




## 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 E78996 approved 
- Totally lead (Pb)-free
- Designed and qualified for multiple level



RoHS  
COMPLIANT

### PRODUCT SUMMARY

$I_{T(AV)}$	135 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 <sup>2</sup> s
	60 Hz	47	92.5	108	
$I^2\sqrt{t}$		515.5	1013	1190	kA <sup>2</sup> √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	

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	Sine half wave, initial $T_J = T_J$ maximum	3200	4500		4870	
		t = 8.3 ms			3360	4712		5100	
		t = 10 ms	100% $V_{RRM}$ reapplied		2700	3785		4100	
		t = 8.3 ms			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			47	92.5		108	
		t = 10 ms	100% $V_{RRM}$ reapplied		36.5	71.6		84	
		t = 8.3 ms			33.3	65.4	76.7		
Maximum $I^2\sqrt{t}$ for fusing	$I^2\sqrt{t}$	t = 0.1 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	V
Maximum required DC gate voltage to trigger	$V_{GT}$	$T_J = -40$ °C	Anode supply = 6 V, resistive load; $R_a = 1$ Ω	4	
		$T_J = 25$ °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/μs

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	K/W
Maximum thermal resistance, case to heatsink per module	$R_{thCS}$	Mounting surface, smooth, flat and greased		0.05	
Mounting torque ± 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	g
Case style				New INT-A-PAK	

ΔR 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

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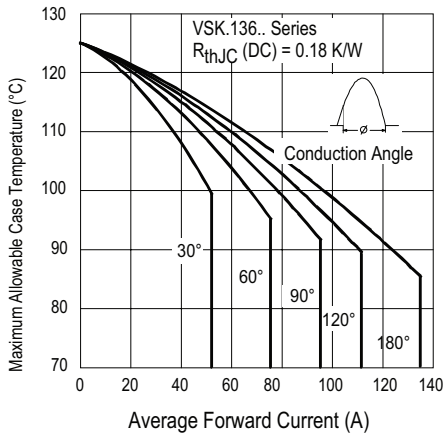


