

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



TO-94 (TO-209AC)


**RoHS  
COMPLIANT**
**FEATURES**

- Center gate
- International standard case TO-94 (TO-209AC)
- Compression bonded encapsulation for heavy duty operations such as severe thermal cycling
- Hermetic glass-metal case with ceramic insulator (Glass-metal seal over 1200 V)
- 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)

**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, 1600 V
$V_{TM}$	1.52 V
$I_{GT}$	150 mA
$T_J$	-40 °C to +125 °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
$I_{T(RMS)}$		175	A
	50 Hz	2700	
$I_{TSM}$	60 Hz	2830	kA <sup>2</sup> s
	50 Hz	36.4	
$I^2t$	60 Hz	33.2	V
		400 to 1600	
$V_{DRM}/V_{RRM}$		100	μs
$t_q$	Typical		°C
$T_J$		-40 to +125	

**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-ST110S	04	400	500	20
	08	800	900	
	12	1200	1300	
	16	1600	1700	



<b>ABSOLUTE MAXIMUM RATINGS</b>					
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 85 °C case temperature		175	
Maximum peak, one-cycle non-repetitive surge current	$I_{TSM}$	t = 10 ms	No voltage reappplied	2700	A
		t = 8.3 ms		100 % $V_{RRM}$ reappplied	
		t = 10 ms	Sinusoidal half wave, initial $T_J = T_J$ maximum		
		t = 8.3 ms		2380	
Maximum $I^2t$ for fusing	$I^2t$	t = 10 ms	No voltage reappplied	36.4	kA <sup>2</sup> s
		t = 8.3 ms		100 % $V_{RRM}$ reappplied	
		t = 10 ms	25.8		
		t = 8.3 ms	23.5		
Maximum $I^2\sqrt{t}$ for fusing	$I^2\sqrt{t}$	t = 0.1 to 10 ms, no voltage reappplied		364	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		0.90	V
High level value of threshold voltage	$V_{T(TO)2}$	(I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum		0.92	
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		1.79	mΩ
High level value of on-state slope resistance	$r_{t2}$	(I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum		1.81	
Maximum on-state voltage	$V_{TM}$	$I_{pk} = 350$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse		1.52	V
Maximum holding current	$I_H$	$T_J = 25$ °C, anode supply 12 V resistive load		600	mA
Typical latching current	$I_L$			1000	

<b>SWITCHING</b>					
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 $\leq 80$ % $V_{DRM}$		500	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		2.0	μs
Typical turn-off time	$t_q$	$I_{TM} = 100$ A, $T_J = T_J$ maximum, $dI/dt = 10$ A/μs, $V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 100 Ω, $t_p = 500$ μs		100	

<b>BLOCKING</b>					
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



<b>TRIGGERING</b>						
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES		UNITS
				TYP.	MAX.	
Maximum peak gate power	$P_{GM}$	$T_J = T_J$ maximum, $t_p \leq 5$ ms		5		W
Maximum average gate power	$P_{G(AV)}$	$T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$		1		
Maximum peak positive gate current	$I_{GM}$	$T_J = T_J$ maximum, $t_p \leq 5$ ms		2.0		A
Maximum peak positive gate voltage	$+V_{GM}$			20		
Maximum peak negative gate voltage	$-V_{GM}$			5.0		
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 6 V anode to cathode applied	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		
				Maximum gate current/voltage not to trigger is the maximum value which will not trigger any unit with rated $V_{DRM}$ anode to cathode applied		

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>				
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	0.195	K/W
Maximum thermal resistance, case to heatsink	$R_{thCS}$	Mounting surface, smooth, flat and greased	0.08	
Mounting torque, $\pm 10$ %		Non-lubricated threads	15.5 (137)	Nm (lbf · in)
		Lubricated threads	14 (120)	
Approximate weight			130	g
Case style		See dimensions - link at the end of datasheet	TO-94 (TO-209AC)	

<b><math>\Delta R_{thJC}</math> CONDUCTION</b>				
CONDUCTION ANGLE	SINUSOIDAL CONDUCTION	RECTANGULAR CONDUCTION	TEST CONDITIONS	UNITS
180°	0.035	0.025	$T_J = T_J$ maximum	K/W
120°	0.041	0.042		
90°	0.052	0.056		
60°	0.076	0.079		
30°	0.126	0.127		

