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# Inverter Grade Thyristors (Stud Version), 330 A



TO- 209AE (TO-118)

### FEATURES

- Center amplifying gate
- High surge current capability
- Low thermal impedance
- High speed performance
- Compression bonding
- 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

- Inverters
- Choppers
- Induction heating
- All types of force-commutated converters

PRODUCT SUMMARY	
$I_{T(AV)}$	330 A
$V_{DRM}/V_{RRM}$	400 V, 2000 V
$V_{TM}$	1.96 V
$I_{TSM}$ at 50 Hz	11 000 A
$I_{TSM}$ at 60 Hz	11 520 A
$I_{GT}$	200 mA
$T_J$	-40 °C to +125 °C
Package	TO-209AE (TO-118)
Diode variation	Single SCR

MAJOR RATINGS AND CHARACTERISTICS			
PARAMETER	TEST CONDITIONS	VALUES	UNITS
$I_{T(AV)}$		330	A
	$T_C$	75	°C
$I_{T(RMS)}$		518	
$I_{TSM}$	50 Hz	11 000	A
	60 Hz	11 520	
$I^2t$	50 Hz	605	kA <sup>2</sup> s
	60 Hz	550	
$V_{DRM}/V_{RRM}$		400 to 800	V
$t_q$		15	µs
$T_J$		-40 to +125	°C

### ELECTRICAL SPECIFICATIONS

VOLTAGE RATINGS				
TYPE NUMBER	VOLTAGE CODE	$V_{DRM}/V_{RRM}$ , MAXIMUM REPETITIVE PEAK VOLTAGE V	$V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK VOLTAGE V	$I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM mA
VS-ST333S	04	400	500	50
	08	800	900	



CURRENT CARRYING CAPABILITY							
FREQUENCY							UNITS
50 Hz	840	600	1280	1040	5430	4350	A
400 Hz	650	450	1280	910	2150	1560	
1000 Hz	430	230	1090	730	1080	720	
2500 Hz	140	60	490	250	400	190	
Recovery voltage $V_R$	50		50		50		V
Voltage before turn-on $V_D$	$V_{DRM}$		$V_{DRM}$		$V_{DRM}$		
Rise of on-state current $di/dt$	50		-		-		A/μs
Case temperature	50	75	50	75	50	75	°C
Equivalent values for RC circuit	10/0.47		10/0.47		10/0.47		Ω/μF

ON-STATE CONDUCTION					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum average on-state current at case temperature	$I_{T(AV)}$	180° conduction, half sine wave		330	A
				75	°C
Maximum RMS on-state current	$I_{T(RMS)}$	DC at 63 °C case temperature		518	A
Maximum peak, one half cycle, non-repetitive surge current	$I_{TSM}$	t = 10 ms	No voltage reapplied	11 000	
		t = 8.3 ms	No voltage reapplied	11 520	
		t = 10 ms	100 % $V_{RRM}$ reapplied	9250	
		t = 8.3 ms	100 % $V_{RRM}$ reapplied	9700	
Maximum $I^2t$ for fusing	$I^2t$	t = 10 ms	No voltage reapplied	605	kA <sup>2</sup> s
		t = 8.3 ms	No voltage reapplied	550	
		t = 10 ms	100 % $V_{RRM}$ reapplied	430	
		t = 8.3 ms	100 % $V_{RRM}$ reapplied	390	
Maximum $I^2\sqrt{t}$ for fusing	$I^2\sqrt{t}$	t = 0.1 ms to 10 ms, no voltage reapplied		6050	kA <sup>2</sup> √s
Maximum peak on-state voltage	$V_{TM}$	$I_{TM} = 1810$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine wave pulse		1.96	V
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		0.91	
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 forward slope resistance	$r_{t1}$	$(16.7 \% \times \pi \times I_{T(AV)}) < I < \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum		0.58	mΩ
High level value of forward slope resistance	$r_{t2}$	$I > \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum		0.58	
Maximum holding current	$I_H$	$T_J = 25$ °C, $I_T > 30$ A		600	mA
Typical latching current	$I_L$	$T_J = 25$ °C, $V_A = 12$ V, $R_a = 6$ Ω, $I_G = 1$ A		1000	