Fig. 1 - Current Ratings Characteristics

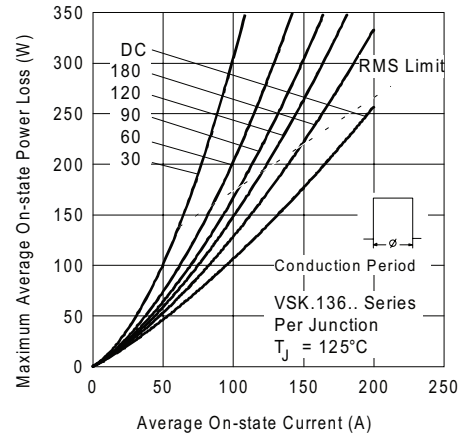


Fig. 4 - On-State Power Loss Characteristics

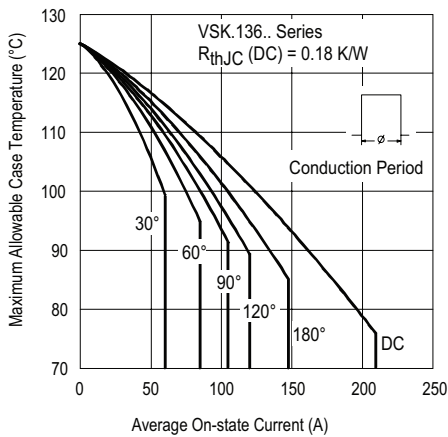


Fig. 2 - Current Ratings Characteristics

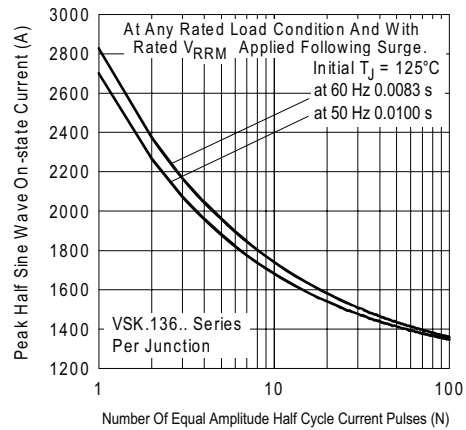


Fig. 5 - Maximum Non-Repetitive Surge Current

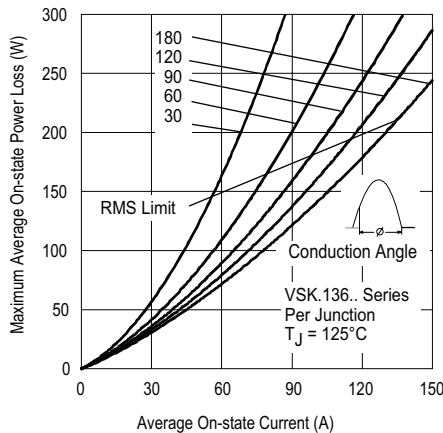


Fig. 3 - On-State Power Loss Characteristics

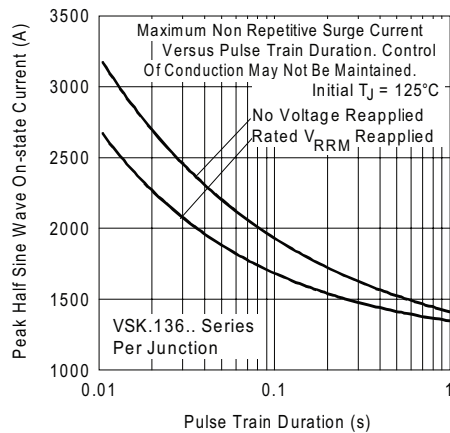


Fig. 6 - Maximum Non-Repetitive Surge Current



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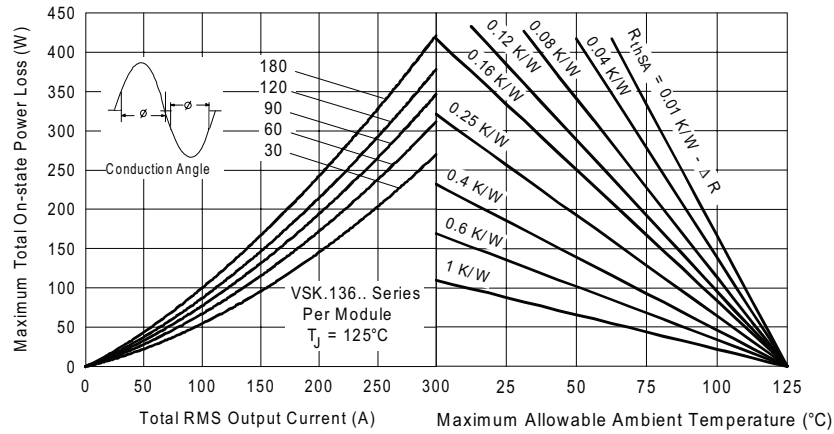


