



## Phase Control Thyristors (Stud Version), 110 A



TO-94 (TO-209AC)

### FEATURES

- High current and high surge ratings
- Hermetic ceramic housing
- Designed and qualified for industrial level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS  
COMPLIANT

### TYPICAL APPLICATIONS

- DC motor controls
- Controlled DC power supplies
- AC controllers

PRIMARY CHARACTERISTICS	
$I_{T(AV)}$	110 A
$V_{DRM}/V_{RRM}$	400 V, 800 V, 1200 V
$V_{TM}$	1.57 V
$I_{GT}$	80 mA
$T_J$	-40 °C to +140 °C
Package	TO-94 (TO-209AC)
Circuit configuration	Single SCR

MAJOR RATINGS AND CHARACTERISTICS			
PARAMETER	TEST CONDITIONS	VALUES	UNITS
$I_{T(AV)}$		110	A
	$T_C$	90	°C
$I_{T(RMS)}$		172	A
$I_{TSM}$	50 Hz	2080	
	60 Hz	2180	
$I^2t$	50 Hz	21.7	kA <sup>2</sup> s
	60 Hz	19.8	
$V_{DRM}/V_{RRM}$		400 to 1200	V
$t_q$	Typical	110	µs
$T_J$		-40 to +140	°C

### ELECTRICAL SPECIFICATIONS

VOLTAGE RATINGS				
TYPE NUMBER	VOLTAGE CODE	$V_{DRM}/V_{RRM}$ , MAXIMUM REPETITIVE PEAK AND OFF-STATE VOLTAGE V	$V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK VOLTAGE V	$I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM mA
VS-110RKI VS-111RKI	40	400	500	20
	80	800	900	
	120	1200	1300	



ABSOLUTE MAXIMUM RATINGS					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum average on-state current at case temperature	$I_{T(AV)}$	180° conduction, half sine wave		110	A
				90	°C
Maximum RMS on-state current	$I_{T(RMS)}$	DC at 83 °C case temperature		172	
Maximum peak, one-cycle non-repetitive surge current	$I_{TSM}$	t = 10 ms	No voltage reapplied	2080	A
		t = 8.3 ms		2180	
		t = 10 ms	100 % $V_{RRM}$ reapplied	1750	
		t = 8.3 ms		1830	
Maximum $I^2t$ for fusing	$I^2t$	t = 10 ms	No voltage reapplied	21.7	kA <sup>2</sup> s
		t = 8.3 ms		19.8	
		t = 10 ms	100 % $V_{RRM}$ reapplied	15.3	
		t = 8.3 ms		14.0	
Maximum $I^2\sqrt{t}$ for fusing	$I^2\sqrt{t}$	t = 0.1 ms to 10 ms, no voltage reapplied		217	kA <sup>2</sup> √s
Low level value of threshold voltage	$V_{T(TO)1}$	(16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)		0.82	V
High level value of threshold voltage	$V_{T(TO)2}$	(I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)		1.02	
Low level value of on-state slope resistance	$r_{t1}$	(16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)		2.16	mΩ
High level value of on-state slope resistance	$r_{t2}$	(I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)		1.70	
Maximum on-state voltage	$V_{TM}$	$I_{pk} = 350$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse		1.57	V
Maximum holding current	$I_H$	$T_J = 25$ °C, anode supply 6 V resistive load		200	mA
Typical latching current	$I_L$			400	

SWITCHING					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum non-repetitive rate of rise of turned-on current	$di/dt$	Gate drive 20 V, 20 Ω, $t_r \leq 1$ μs $T_J = T_J$ maximum, anode voltage $\leq 80$ % $V_{DRM}$		300	A/μs
Typical delay time	$t_d$	Gate current 1 A, $di_g/dt = 1$ A/μs $V_d = 0.67$ % $V_{DRM}$ , $T_J = 25$ °C		1	μs
Typical turn-off time	$t_q$	$I_{TM} = 50$ A, $T_J = T_J$ maximum, $di/dt = -5$ A/μs $V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 25 Ω		110	