SWITCHING					
PARAMETER	SYMBOL	TEST CONDITIONS		VALUES	UNITS
Maximum non-repetitive rate of rise of turned-on current	$di/dt$	$T_J = T_J$ maximum, $V_{DRM} = \text{Rated } V_{DRM}$ $I_{TM} = 2 \times di/dt$		1000	A/μs
Typical delay time	$t_d$	$T_J = 25$ °C, $V_{DM} = \text{Rated } V_{DRM}$ , $I_{TM} = 50$ A DC, $t_p = 1$ μs Resistive load, gate pulse: 10 V, 5 Ω source		1.0	μs
Maximum turn-off time	$t_q$	$T_J = T_J$ maximum, $I_{TM} = 550$ A, commutating $di/dt = 40$ A/μs $V_R = 50$ V, $t_p = 500$ μs, $dV/dt = 200$ V/μs		15	





<b>BLOCKING</b>				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Maximum critical rate of rise of off-state voltage	dV/dt	T <sub>J</sub> = T <sub>J</sub> maximum, linear to 80 % V <sub>DRM</sub> , higher value available on request	500	V/μs
Maximum peak reverse and off-state leakage current	I <sub>RRM</sub> , I <sub>DRM</sub>	T <sub>J</sub> = T <sub>J</sub> maximum, rated V <sub>DRM</sub> /V <sub>RRM</sub> applied	50	mA

<b>TRIGGERING</b>				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Maximum peak gate power	P <sub>GM</sub>	T <sub>J</sub> = T <sub>J</sub> maximum, f = 50 Hz, d% = 50	60	W
Maximum average gate power	P <sub>G(AV)</sub>		10	
Maximum peak positive gate current	I <sub>GM</sub>	T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms	10	A
Maximum peak positive gate voltage	+V <sub>GM</sub>		20	V
Maximum peak negative gate voltage	-V <sub>GM</sub>		5	
Maximum DC gate current required to trigger	I <sub>GT</sub>	T <sub>J</sub> = 25 °C, V <sub>A</sub> = 12 V, R <sub>a</sub> = 6 Ω	200	mA
Maximum DC gate voltage required to trigger	V <sub>GT</sub>		3	V
Maximum DC gate current not to trigger	I <sub>GD</sub>	T <sub>J</sub> = T <sub>J</sub> maximum, rated V <sub>DRM</sub> applied	20	mA
Maximum DC gate voltage not to trigger	V <sub>GD</sub>		0.25	V

<b>THERMAL AND MECHANICAL SPECIFICATIONS</b>				
PARAMETER	SYMBOL	TEST CONDITIONS	VALUES	UNITS
Maximum operating junction temperature range	T <sub>J</sub>		-40 to +125	°C
Maximum storage temperature range	T <sub>Stg</sub>		-40 to +150	
Maximum thermal resistance, junction to case	R <sub>thJC</sub>	DC operation	0.10	K/W
Maximum thermal resistance, case to heatsink	R <sub>thCS</sub>	Mounting surface, smooth, flat and greased	0.03	
Mounting torque, ± 10 %		Non-lubricated threads	48.5 (425)	N · m (lbf · in)
Approximate weight			535	g
Case style		See dimensions - link at the end of datasheet	TO-209AE (TO-118)	

<b>ΔR<sub>thJ-hs</sub> CONDUCTION</b>				
CONDUCTION ANGLE	SINUSOIDAL CONDUCTION	RECTANGULAR CONDUCTION	TEST CONDITIONS	UNITS
180°	0.011	0.008	T <sub>J</sub> = T <sub>J</sub> maximum	K/W
120°	0.013	0.014		
90°	0.017	0.018		
60°	0.025	0.026		
30°	0.041	0.042		

**Note**

- The table above shows the increment of thermal resistance R<sub>thJ-hs</sub> when devices operate at different conduction angles than DC