Fig. 7 - On-State Power Loss Characteristics

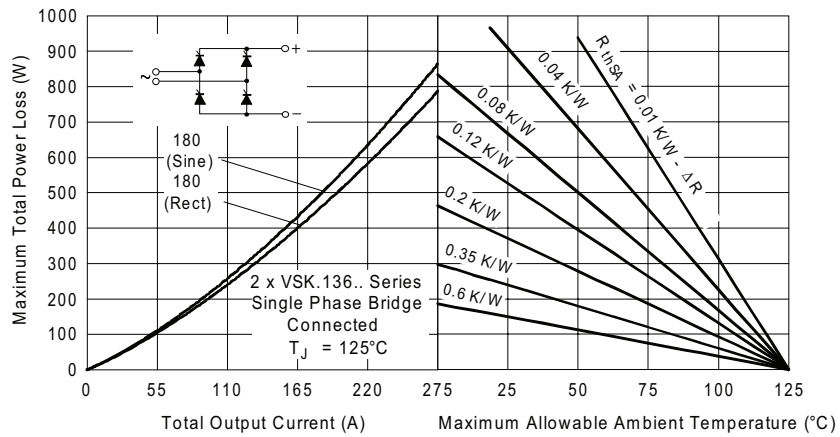


Fig. 8 - On-State Power Loss Characteristics

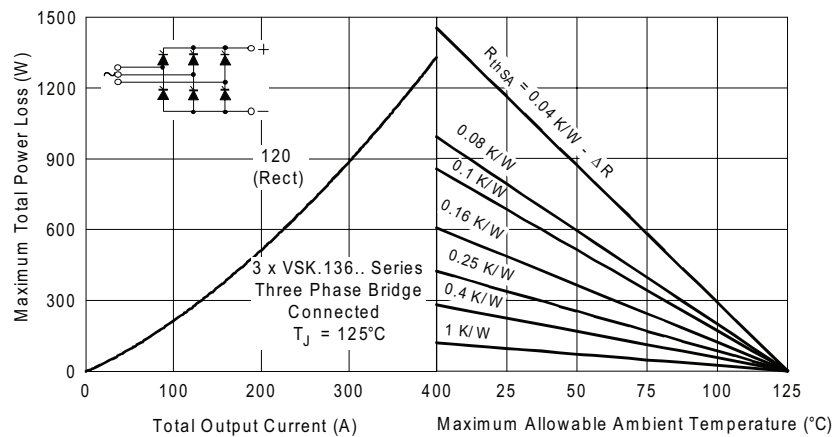


Fig. 9 - On-State Power Loss Characteristics

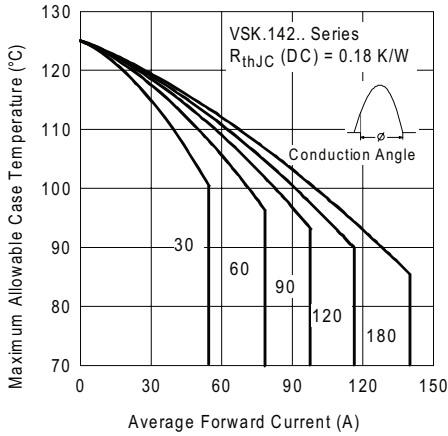


Fig. 10 - Current Ratings Characteristics

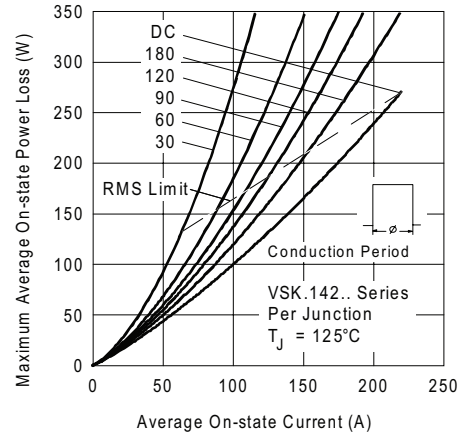


Fig. 13 - On-State Power Loss Characteristics

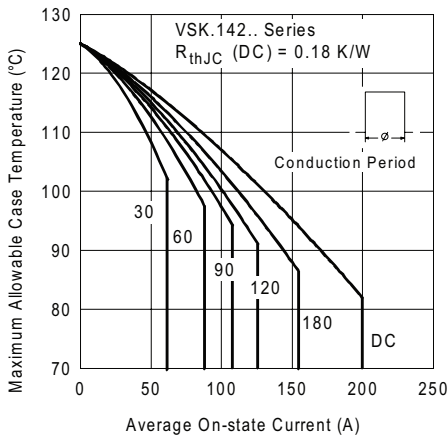