BLOCKING					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum critical rate of rise of off-state voltage	$dV/dt$	$T_J = T_J$ maximum linear to 80 % rated $V_{DRM}$		500	V/μs
Maximum peak reverse and off-state leakage current	$I_{RRM}, I_{DRM}$	$T_J = T_J$ maximum rated $V_{DRM}/V_{RRM}$ applied		20	mA



TRIGGERING						
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES		UNITS
				TYP.	MAX.	
Maximum peak gate power	$P_{GM}$	$T_J = T_J$ maximum, $t_p \leq 5$ ms		12		W
Maximum average gate power	$P_{G(AV)}$	$T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$		3.0		
Maximum peak positive gate current	$I_{GM}$	$T_J = T_J$ maximum, $t_p \leq 5$ ms		3.0		A
Maximum peak positive gate voltage	$+V_{GM}$			20		V
Maximum peak negative gate voltage	$-V_{GM}$			10		
DC gate current required to trigger	$I_{GT}$	$T_J = -40$ °C	Maximum required gate trigger/current/voltage are the lowest value which will trigger all units 12 V anode to cathode applied	180	-	mA
		$T_J = 25$ °C		80	120	
		$T_J = 140$ °C		40	-	
DC gate voltage required to trigger	$V_{GT}$	$T_J = -40$ °C		2.5	-	V
		$T_J = 25$ °C		1.6	2	
		$T_J = 140$ °C		1	-	
DC gate current not to trigger	$I_{GD}$	$T_J = T_J$ maximum		6.0		mA
DC gate voltage not to trigger	$V_{GD}$			0.25		V

THERMAL AND MECHANICAL SPECIFICATIONS				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Maximum operating junction temperature range	$T_J$		-40 to +140	°C
Maximum storage temperature range	$T_{Stg}$		-40 to +150	
Maximum thermal resistance, junction to case	$R_{thJC}$	DC operation	0.27	K/W
Maximum thermal resistance, case to heatsink	$R_{thCS}$	Mounting surface, smooth, flat and greased	0.1	
Mounting torque, $\pm 10$ %		Non-lubricated threads	15.5 (137)	N · m (lbf · in)
		Lubricated threads	14 (120)	
Approximate weight			130	g
Case style		See dimensions - link at the end of datasheet	TO-94 (TO-209AC)	

$\Delta R_{thJC}$ CONDUCTION				
CONDUCTION ANGLE	SINUSOIDAL CONDUCTION	RECTANGULAR CONDUCTION	TEST CONDITIONS	UNITS
180°	0.043	0.031	$T_J = T_J$ maximum	K/W
120°	0.052	0.053		
90°	0.066	0.071		
60°	0.096	0.101		
30°	0.167	0.169		