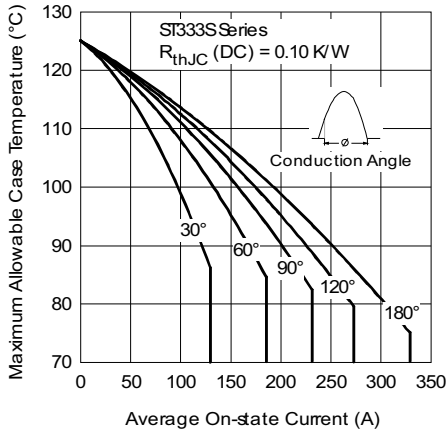


Fig. 1 - Current Ratings Characteristics

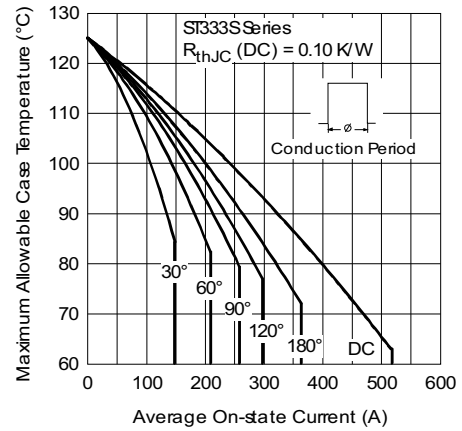


Fig. 2 - Current Ratings Characteristics

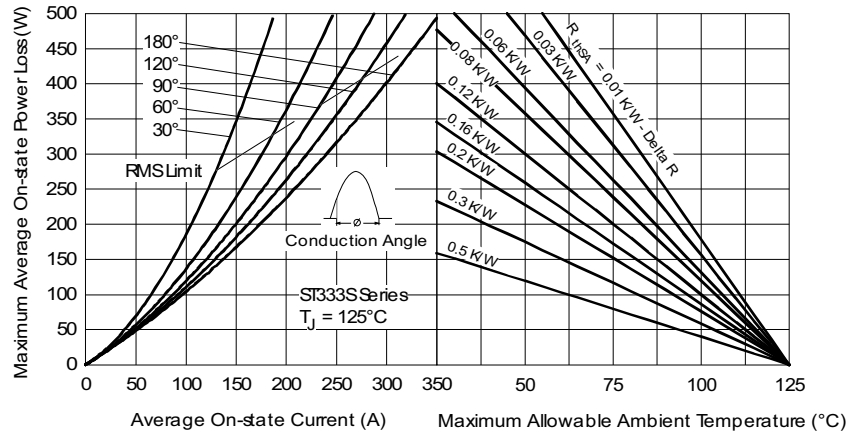


Fig. 3 - On-State Power Loss Characteristics

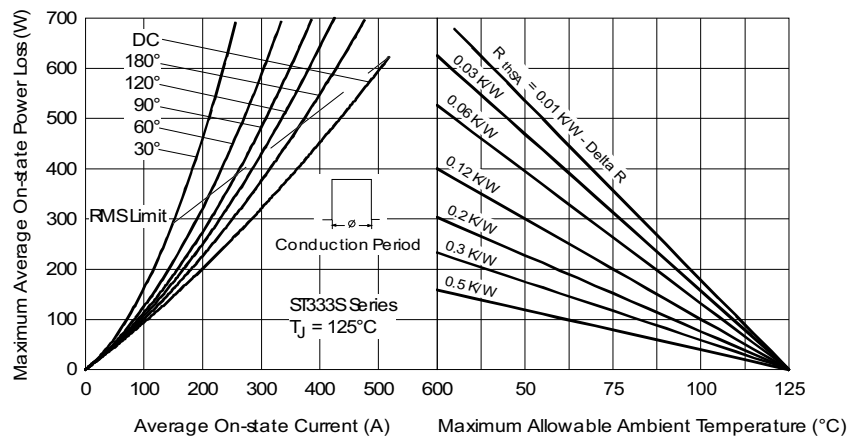


Fig. 4 - On-State Power Loss Characteristics

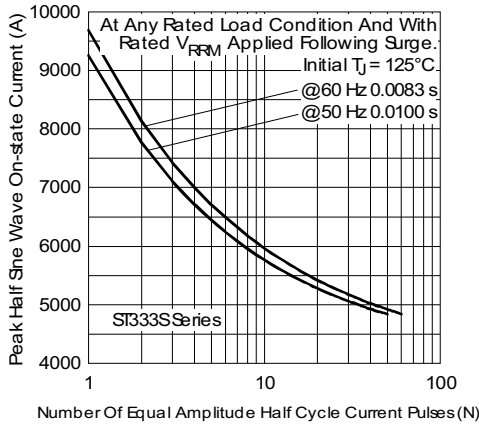