Fig. 11 - Current Ratings Characteristics

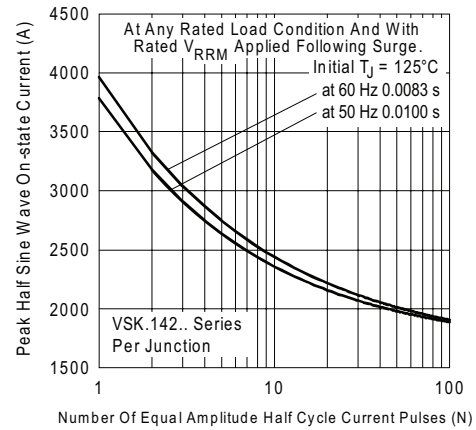


Fig. 14 - Maximum Non-Repetitive Surge Current

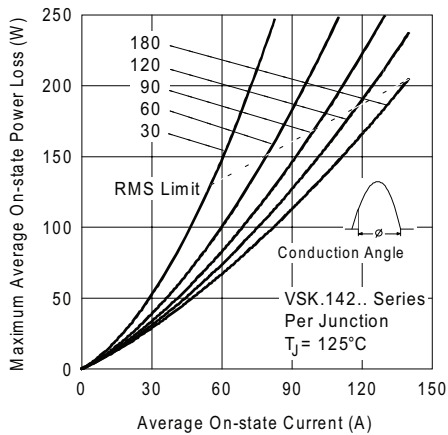


Fig. 12 - On-State Power Loss Characteristics

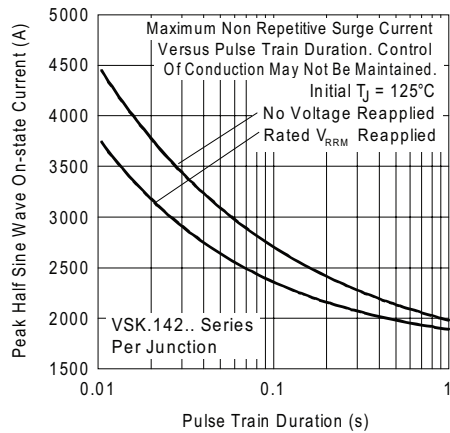


Fig. 15 - Maximum Non-Repetitive Surge Current



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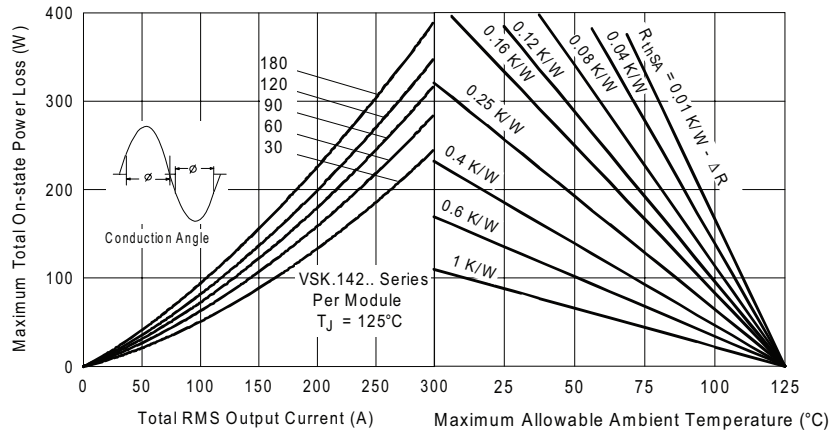


