Bulletin I25175 rev. C 12/96

International
IOR Rectifier

ST223S SERIES

INVERTER GRADE THYRISTORS

Stud Version

220A

Features

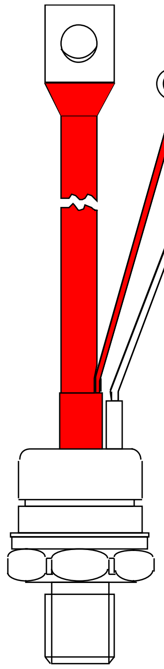
- All diffused design
- Center amplifying gate
- Guaranteed high dv/dt
- Guaranteed high di/dt
- High surge current capability
- Low thermal impedance
- High speed performance

Typical Applications

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

Major Ratings and Characteristics

Parameters		ST223S	Units
$I_{T(AV)}$		220	A
	@ T_C	85	°C
$I_{T(RMS)}$		345	A
I_{TSM}	@ 50Hz	5850	A
	@ 60Hz	6120	A
I^2t	@ 50Hz	171	KA^2s
	@ 60Hz	156	KA^2s
V_{DRM}/V_{RRM}		400 to 800	V
t_q range		10 to 20	µs
T_J		- 40 to 125	°C



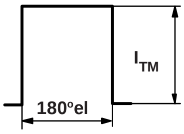
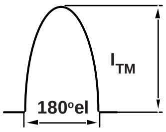
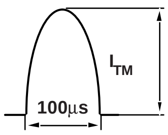
case style
TO-209AB (TO-93)

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} max. @ $T_J = T_J$ max. mA
ST223S	04	400	500	40
	08	800	900	

Current Carrying Capability

Frequency							Units
50Hz	630	430	970	690	6450	4850	A
400Hz	630	420	1010	710	3140	2280	
1000Hz	580	370	1000	680	1860	1310	
2500Hz	420	250	860	630	980	790	
Recovery voltage Vr	50	50	50	50	50	50	V
Voltage before turn-on Vd	V_{DRM}		V_{DRM}		V_{DRM}		
Rise of on-state current di/dt	50	50	-	-	-	-	A/µs
Case temperature	60	85	60	85	60	85	°C
Equivalent values for RC circuit	47Ω / 0.22µF		47Ω / 0.22µF		47Ω / 0.22µF		

On-state Conduction

	Parameter	ST223S	Units	Conditions		
$I_{T(AV)}$	Max. average on-state current	220	A	180° conduction, half sine wave		
	@ Case temperature	85	°C			
$I_{T(RMS)}$	Max. RMS on-state current	345	A	DC @ 76°C case temperature		
I_{TSM}	Max. peak, one half cycle, non-repetitive surge current	5850		t = 10ms	No voltage	Sinusoidal half wave, Initial $T_J = T_J$ max
		6120		t = 8.3ms	reapplied	
		4920		t = 10ms	100% V_{RRM}	
		5150		t = 8.3ms	reapplied	
I^2t	Maximum I^2t for fusing	171	KA^2s	t = 10ms	No voltage	
		156		t = 8.3ms	reapplied	
		121		t = 10ms	100% V_{RRM}	
		111		t = 8.3ms	reapplied	
$I^2\sqrt{t}$	Maximum $I^2\sqrt{t}$ for fusing	1710	$KA^2\sqrt{s}$	t = 0.1 to 10ms, no voltage reapplied		

On-state Conduction

	Parameter	ST223S	Units	Conditions
V_{TM}	Max. peak on-state voltage	1.58	V	I_{TM}= 600A, $T_J = T_J$ max, t_p = 10ms sine wave pulse
$V_{T(TO)1}$	Low level value of threshold voltage	1.05		(16.7% x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ max.
$V_{T(TO)2}$	High level value of threshold voltage	1.09		(I > π x $I_{T(AV)}$), $T_J = T_J$ max.
r_{t1}	Low level value of forward slope resistance	0.88	mΩ	(16.7% x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ max.
r_{t2}	High level value of forward slope resistance	0.82		(I > π x $I_{T(AV)}$), $T_J = T_J$ max.
I_H	Maximum holding current	600	mA	T_J = 25°C, I_T > 30A
I_L	Typical latching current	1000		T_J = 25°C, V_A= 12V, Ra = 6Ω, I_G= 1A