**Note**

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

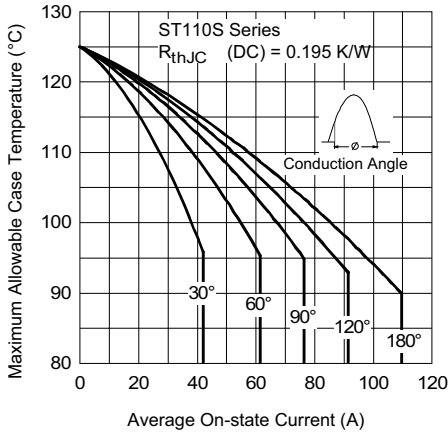


Fig. 1 - Current Ratings Characteristics

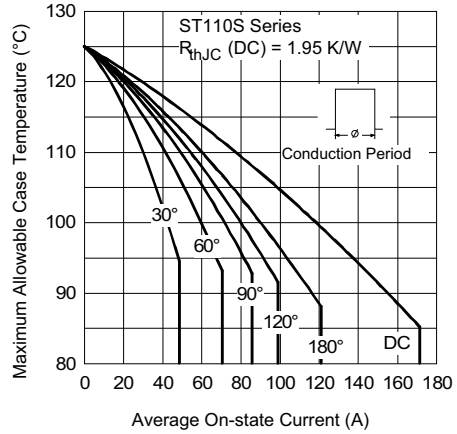


Fig. 2 - Current Ratings Characteristics

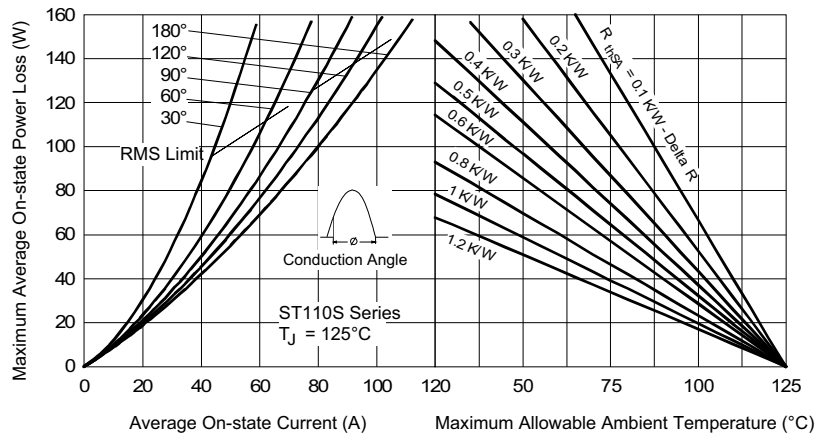


Fig. 3 - On-State Power Loss Characteristics

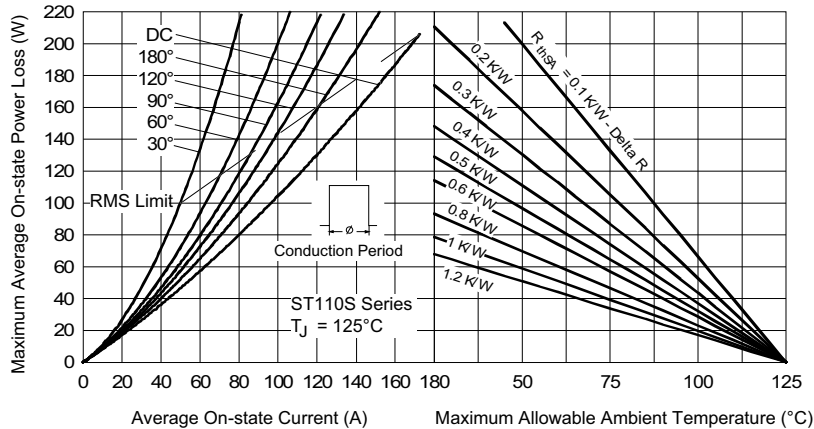


Fig. 4 - On-State Power Loss Characteristics

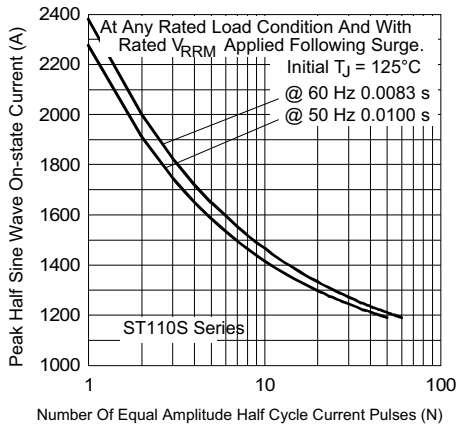


Fig. 5 - Maximum Non-Repetitive Surge Current

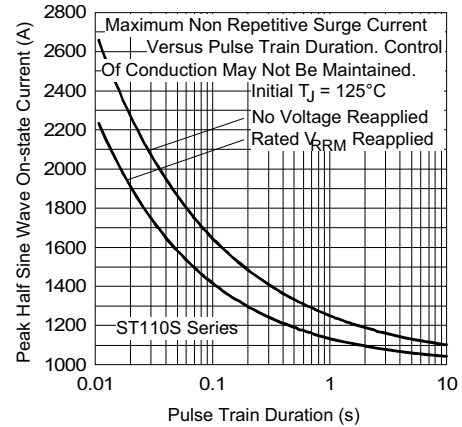


Fig. 6 - Maximum Non-Repetitive Surge Current

