

## Phase Control Thyristors (Stud Version), 230 A



TO-209AB (TO-93)

### FEATURES

- Center amplifying gate
- International standard case TO-209AB (TO-93)
- Hermetic metal case with ceramic insulator (Also available with glass-metal seal up to 1200 V)
- Compression bonded encapsulation for heavy duty operations such as severe thermal cycling
- 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

### PRODUCT SUMMARY

$I_{T(AV)}$	230 A
$V_{DRM}/V_{RRM}$	400 V, 1600 V
$V_{TM}$	1.55 V
$I_{GT}$	150 mA
$T_J$	-40 °C to 125 °C
Package	TO-209AB (TO-93)
Diode variation	Single SCR

### TYPICAL APPLICATIONS

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

### MAJOR RATINGS AND CHARACTERISTICS

PARAMETER	TEST CONDITIONS	VALUES	UNITS
$I_{T(AV)}$		230	A
	$T_C$	85	°C
$I_{T(RMS)}$		360	A
$I_{TSM}$	50 Hz	5700	A
	60 Hz	5970	
$I^2t$	50 Hz	163	kA <sup>2</sup> s
	60 Hz	149	
$V_{DRM}/V_{RRM}$		400 to 1600	V
$t_q$	Typical	100	μs
$T_J$		-40 to 125	°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-ST230S	04	400	500	30
	08	800	900	
	12	1200	1300	
	16	1600	1700	



ABSOLUTE MAXIMUM RATINGS						
PARAMETER	SYMBOL	TEST CONDITIONS			VALUES	UNITS
Maximum average on-state current at case temperature	I <sub>T(AV)</sub>	180° conduction, half sine wave			230	A
					85	°C
Maximum RMS on-state current	I <sub>T(RMS)</sub>	DC at 78 °C case temperature			360	A
Maximum peak, one-cycle non-repetitive surge current	I <sub>TSM</sub>	t = 10 ms	No voltage reapplied	Sinusoidal half wave, initial T <sub>J</sub> = T <sub>J</sub> maximum	5700	
		t = 8.3 ms			5970	
		t = 10 ms	100 % V <sub>RRM</sub>		4800	
		t = 8.3 ms	reapplied		5000	
Maximum I <sup>2</sup> t for fusing	I <sup>2</sup> t	t = 10 ms	No voltage reapplied		163	kA <sup>2</sup> s
		t = 8.3 ms			148	
		t = 10 ms	100 % V <sub>RRM</sub>		115	
		t = 8.3 ms	reapplied		105	
Maximum I <sup>2</sup> √t for fusing	I <sup>2</sup> √t	t = 0.1 to 10 ms, no voltage reapplied			1630	kA <sup>2</sup> √s
Low level value of threshold voltage	V <sub>T(TO)1</sub>	(16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum			0.92	V
High level value of threshold voltage	V <sub>T(TO)2</sub>	(I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum			0.98	
Low level value of on-state slope resistance	r <sub>t1</sub>	(16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum			0.88	mΩ
High level value of on-state slope resistance	r <sub>t2</sub>	(I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum			0.81	
Maximum on-state voltage	V <sub>TM</sub>	I <sub>pk</sub> = 720 A, T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> = 10 ms sine pulse			1.55	V
Maximum holding current	I <sub>H</sub>	T <sub>J</sub> = 25 °C, anode supply 12 V resistive load			600	mA
Maximum (typical) latching current	I <sub>L</sub>				1000 (300)	

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 $\leq 80$ % $V_{DRM}$	1000	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	1.0	μs
Typical turn-off time	$t_q$	$I_{TM} = 300$ A, $T_J = T_J$ maximum, $dI_F/dt = 20$ A/μs, $V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 100 Ω, $t_p = 500$ μs	100	