Switching

	Parameter	ST223S	Units	Conditions
di/dt	Max. non-repetitive rate of rise of turned-on current	1000	A/µs	$T_J = T_J$ max, V_{DRM} = rated V_{DRM} I_{TM} = 2 x di/dt
t_d	Typical delay time	0.78	µs	T_J = 25°C, V_{DM} = rated V_{DRM}, I_{TM} = 50A DC, t_p= 1µs Resistive load, Gate pulse: 10V, 5Ω source
t_q	Max. turn-off time	Min 10 Max 20		$T_J = T_J$ max, I_{TM} = 300A, commutating di/dt = 20A/µs V_R = 50V, t_p = 500µs, dv/dt: see table in device code

Blocking

	Parameter	ST223S	Units	Conditions
dv/dt	Maximum critical rate of rise of off-state voltage	500	V/µs	$T_J = T_J$ max., linear to 80% V_{DRM}, higher value available on request
I_{RRM} I_{DRM}	Max. peak reverse and off-state leakage current	40	mA	$T_J = T_J$ max., rated V_{DRM}/V_{RRM} applied

Triggering

	Parameter	ST223S	Units	Conditions
P_{GM}	Maximum peak gate power	60	W	$T_J = T_J$ max, f = 50Hz, d% = 50
$P_{G(AV)}$	Maximum average gate power	10		
I_{GM}	Max. peak positive gate current	10	A	$T_J = T_J$ max, $t_p \leq$ 5ms
$+V_{GM}$	Maximum peak positive gate voltage	20	V	$T_J = T_J$ max, $t_p \leq$ 5ms
$-V_{GM}$	Maximum peak negative gate voltage	5		
I_{GT}	Max. DC gate current required to trigger	200	mA	T_J = 25°C, V_A = 12V, Ra = 6Ω
V_{GT}	Max. DC gate voltage required to trigger	3	V	
I_{GD}	Max. DC gate current not to trigger	20	mA	$T_J = T_J$ max, rated V_{DRM} applied
V_{GD}	Max. DC gate voltage not to trigger	0.25	V	

Thermal and Mechanical Specifications

	Parameter	ST223S	Units	Conditions
T_J	Max. junction operating temperature range	-40 to 125	°C	
T_{stg}	Max. storage temperature range	-40 to 150		
R_{thJC}	Max. thermal resistance, junction to case	0.105	K/W	DC operation
R_{thCS}	Max. thermal resistance, case to heatsink	0.04		Mounting surface, smooth, flat and greased
T	Mounting torque, ± 10%	31 (275)	Nm (lbf-in)	Non lubricated threads
		24.5 (210)	Nm (lbf-in)	Lubricated threads
wt	Approximate weight	280	g	
	Case style	TO-209AB (TO-93)		See Outline Table

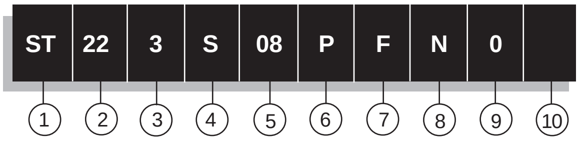
ΔR_{thJC} Conduction

(The following table shows the increment of thermal resistence R_{thJC} when devices operate at different conduction angles than DC)

Conduction angle	Sinusoidal conduction	Rectangular conduction	Units	Conditions
180°	0.016	0.012	K/W	$T_J = T_J$ max.
120°	0.019	0.020		
90°	0.025	0.027		
60°	0.036	0.037		
30°	0.060	0.060		