Fig. 5 - Maximum Non-Repetitive Surge Current

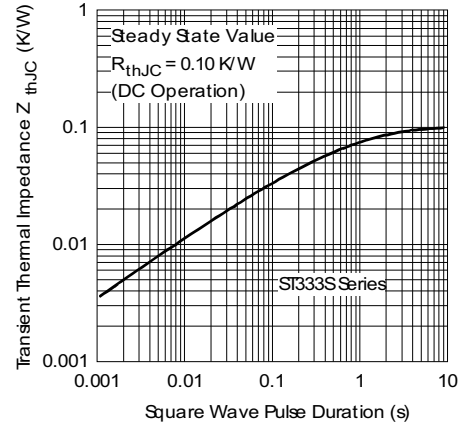


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

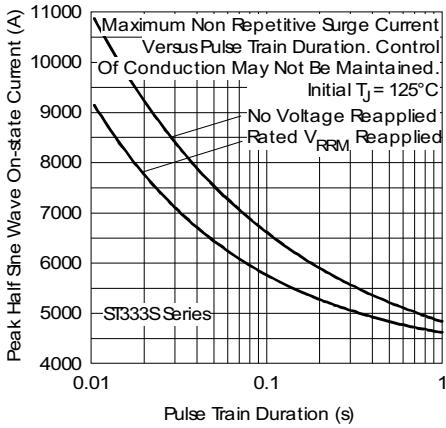


Fig. 6 - Maximum Non-Repetitive Surge Current

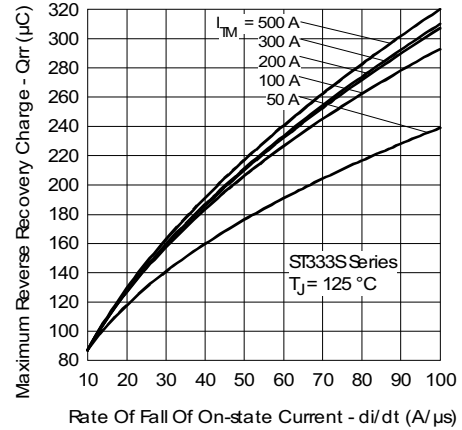


Fig. 9 - Reverse Recovered Charge Characteristics

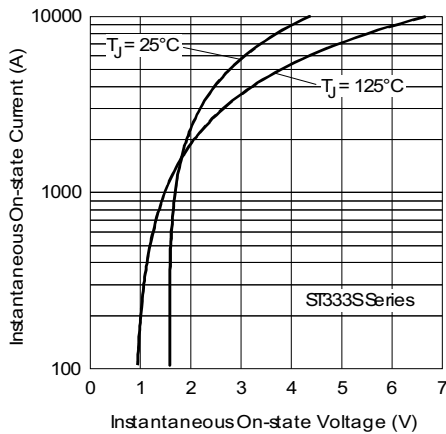


Fig. 7 - On-State Voltage Drop Characteristics