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	30	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	10.0		W
Maximum average gate power	$P_{G(AV)}$	$T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$	2.0		
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	$+V_{GM}$	$T_J = T_J$ maximum, $t_p \leq 5$ ms	20		V
Maximum peak negative gate voltage	$-V_{GM}$		5.0		
DC gate current required to trigger	$I_{GT}$	$T_J = -40$ °C	180	-	mA
		$T_J = 25$ °C	90	150	
		$T_J = 125$ °C	40	-	
DC gate voltage required to trigger	$V_{GT}$	$T_J = -40$ °C	2.9	-	V
		$T_J = 25$ °C	1.8	3.0	
		$T_J = 125$ °C	1.2	-	
DC gate current not to trigger	$I_{GD}$	$T_J = T_J$ maximum	10		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 125	°C
Maximum storage temperature range	$T_{Stg}$		-40 to 150	
Maximum thermal resistance, junction to case	$R_{thJC}$	DC operation	0.10	K/W
Maximum thermal resistance, case to heatsink	$R_{thC-hs}$	Mounting surface, smooth, flat and greased	0.04	
Mounting torque, $\pm 10$ %		Non-lubricated threads	31 (275)	N · m (lbf · in)
		Lubricated threads	24.5 (210)	
Approximate weight			280	g
Case style		See dimensions - link at the end of datasheet	TO-209AB (TO-93)	

$\Delta R_{thJC}$ CONDUCTION				
CONDUCTION ANGLE	SINUSOIDAL CONDUCTION	RECTANGULAR CONDUCTION	TEST CONDITIONS	UNITS
180°	0.016	0.012	$T_J = T_J$ maximum	K/W
120°	0.019	0.020		
90°	0.025	0.027		
60°	0.036	0.037		
30°	0.060	0.060		