**Note**

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

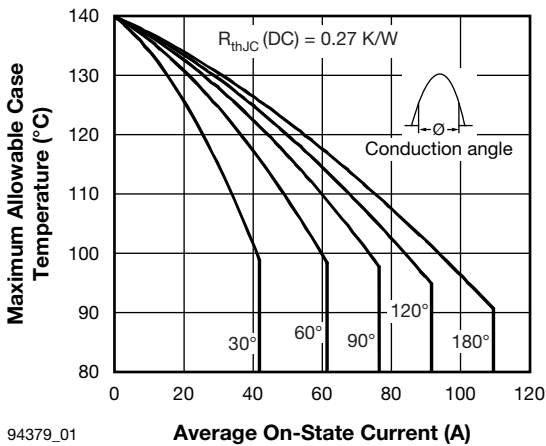


Fig. 1 - Current Ratings Characteristics

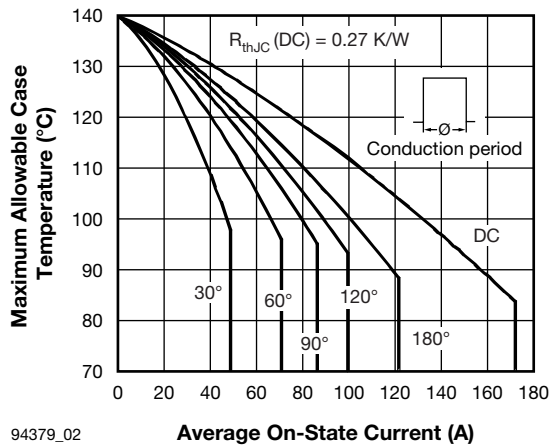


Fig. 2 - Current Ratings Characteristics

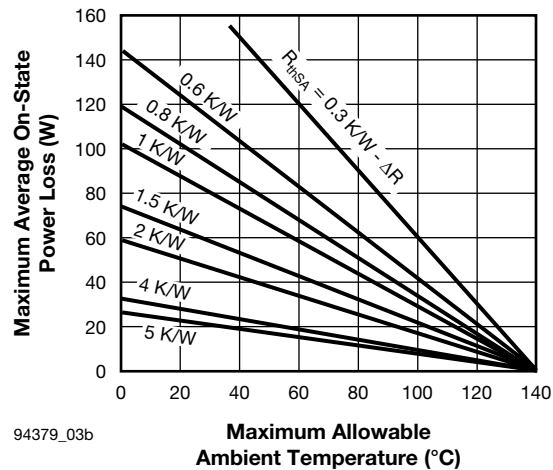
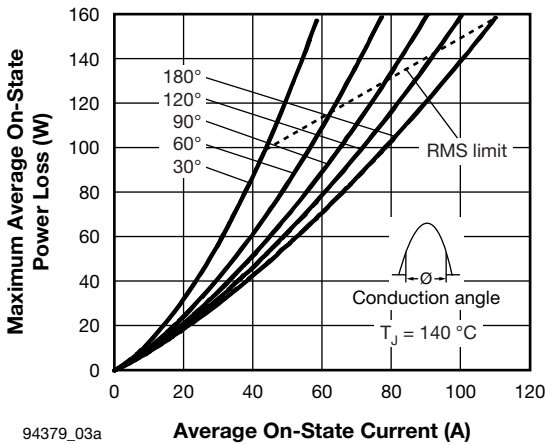


Fig. 3 - On-State Power Loss Characteristics

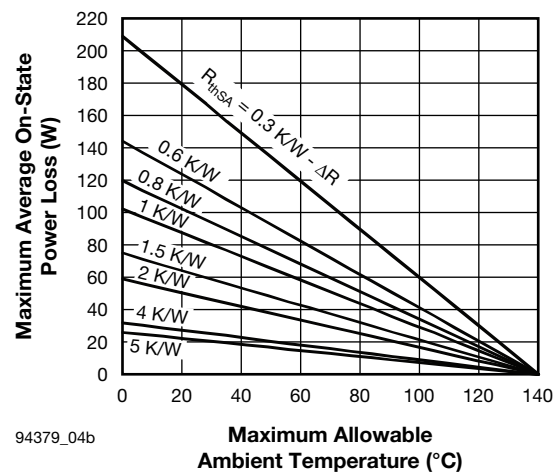
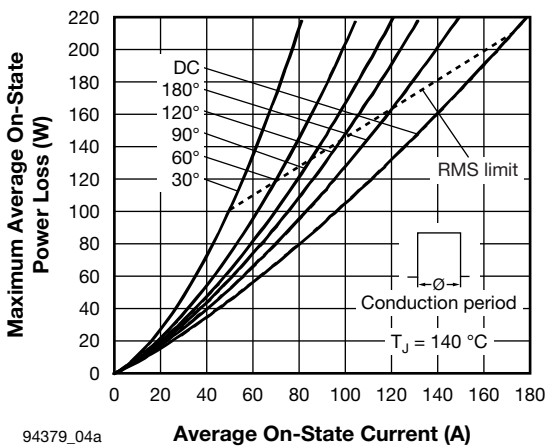