Fig. 16 - On-State Power Loss Characteristics

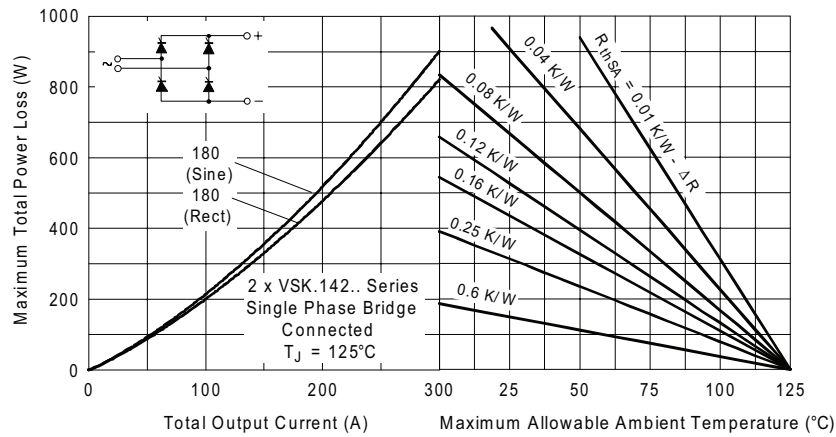


Fig. 17 - On-State Power Loss Characteristics

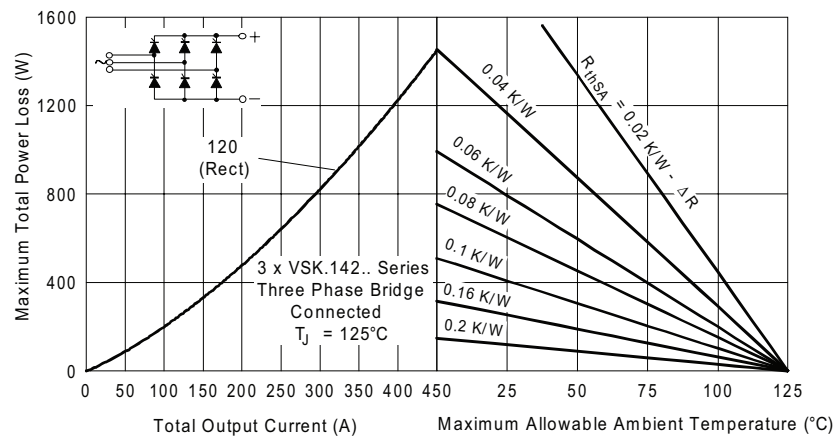


Fig. 18 - On-State Power Loss Characteristics

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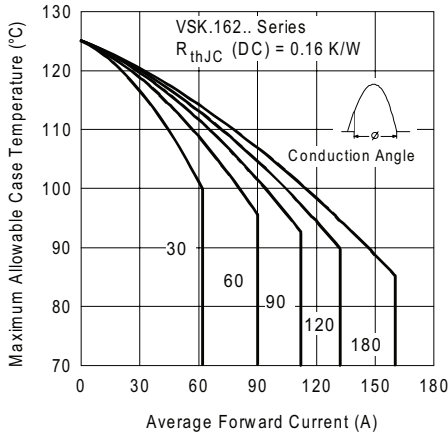