**Note**

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

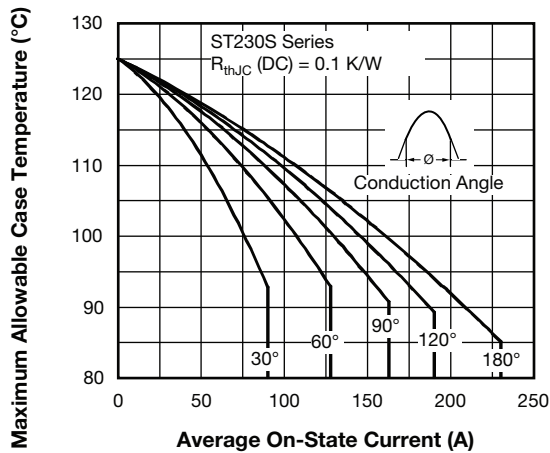


Fig. 1 - Current Ratings Characteristics

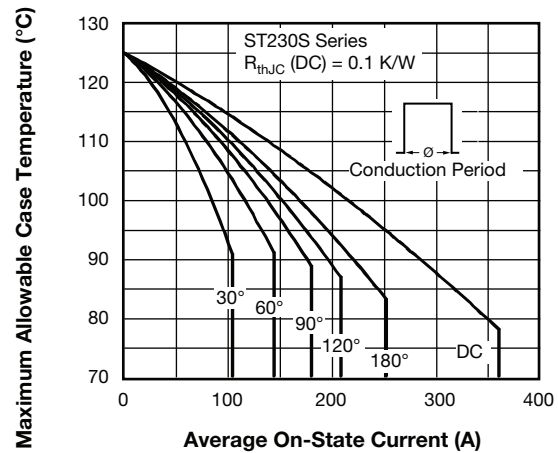


Fig. 2 - Current Ratings Characteristics

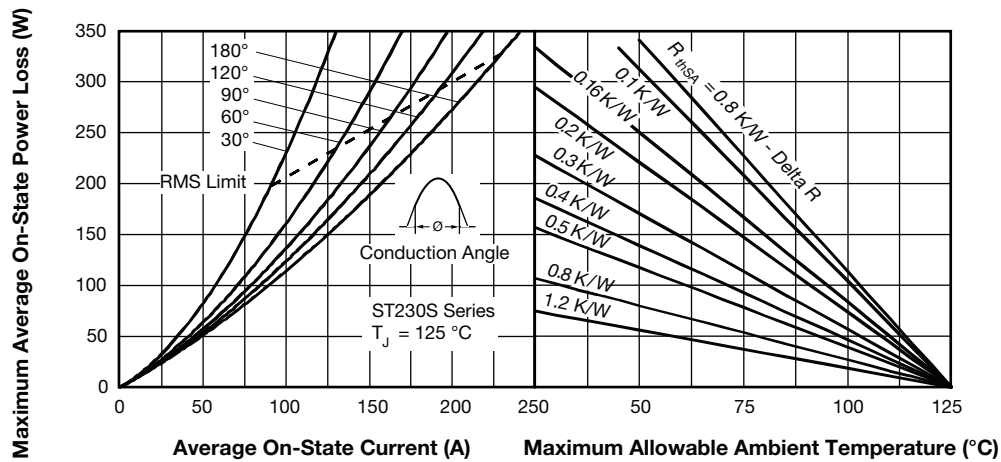


Fig. 3 - On-State Power Loss Characteristics

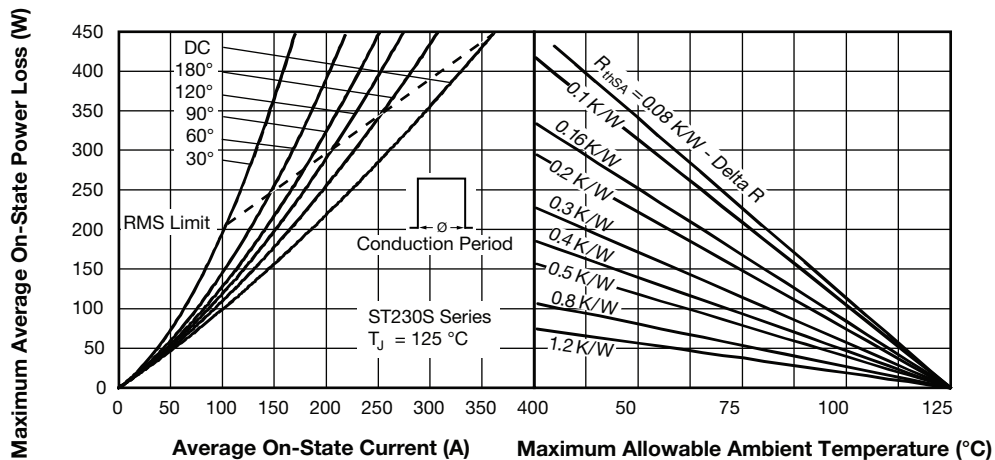


Fig. 4 - On-State Power Loss Characteristics

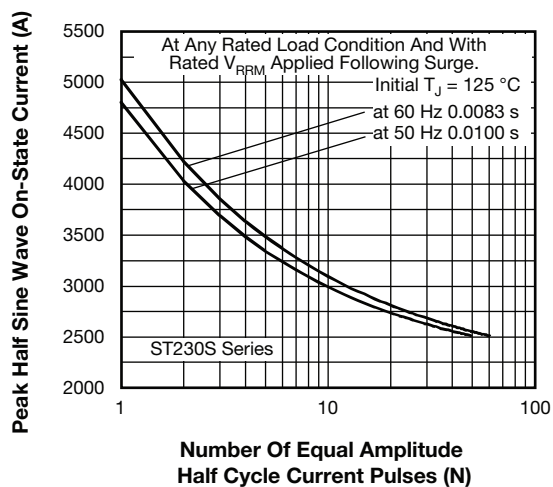


Fig. 5 - Maximum Non-Repetitive Surge Current

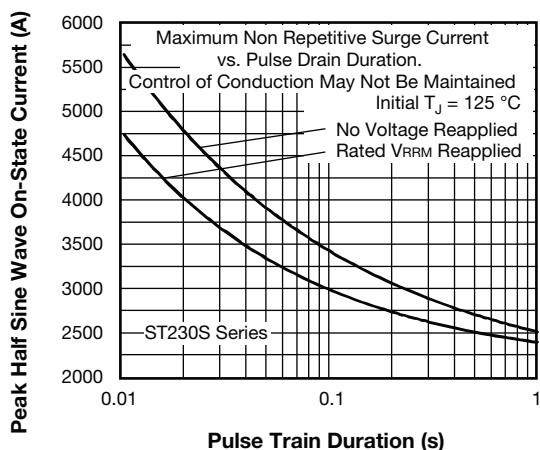


Fig. 6 - Maximum Non-Repetitive Surge Current

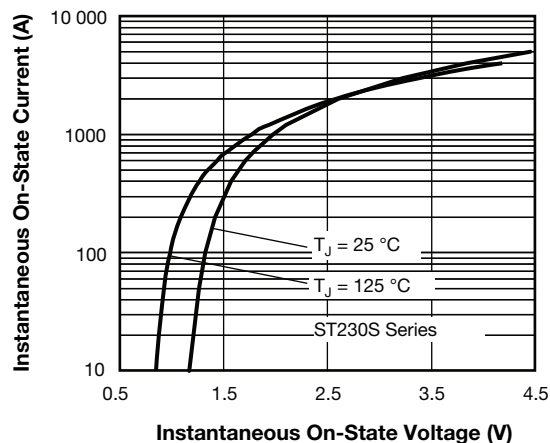
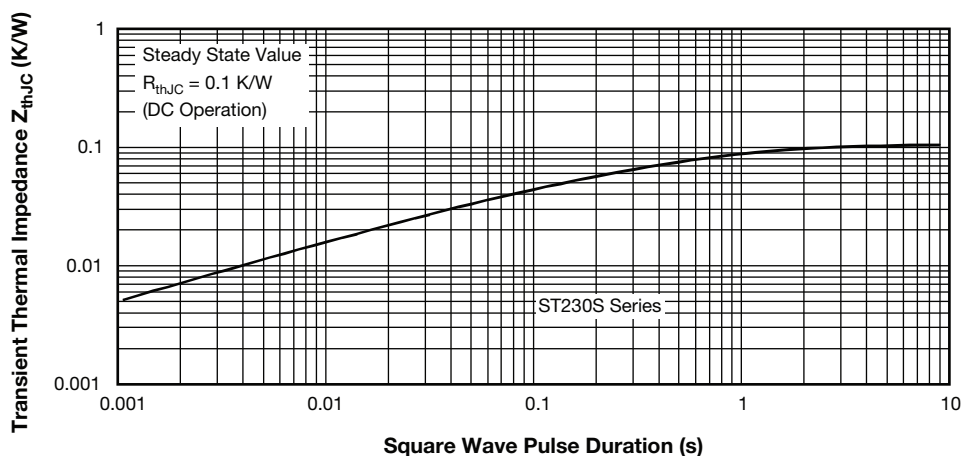


Fig. 7 - On-State Voltage Drop Characteristics