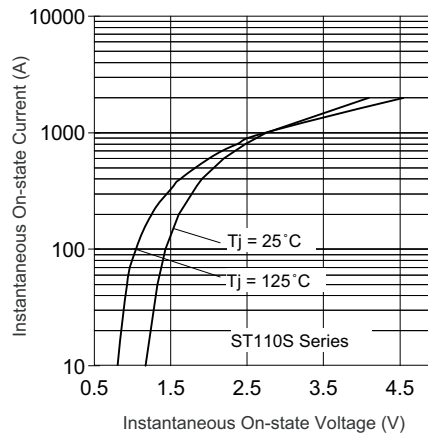


Fig. 7 - On-State Voltage Drop Characteristics

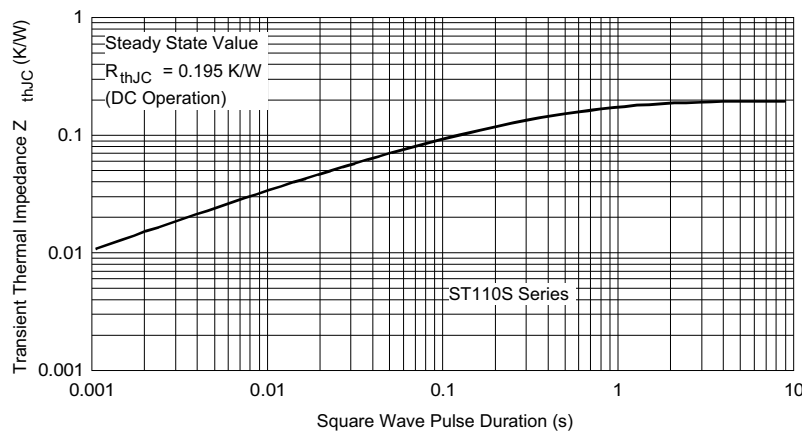


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic

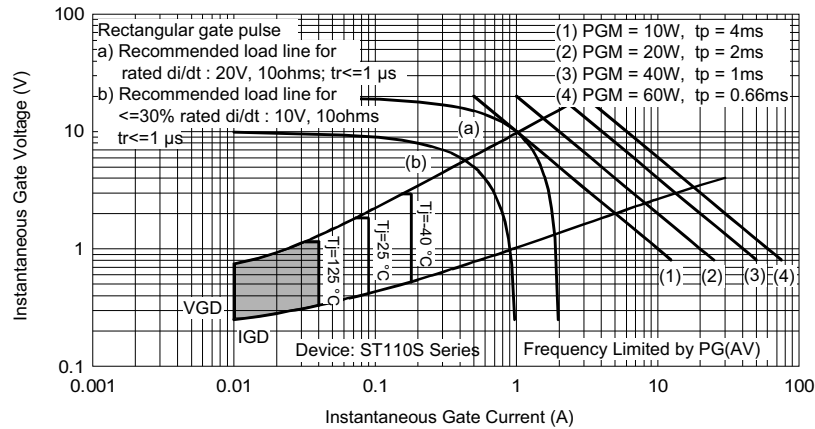


Fig. 9 - Gate Characteristics

**ORDERING INFORMATION TABLE**

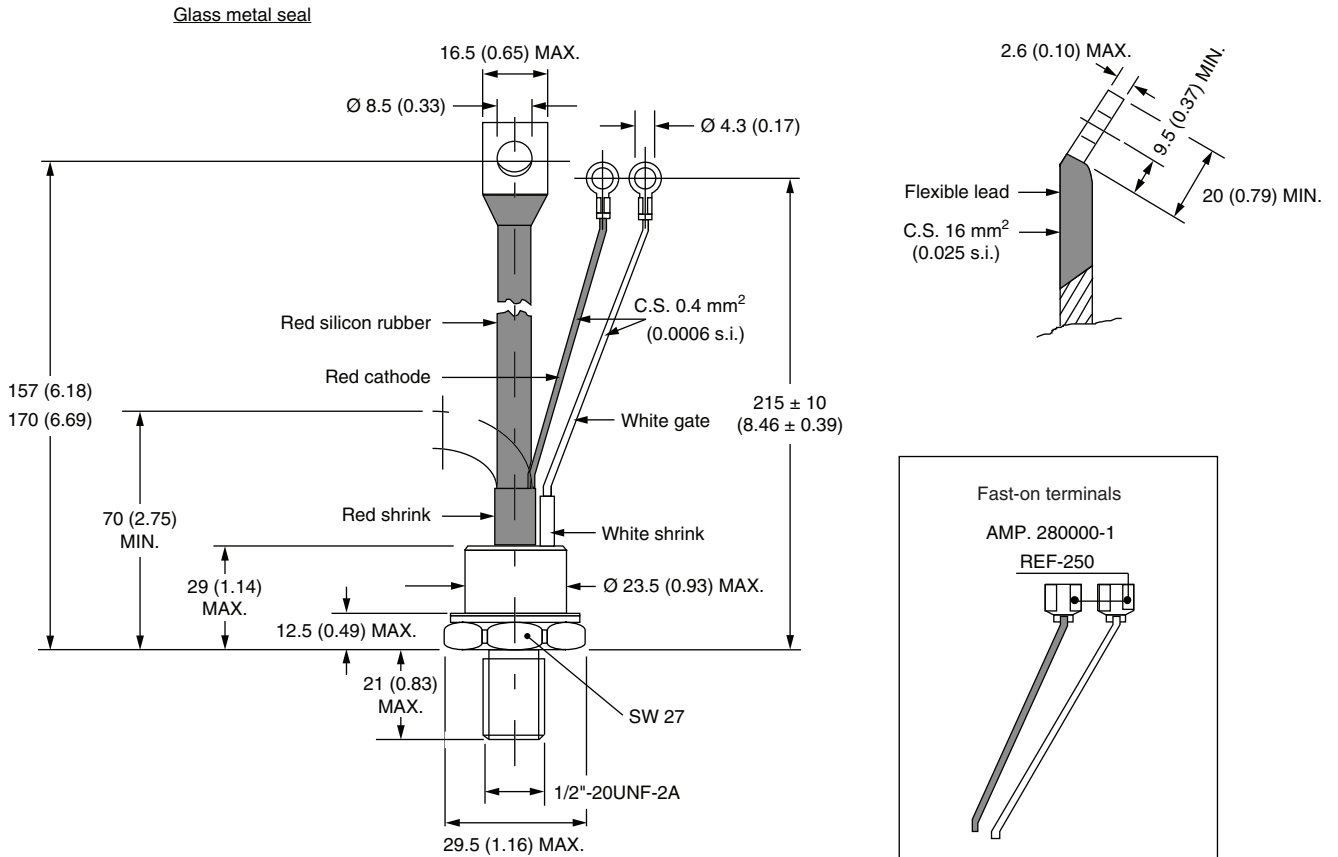
Device code	<b>VS-</b>	<b>ST</b>	<b>11</b>	<b>0</b>	<b>S</b>	<b>16</b>	<b>P</b>	<b>0</b>	<b>V</b>	<b>L</b>	<b>PbF</b>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part marking
- 4** - 0 = converter grade
- 5** - S = compression bonding stud
- 6** - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7** - P = stud base 20UNF threads
- 8** - 0 = eyelet terminals (gate and auxiliary cathode leads)  
1 = fast-on terminals (gate and auxiliary cathode leads)  
2 = flag terminals (for cathode and gate terminals)
- 9** - • V = glass-metal seal (only up to 1200 V)  
• None = ceramic housing (over 1200 V)
- 10** - Critical dV/dt:  
• None = 500 V/ $\mu$ s (standard value)  
• L = 1000 V/ $\mu$ s (special selection)
- 11** - None = standard production  
- PbF = lead (Pb)-free

LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95078">www.vishay.com/doc?95078</a>

## TO-209AC (TO-94) for ST110S Series

**DIMENSIONS** in millimeters (inches)

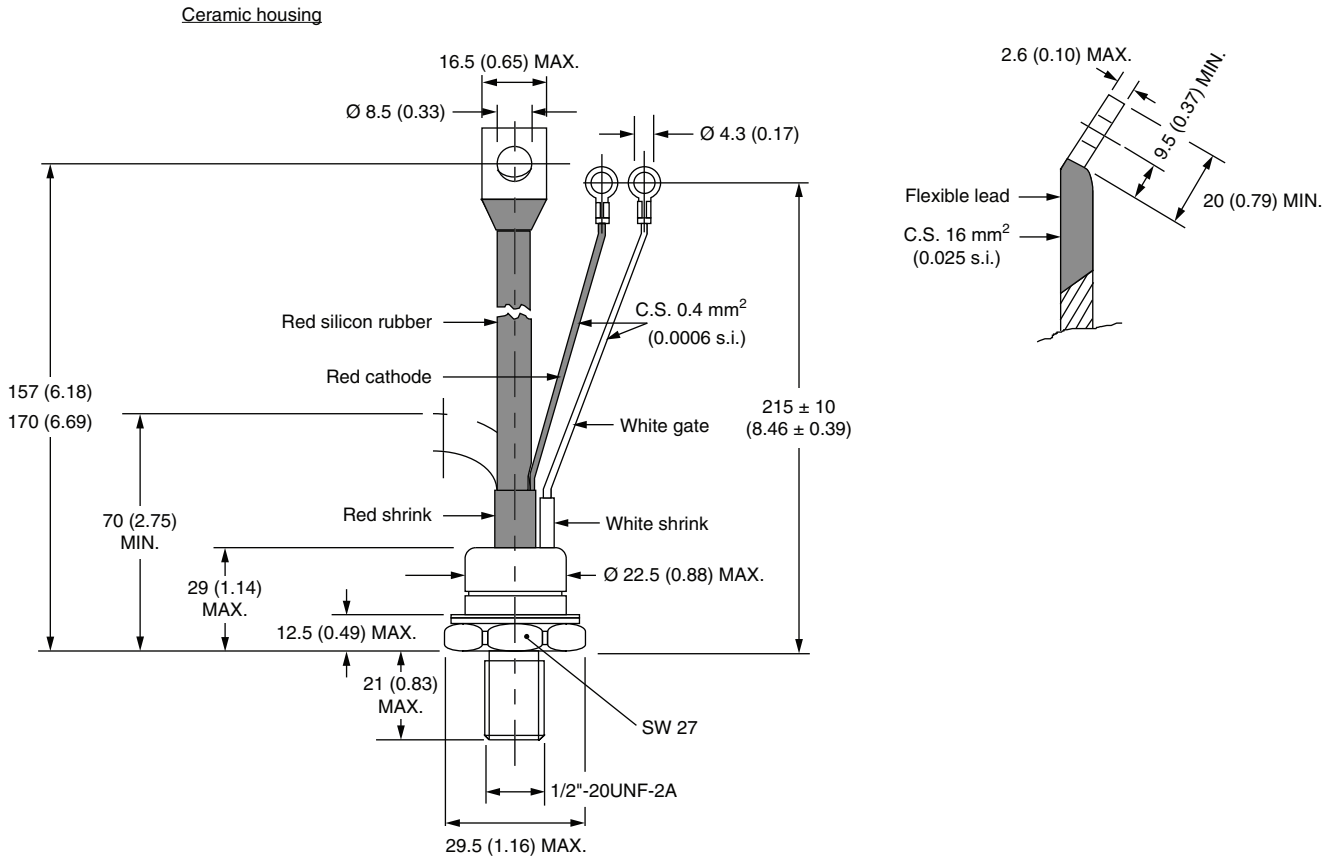


# Outline Dimensions

Vishay Semiconductors TO-209AC (TO-94) for ST110S Series



**DIMENSIONS** in millimeters (inches)







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