Fig. 4 - On-State Power Loss Characteristics

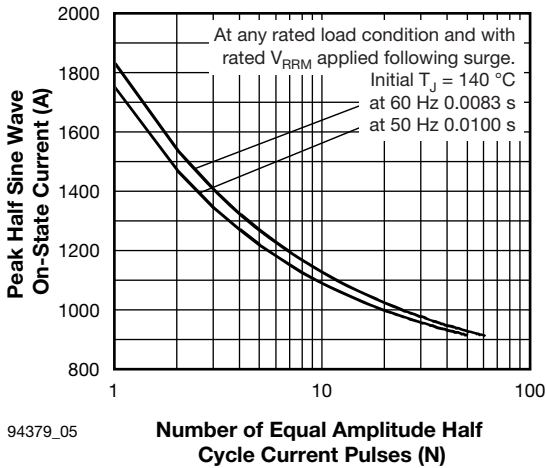


Fig. 5 - Maximum Non-Repetitive Surge Current

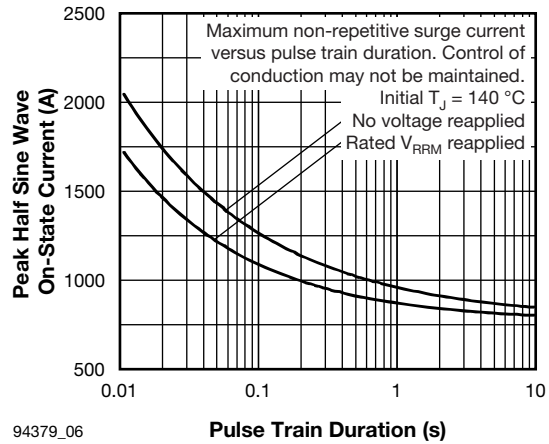


Fig. 6 - Maximum Non-Repetitive Surge Current



Fig. 7 - On-State Voltage Drop Characteristics

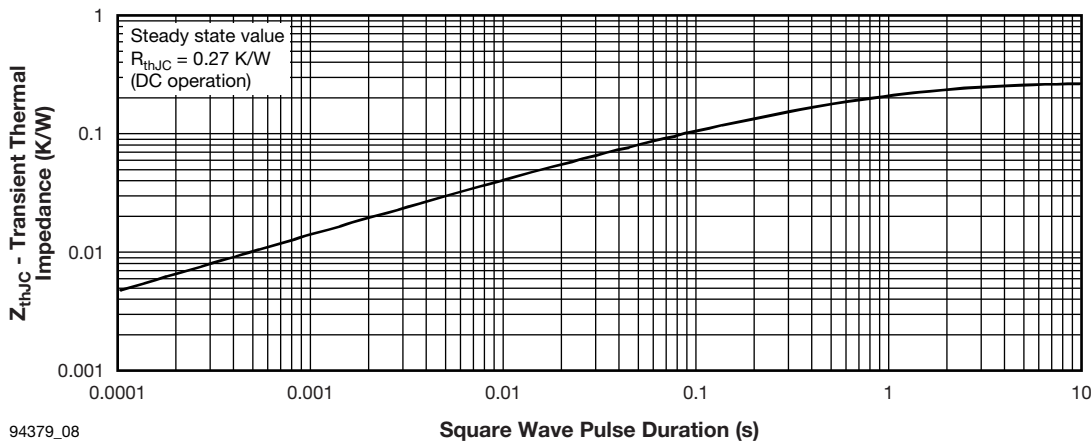


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic



94379\_09

Fig. 9 - Gate Characteristics

**ORDERING INFORMATION TABLE**

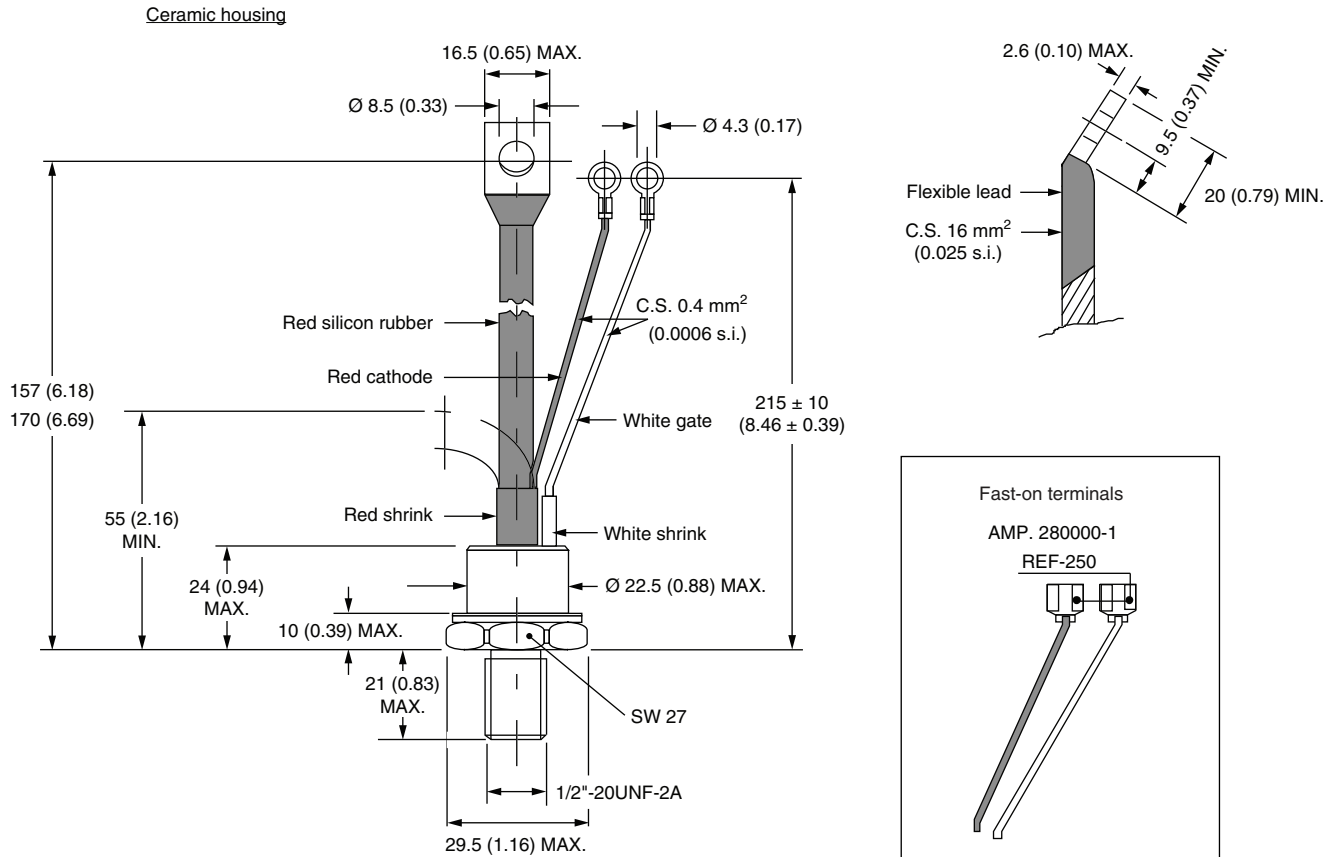
Device code	<b>VS-</b>	<b>11</b>	<b>0</b>	<b>RKI</b>	<b>120</b>	<b>M</b>	<b>PbF</b>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

- 1** - Vishay Semiconductors product
- 2** -  $I_{T(AV)}$  rated average output current (rounded/10)
- 3** -
  - 0 = eyelet terminals (gate and auxiliary cathode leads)
  - 1 = fast-on terminals (gate and auxiliary cathode leads)
- 4** - Thyristor
- 5** - Voltage code x 10 =  $V_{RRM}$  (see Voltage Ratings table)
- 6** -
  - None = stud base 1/2"-20UNF-2A threads
  - M = stud base metric threads M12 x 1.75 E 6
- 7** -
  - None = standard production
  - PbF = lead (Pb)-free

LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95003">www.vishay.com/doc?95003</a>

## TO-209AC (TO-94) for 110RKI and 111RKI Series

**DIMENSIONS** in millimeters (inches)



**Note**

- For metric device: M12 x 1.75 contact factory



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