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

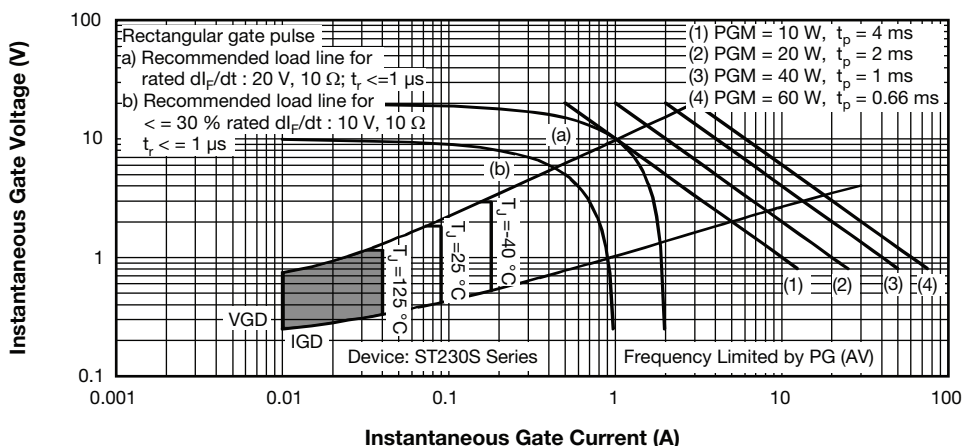


Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

Device code

VS-	ST	23	0	S	16	P	0	V	PbF
1	2	3	4	5	6	7	8	9	10

- 1 - Vishay Semiconductors product
- 2 - Thyristor
- 3 - Essential part number
- 4 - 0 = Converter grade
- 5 - S = Compression bonding stud
- 6 - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7 - P = Stud base 3/4"-16UNF2A threads
- 8 - 0 = Eyelet terminals (gate and auxiliary cathode leads)  
1 = Fast-on terminals (gate and auxiliary cathode leads)
- 9 - • V = Glass-metal seal (only up to 1200 V)  
• None = Ceramic housing (over 1200 V)
- 10 - None = Standard production  
PbF = Lead (Pb)-free