Ordering Information Table

Device Code



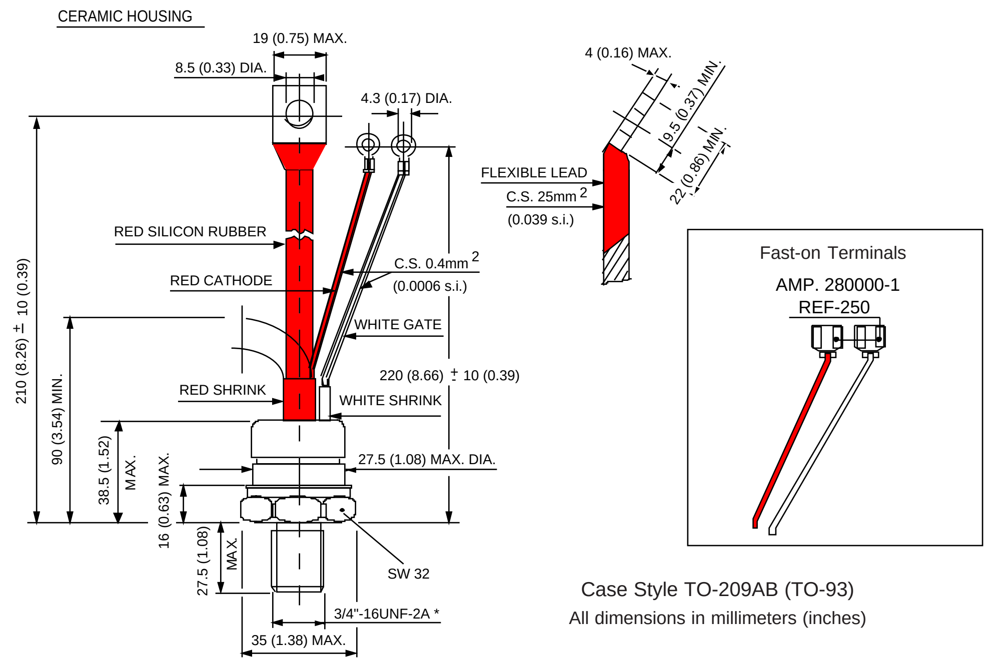
1 - Thyristor
2 - Essential part number
3 - 3 = Fast turn off
4 - S = Compression bonding Stud
5 - Voltage code: Code x 100 = V_{RRM} (See Voltage Ratings table)
6 - P = Stud base 3/4" 16UNF-2A
M = Stud base metric threads M16 x 1.5
7 - Reapplied dv/dt code (for t_q test condition)
8 - t_q code
9 - 0 = Eyelet terminals (Gate and Aux. Cathode Leads)
1 = Fast-on terminals (Gate and Aux. Cathode Leads)
2 = Flag terminals (For Cathode and Gate Terminals)
10 - Critical dv/dt:
None = 500V/µsec (Standard value)
L = 1000V/µsec (Special selection)

dv/dt - t_q combinations available

	dv/dt (V/µs)	20	50	100	**200**	400
t_q(µs)	10	CN	DN	EN	**FN ***	--
	12	CM	DM	EM	FM	--
	15	CL	DL	EL	**FL ***	HL
	18	CP	DP	EP	FP	HP
	20	CK	DK	EK	FK	HK
	25	--	--	--	--	HJ
	30	--	--	--	--	HH

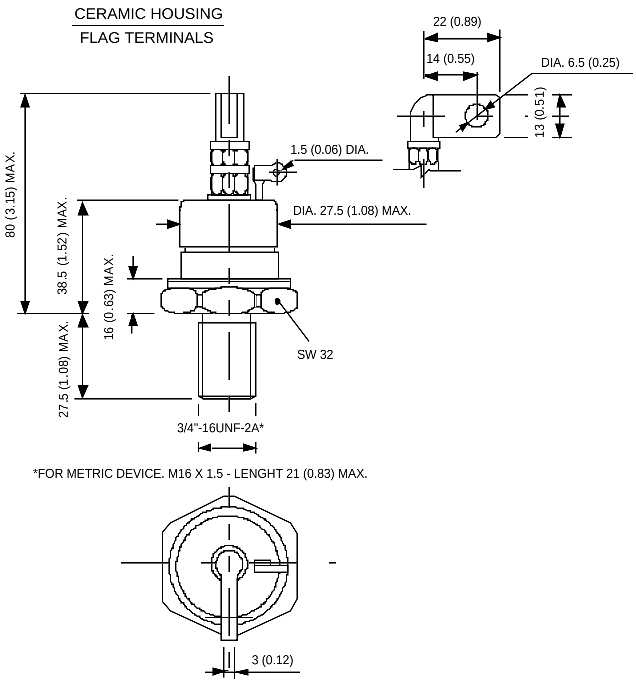
*Standard part number.
All other types available only on request.

Outline Table



Case Style TO-209AB (TO-93)
All dimensions in millimeters (inches)

* FOR METRIC DEVICE : M16 x 1.5 - LENGHT 21 (0.83) MAX.



*FOR METRIC DEVICE. M16 X 1.5 - LENGHT 21 (0.83) MAX.

