712	5100		
		t = 10 ms	100 % $V_{RRM}$ reapplied	2700	3785	4100		
		t = 8.3 ms	100 % $V_{RRM}$ reapplied	2800	3963	4300		
Maximum $I^2t$ for fusing	$I^2t$	t = 10 ms	No voltage reapplied	51.5	102	119		kA <sup>2</sup> s
		t = 8.3 ms	No voltage reapplied	47	92.5	108		
		t = 10 ms	100 % $V_{RRM}$ reapplied	36.5	71.6	84		
		t = 8.3 ms	100 % $V_{RRM}$ reapplied	33.3	65.4	76.7		
Maximum $I^2\sqrt{t}$ for fusing	$I^2\sqrt{t}$	t = 0.1 ms to 10 ms, no voltage reapplied		515.5	1013	1190	kA <sup>2</sup> √s	
Low level value of threshold voltage	$V_{T(TO)1}$	$(16.7 \% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J$ maximum		0.86	0.83	0.8	V	
High level value of threshold voltage	$V_{T(TO)2}$	$(I > \pi \times I_{T(AV)})$ , $T_J$ maximum		1.05	1	0.98		
Low level value on-state slope resistance	$r_{t1}$	$(16.7 \% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J$ maximum		2.02	1.78	1.67	mΩ	
High level value on-state slope resistance	$r_{t2}$	$(I > \pi \times I_{T(AV)})$ , $T_J$ maximum		1.65	1.43	1.38		
Maximum on-state voltage drop	$V_{TM}$	$I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$ , 180° conduction		1.57	1.55	1.54	V	
Maximum forward voltage drop	$V_{FM}$	$I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$ , 180° conduction		1.57	1.55	1.54	V	
Maximum holding current	$I_H$	Anode supply = 6 V initial $I_T = 30\text{ A}$ , $T_J = 25\text{ °C}$		200			mA	
Maximum latching current	$I_L$	Anode supply = 6 V resistive load = 1 Ω Gate pulse: 10 V, 100 μs, $T_J = 25\text{ °C}$		400				

SWITCHING						
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES		UNITS
Typical delay time	$t_{gd}$	$T_J = 25\text{ °C}$	Gate current = 1 A, $di_g/dt = 1\text{ A}/\mu\text{s}$ $V_d = 0.67\% V_{DRM}$	1		μs
Typical rise time	$t_{gr}$			2		
Typical turn-off time	$t_q$	$I_{TM} = 300\text{ A}$ , $-di/dt = 15\text{ A}/\mu\text{s}$ ; $T_J = T_J$ maximum $V_R = 50\text{ V}$ ; $dV/dt = 20\text{ V}/\mu\text{s}$ ; gate 0 V, 100 Ω		50 to 200		

BLOCKING						
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES		UNITS
Maximum peak reverse and off-state leakage current	$I_{RRM}$ , $I_{DRM}$	$T_J = 125\text{ °C}$		50		mA
RMS insulation voltage	$V_{INS}$	50 Hz, circuit to base, all terminals shorted, t = 1 s		3500		V
Critical rate of rise of off-state voltage	$dV/dt$	$T_J = T_J$ maximum, exponential to 67 % rated $V_{DRM}$		1000		V/μs



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TRIGGERING					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum peak gate power	$P_{GM}$	$t_p \leq 5$ ms, $T_J = T_J$ maximum		12	W
Maximum average gate power	$P_{G(AV)}$	f = 50 Hz, $T_J = T_J$ maximum		3	
Maximum peak gate current	$I_{GM}$	$t_p \leq 5$ ms, $T_J = T_J$ maximum		3	A
Maximum peak negative gate voltage	$-V_{GT}$			10	
Maximum required DC gate voltage to trigger	$V_{GT}$	$T_J = -40$ °C	Anode supply = 6 V, resistive load; $R_a = 1$ $\Omega$	4	V
		$T_J = 25$ °C		2.5	
		$T_J = T_J$ maximum		1.7	
Maximum required DC gate current to trigger	$I_{GT}$	$T_J = -40$ °C		270	mA
		$T_J = 25$ °C		150	
		$T_J = T_J$ maximum		80	
Maximum gate voltage that will not trigger	$V_{GD}$	$T_J = T_J$ maximum, rated $V_{DRM}$ applied		0.3	V
Maximum gate current that will not trigger	$I_{GD}$			10	mA
Maximum rate of rise of turned-on current	di/dt	$T_J = T_J$ maximum, $I_{TM} = 400$ A rated $V_{DRM}$ applied		300	A/ $\mu$ s

THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS	
Maximum junction operating temperature range	$T_J$		- 40 to 125	°C	
Maximum storage temperature range	$T_{Stg}$		- 40 to 150		
Maximum thermal resistance, junction to case per junction	$R_{thJC}$	DC operation	0.18	0.16	K/W
Maximum thermal resistance, case to heatsink per module	$R_{thCS}$	Mounting surface, smooth, flat and greased	0.05		
Mounting torque $\pm 10$ %	IAP to heatsink busbar to IAP	A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound. Lubricated threads.	4 to 6		Nm
Approximate weight			200	7.1	g oz.
Case style			New INT-A-PAK		

$\Delta R$ CONDUCTION PER JUNCTION											
DEVICES	SINUSOIDAL CONDUCTION AT $T_J$ MAXIMUM					RECTANGULAR CONDUCTION AT $T_J$ MAXIMUM					UNITS
	180°	120°	90°	60°	30°	180°	120°	90°	60°	30°	
VSK.136	0.007	0.01	0.013	0.0155	0.017	0.009	0.012	0.014	0.015	0.017	K/W
VSK.142	0.0019	0.0019	0.0020	0.0020	0.0021	0.0018	0.0022	0.0023	0.0023	0.0020	
VSK.162	0.0030	0.0031	0.0032	0.0033	0.0034	0.0029	0.0036	0.0039	0.0041	0.0040	

**Note**

- Table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC



Fig. 1 - Current Ratings Characteristics



Fig. 4 - On-State Power Loss Characteristics



Fig. 2 - Current Ratings Characteristics

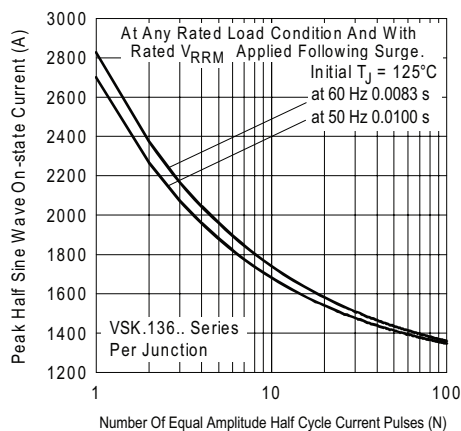


Fig. 5 - Maximum Non-Repetitive Surge Current



Fig. 3 - On-State Power Loss Characteristics



Fig. 6 - Maximum Non-Repetitive Surge Current



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Fig. 7 - On-State Power Loss Characteristics



Fig. 8 - On-State Power Loss Characteristics



Fig. 9 - On-State Power Loss Characteristics

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Fig. 10 - Current Ratings Characteristics



Fig. 13 - On-State Power Loss Characteristics



Fig. 11 - Current Ratings Characteristics



Fig. 14 - Maximum Non-Repetitive Surge Current



Fig. 12 - On-State Power Loss Characteristics



Fig. 15 - Maximum Non-Repetitive Surge Current



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Fig. 16 - On-State Power Loss Characteristics



Fig. 17 - On-State Power Loss Characteristics



Fig. 18 - On-State Power Loss Characteristics

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Fig. 19 - Current Ratings Characteristics



Fig. 22 - On-State Power Loss Characteristics



Fig. 20 - Current Ratings Characteristics



Fig. 23 - Maximum Non-Repetitive Surge Current



Fig. 21 - On-State Power Loss Characteristics



Fig. 24 - Maximum Non-Repetitive Surge Current





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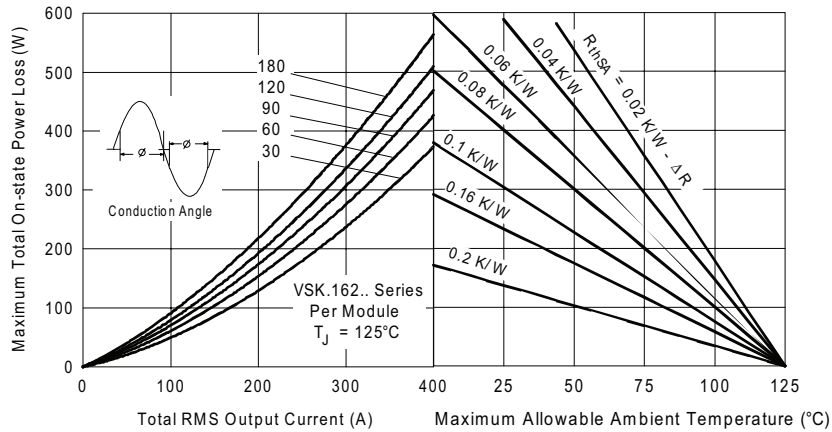