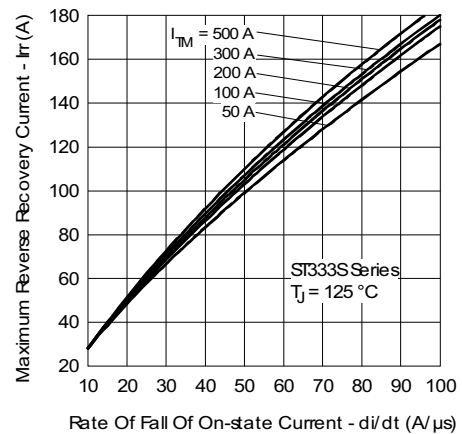


Fig. 10 - Reverse Recovery Current Characteristics

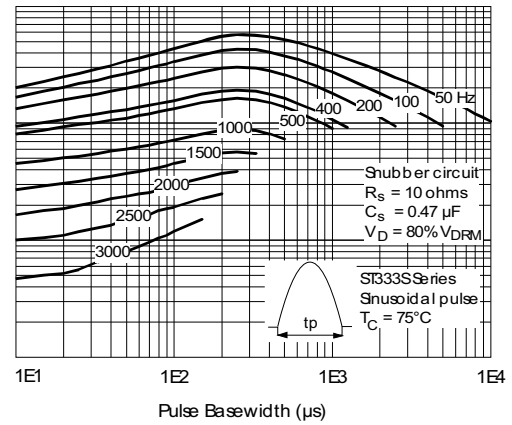
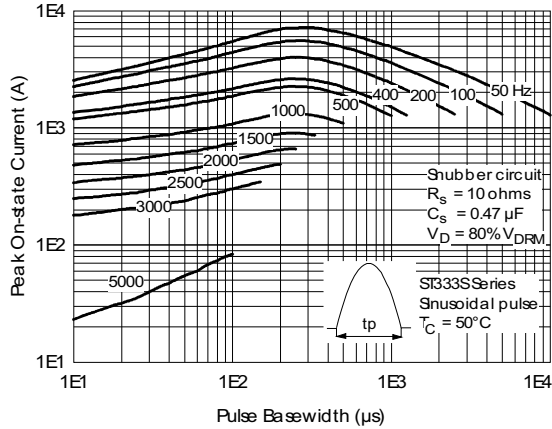


Fig. 11 - Frequency Characteristics

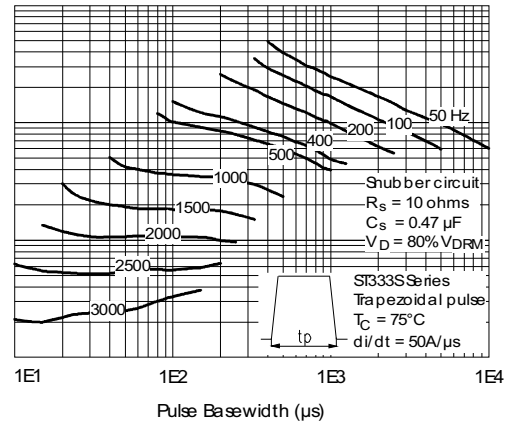
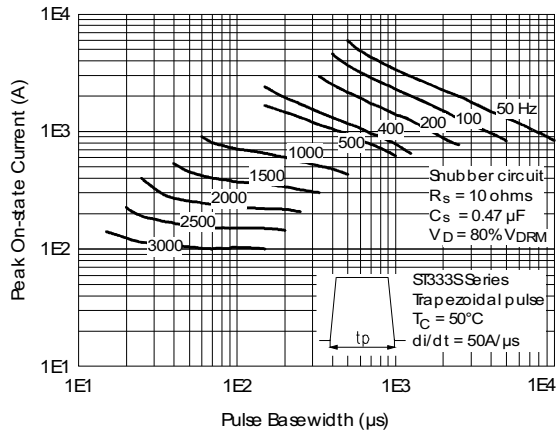


Fig. 12 - Frequency Characteristics

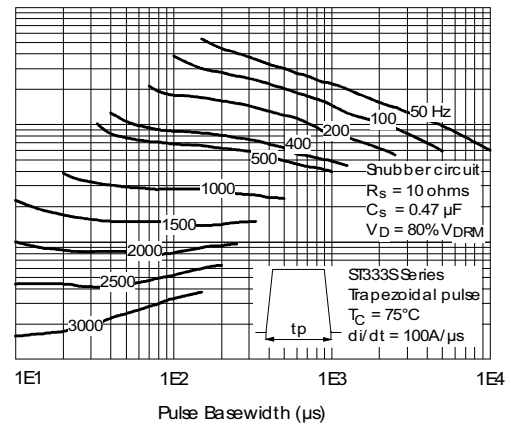
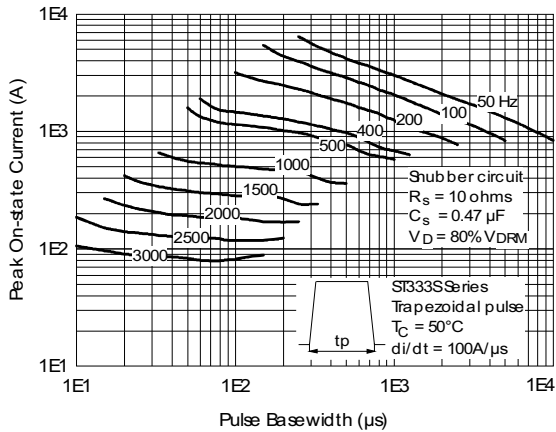