Case Style TO-209AB (TO-93) Flag
All dimensions in millimeters (inches)

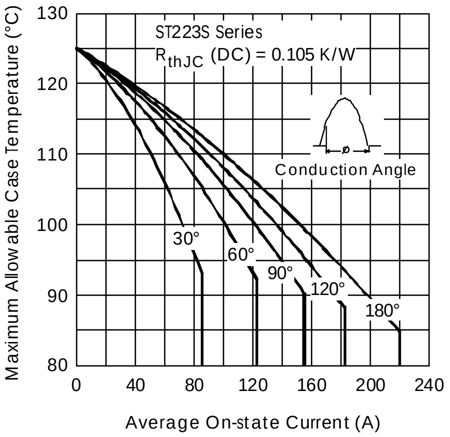


Fig. 1 - Current Ratings Characteristics

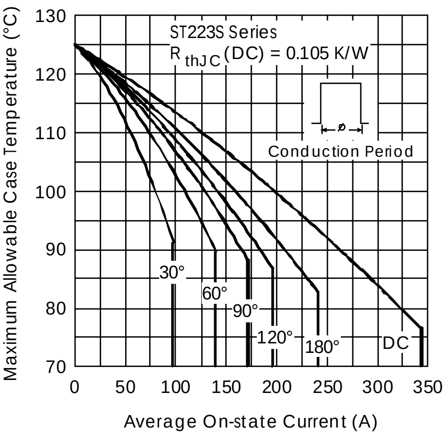


Fig. 2 - Current Ratings Characteristics

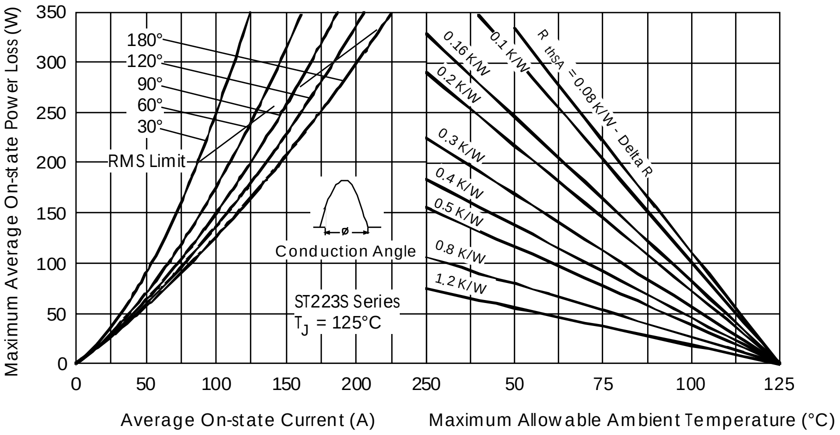


Fig. 3 - On-state Power Loss Characteristics

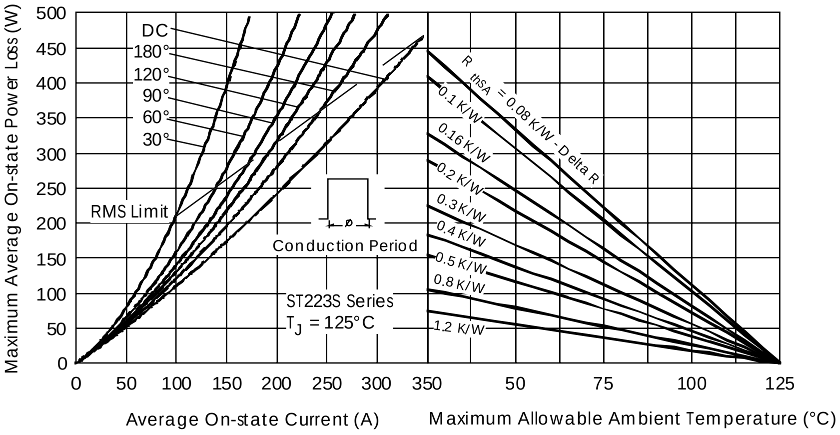


Fig. 4 - On-state Power Loss Characteristics