Fig. 25 - On-State Power Loss Characteristics



Fig. 26 - On-State Power Loss Characteristics



Fig. 27 - On-State Power Loss Characteristics

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Fig. 28 - On-State Voltage Drop Characteristics



Fig. 31 - Thermal Impedance  $Z_{thJC}$  Characteristics



Fig. 29 - On-State Voltage Drop Characteristics



Fig. 32 - Thermal Impedance  $Z_{thJC}$  Characteristics



Fig. 30 - On-State Voltage Drop Characteristics



Fig. 33 - Thermal Impedance  $Z_{thJC}$  Characteristics



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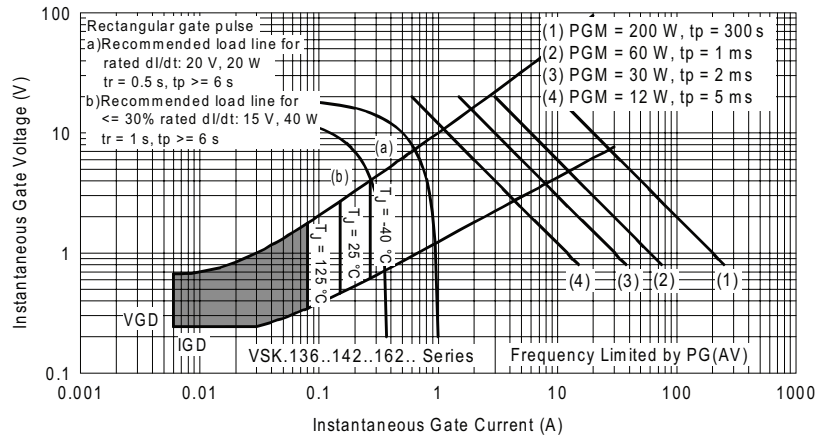


Fig. 34 - Gate Characteristics

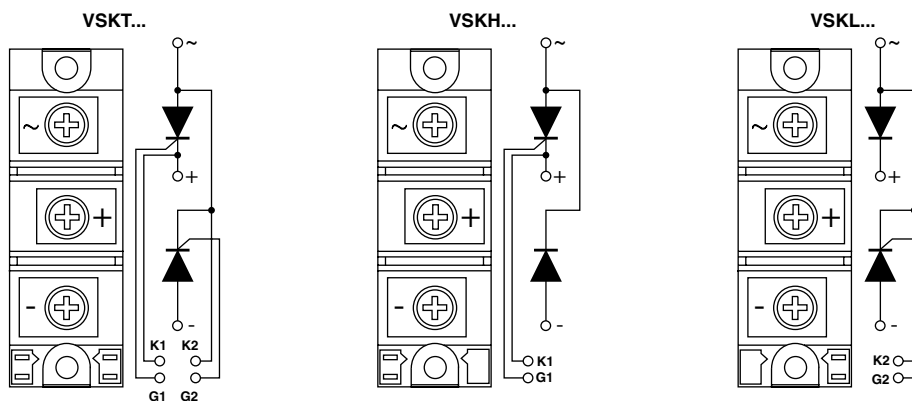
## ORDERING INFORMATION TABLE

Device code	<b>VSK</b>	<b>T</b>	<b>162</b>	<b>/</b>	<b>16</b>	<b>PbF</b>
	①	②	③		④	⑤
	<b>1</b>	-	Module type		<b>2</b>	-
	<b>2</b>	-	Circuit configuration		<b>3</b>	-
	<b>3</b>	-	Current rating: $I_{T(AV)}$		<b>4</b>	-
	<b>4</b>	-	Voltage code x 100 = $V_{RRM}$		<b>5</b>	-
	<b>5</b>	-	PbF = Lead (Pb)-free			

### Note

- To order the optional hardware go to [www.vishay.com/doc?95172](http://www.vishay.com/doc?95172)

## CIRCUIT CONFIGURATION



## LINKS TO RELATED DOCUMENTS

Dimensions

[www.vishay.com/doc?95067](http://www.vishay.com/doc?95067)

## INT-A-PAK IGBT/Thyristor

**DIMENSIONS** in millimeters (inches)





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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А