Fig. 13 - Frequency Characteristics

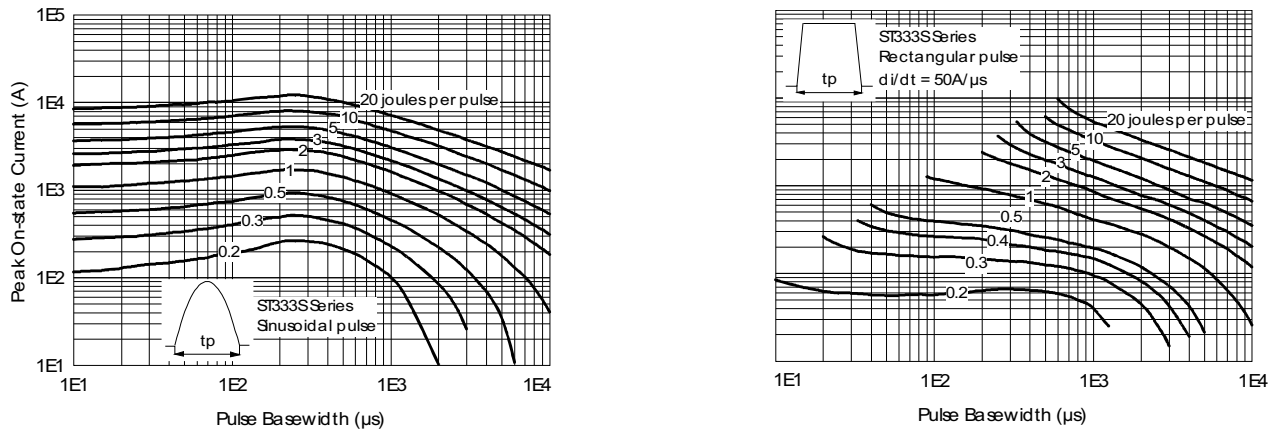


Fig. 14 - Maximum On-State Energy Power Loss Characteristics

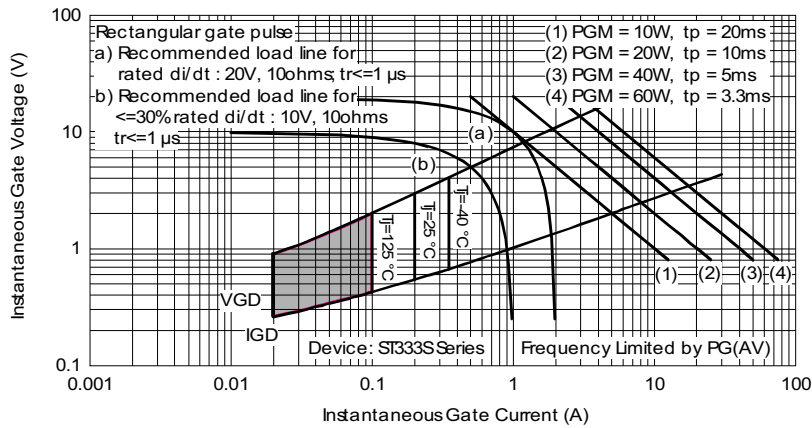
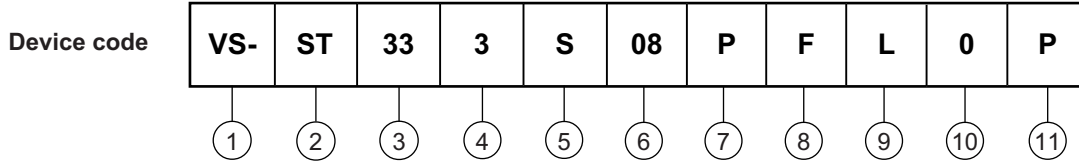