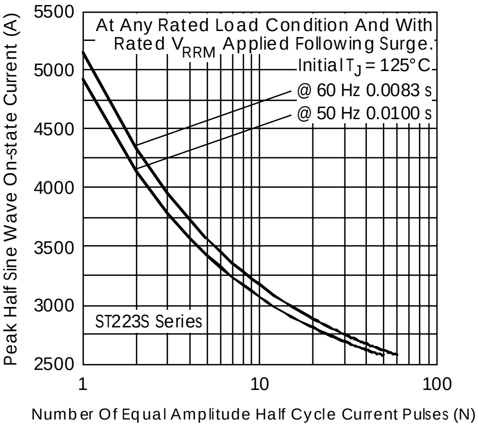


Fig. 5 - Maximum Non-repetitive Surge Current

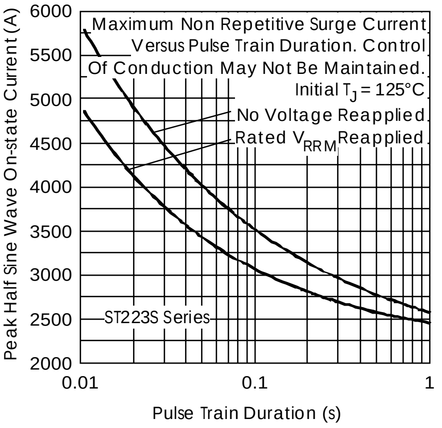


Fig. 6 - Maximum Non-repetitive Surge Current

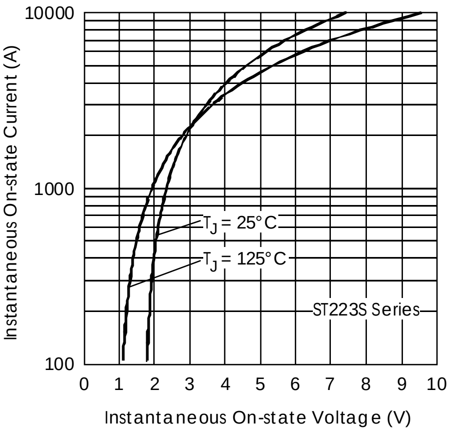


Fig. 7 - On-state Voltage Drop Characteristics

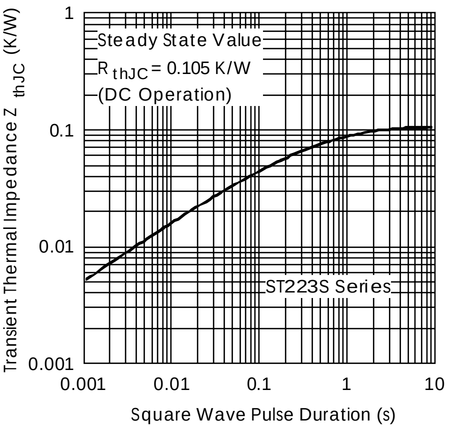


Fig. 8 - Thermal Impedance Z_{thJC} Characteristic

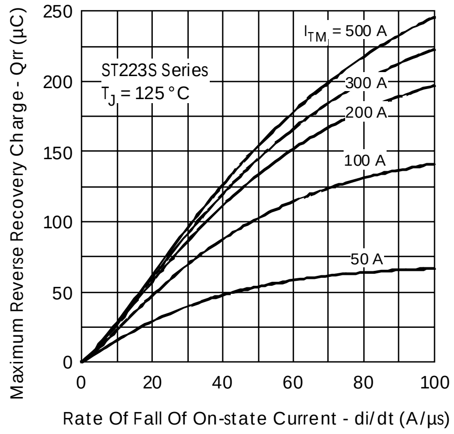