Note: For metric device M16 x 1.5 contact factory

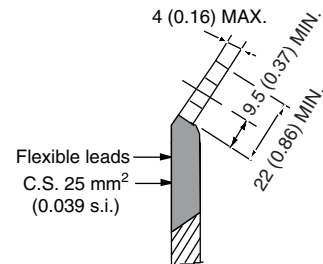
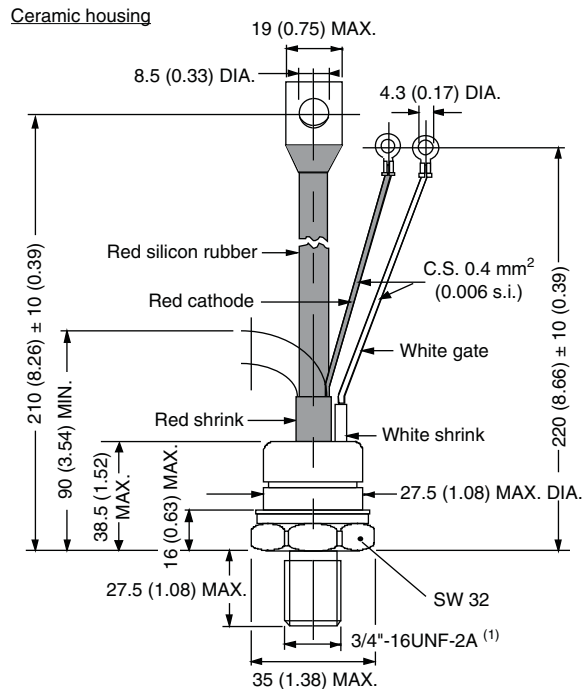
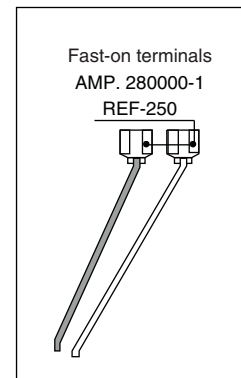
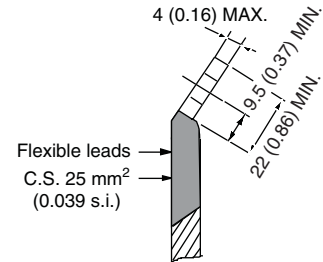
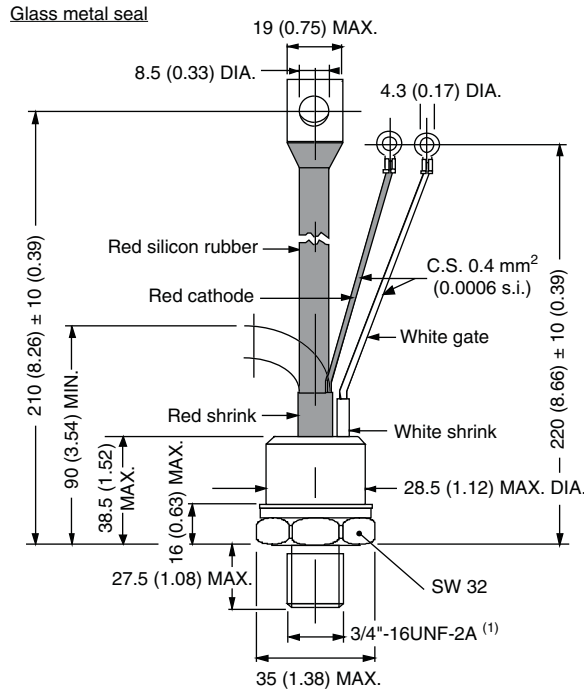
## LINKS TO RELATED DOCUMENTS

Dimensions

[www.vishay.com/doc?95082](http://www.vishay.com/doc?95082)

### TO-209AB (TO-93)

**DIMENSIONS** in millimeters (inches)



#### Note

<sup>(1)</sup> For metric device: M16 x 1.5 - length 21 (0.83) maximum



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