Fig. 15 - Gate Characteristics





## ORDERING INFORMATION TABLE



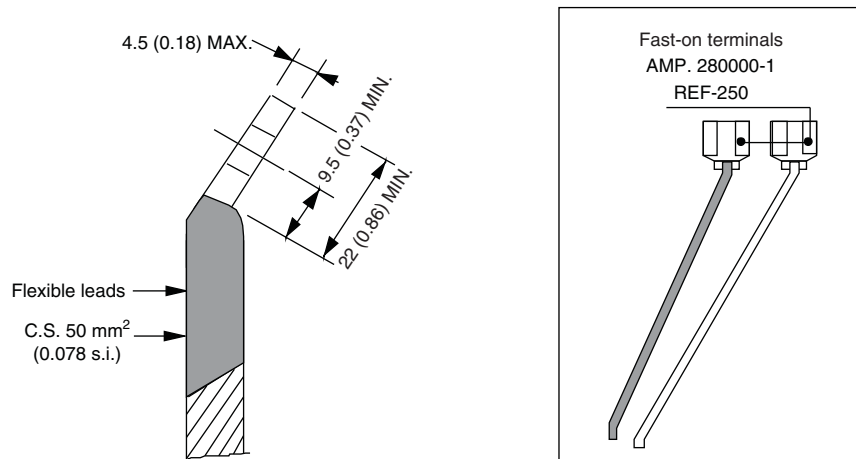
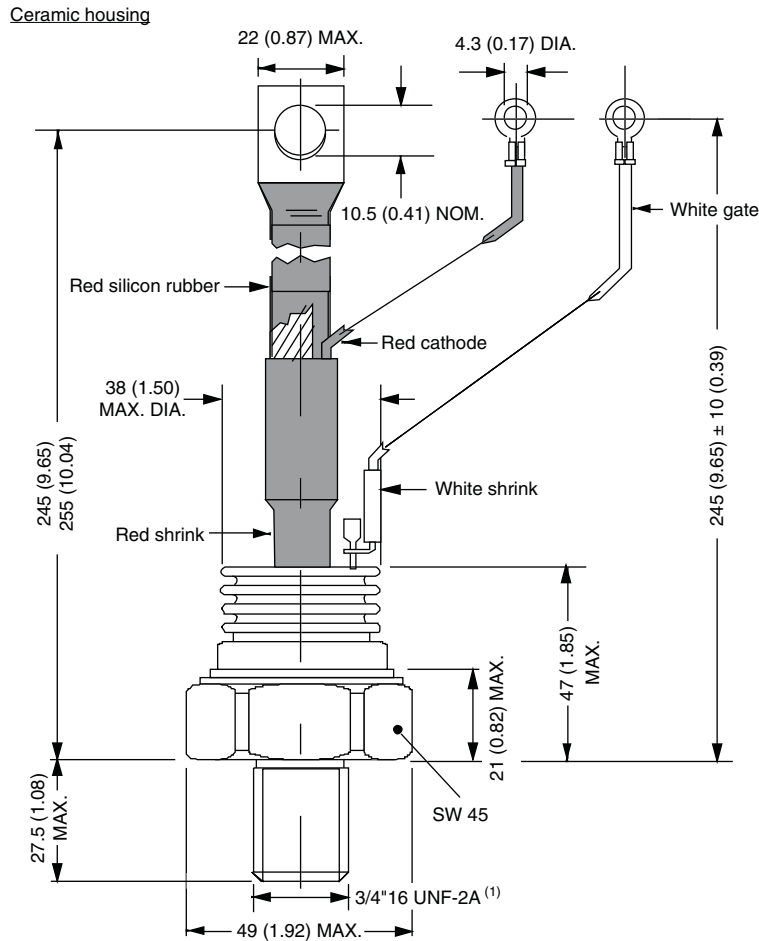
- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part number
- 4** - 3 = Fast turn-off
- 5** - S = Compression bonding stud
- 6** - Voltage code x 100 =  $V_{RRM}$   
(see Voltage Ratings table)
- 7** - P = Stud base 3/4" 16UNF-2A / M = metric device
- 8** - Reapplied  $dV/dt$  code (for  $t_q$  test condition) F = 200 V/ $\mu$ s
- 9** -  $t_q$  code (L = 15  $\mu$ s) M = 12  $\mu$ s
- 10** - 0 = Eyelet terminals  
(gate and auxiliary cathode leads)  
1 = Fast-on terminals  
(gate and auxiliary cathode leads)
- 11** - None = Standard production  
- P = Lead (Pb)-free

Note: For metric device M24 x 1.5 contact factory

LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95080">www.vishay.com/doc?95080</a>

## TO-209AE (TO-118)

**DIMENSIONS** in millimeters (inches)



**Note**

<sup>(1)</sup> For metric device: M24 x 1.5 - length 21 (0.83) maximum



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