Fig. 19 - Current Ratings Characteristics

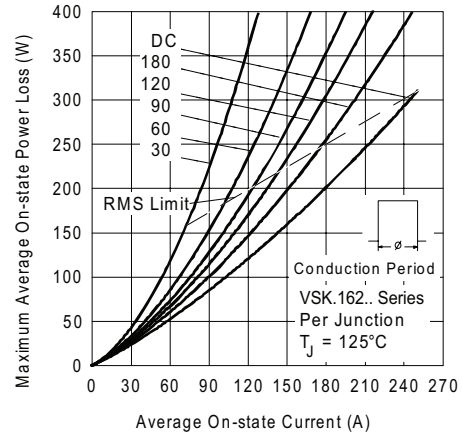


Fig. 22 - On-State Power Loss Characteristics

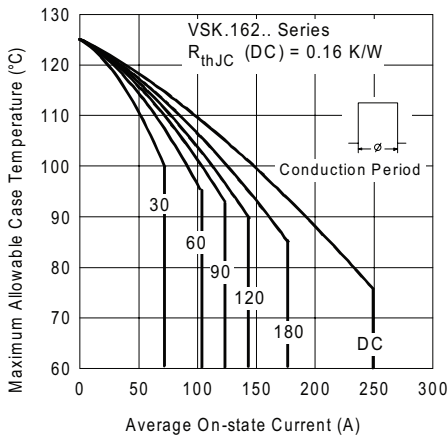


Fig. 20 - Current Ratings Characteristics

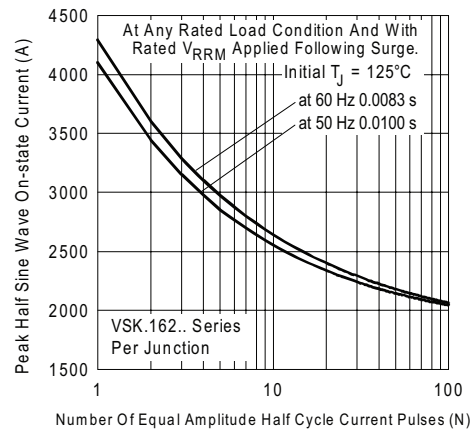


Fig. 23 - Maximum Non-Repetitive Surge Current

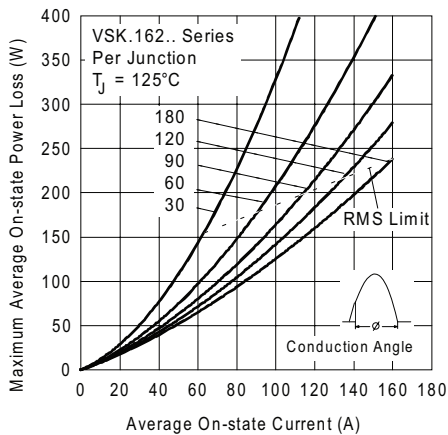


Fig. 21 - On-State Power Loss Characteristics

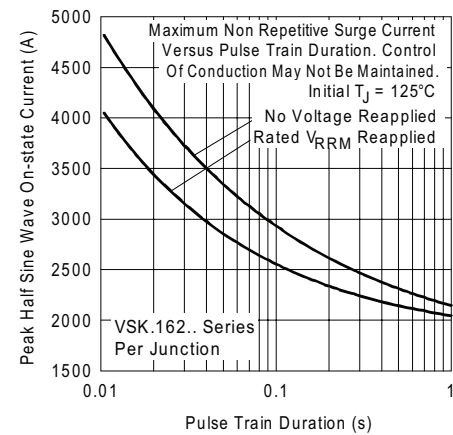


Fig. 24 - Maximum Non-Repetitive Surge Current





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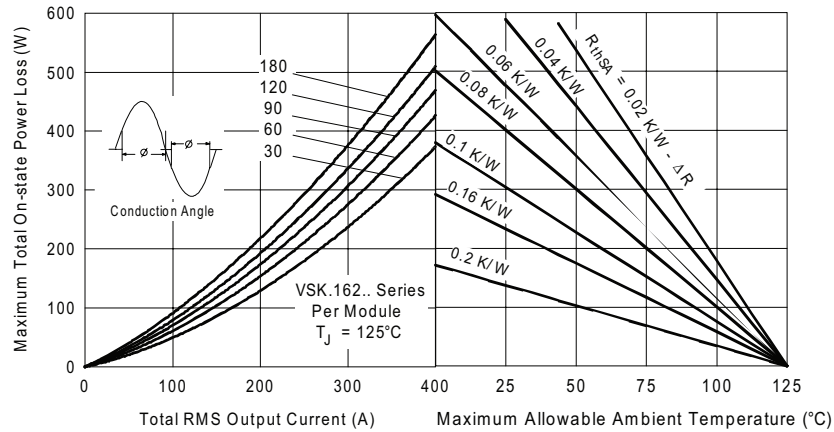


Fig. 25 - On-State Power Loss Characteristics

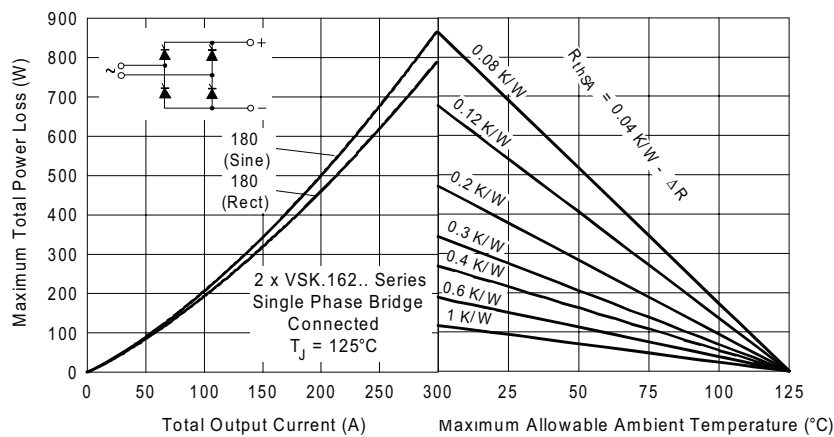


Fig. 26 - On-State Power Loss Characteristics

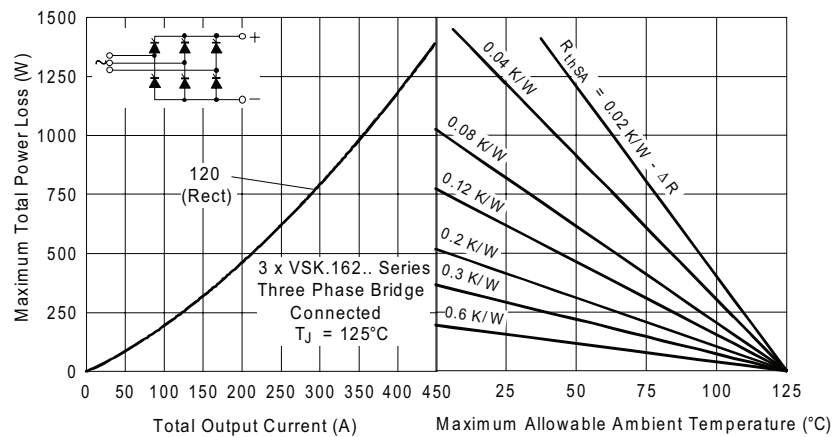


Fig. 27 - On-State Power Loss Characteristics

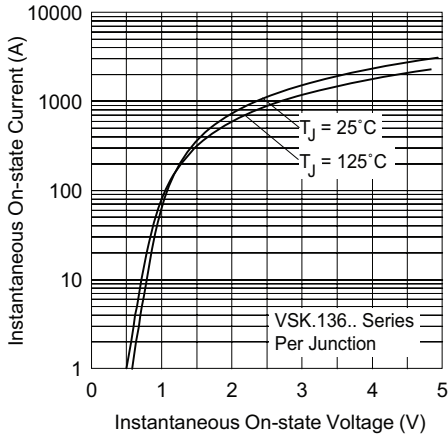


Fig. 28 - On-State Voltage Drop Characteristics

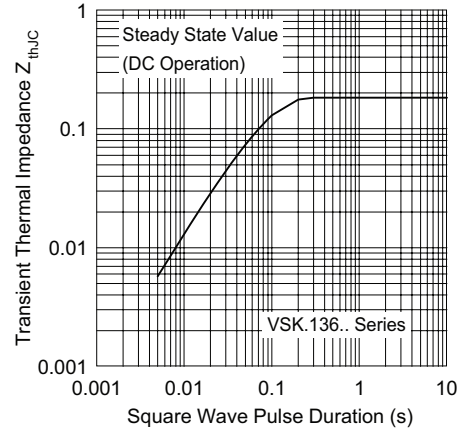


Fig. 31 - Thermal Impedance  $Z_{thJC}$  Characteristics

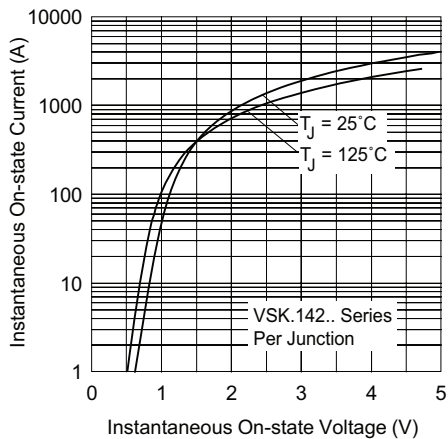


Fig. 29 - On-State Voltage Drop Characteristics

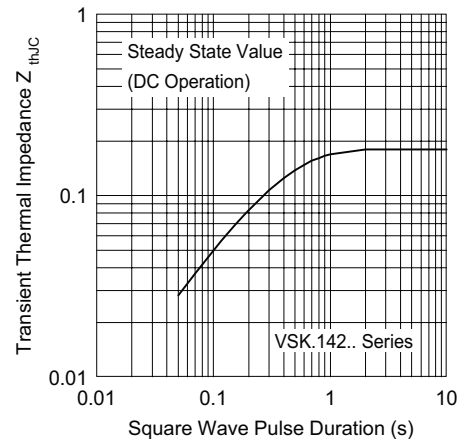


Fig. 32 - Thermal Impedance  $Z_{thJC}$  Characteristics

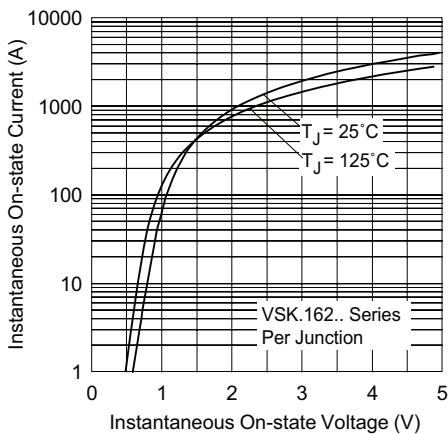


Fig. 30 - On-State Voltage Drop Characteristics

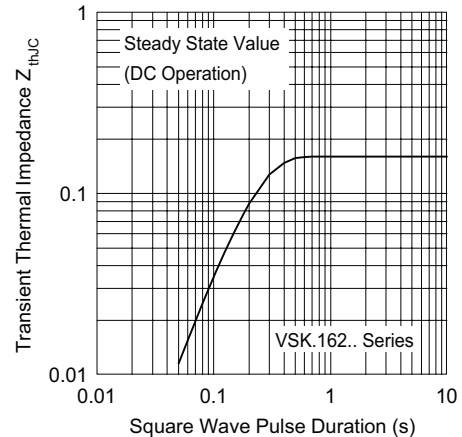


Fig. 33 - Thermal Impedance  $Z_{thJC}$  Characteristics



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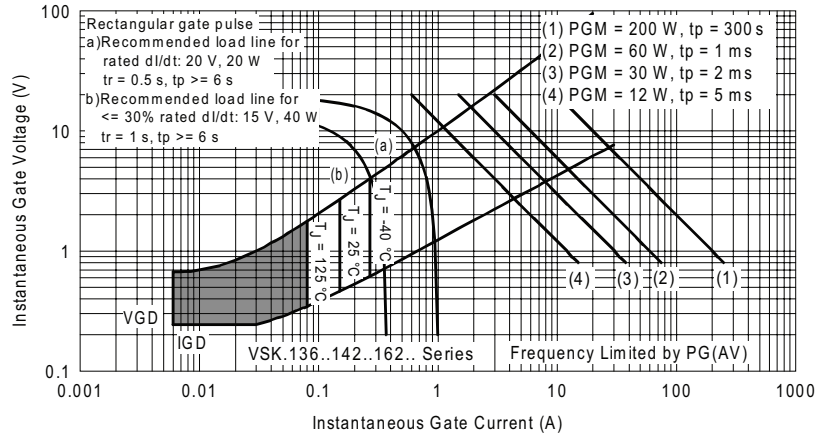


Fig. 34 - Gate Characteristics

## ORDERING INFORMATION TABLE

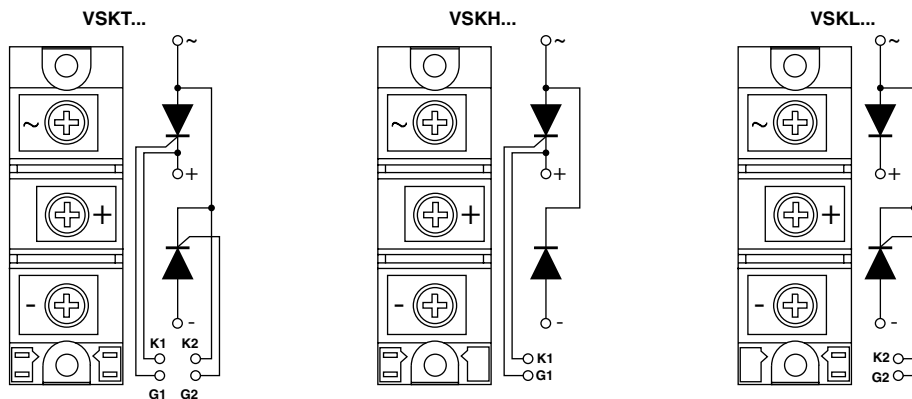
Device code	VSK	T	162	/	16	PbF
	①	②	③		④	⑤
	1	2	3		4	5

- 1 - Module type
- 2 - Circuit configuration
- 3 - Current rating:  $I_{T(AV)}$
- 4 - Voltage code x 100 =  $V_{RRM}$
- 5 - 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

<http://www.vishay.com/doc?95067>



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