Fig. 9 - Reverse Recovered Charge Characteristics

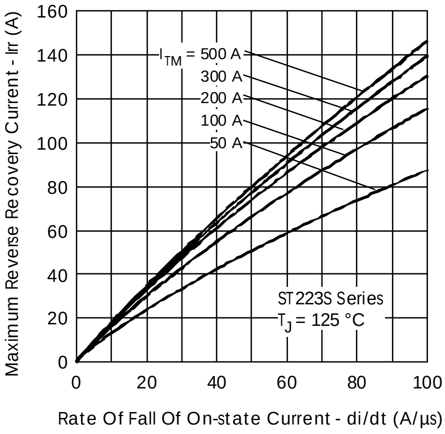


Fig. 10 - Reverse Recovery Current Characteristics

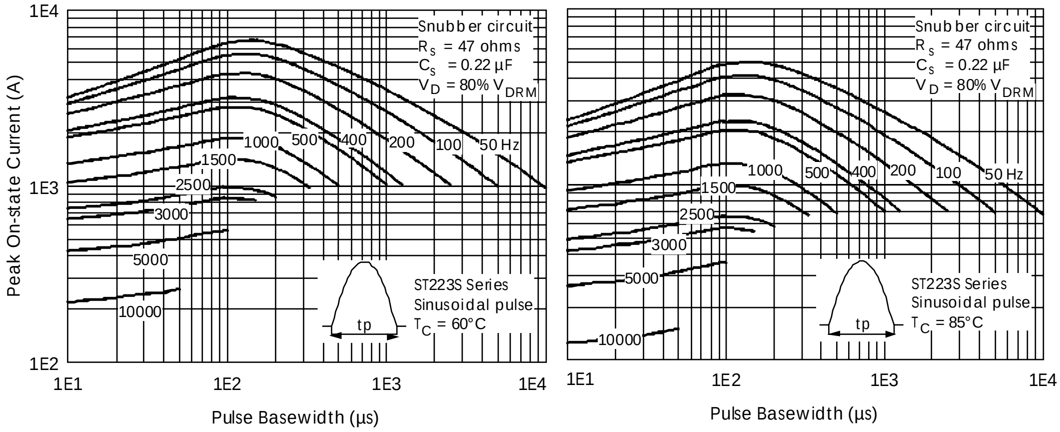


Fig. 11 - Frequency Characteristics

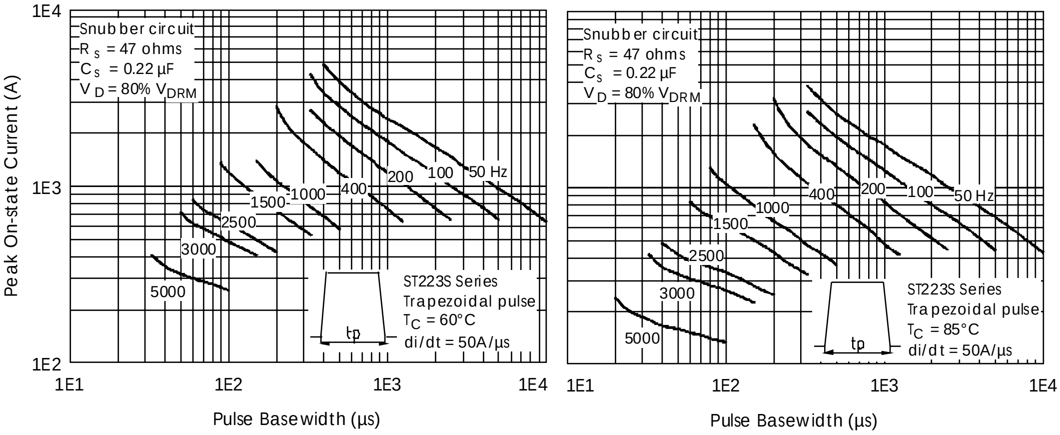


Fig. 12 - Frequency Characteristics

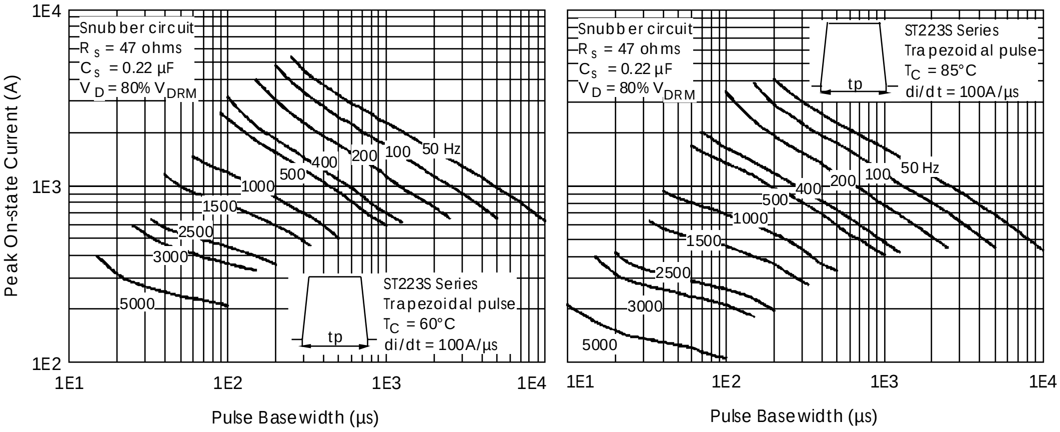


Fig. 13 - Frequency Characteristics

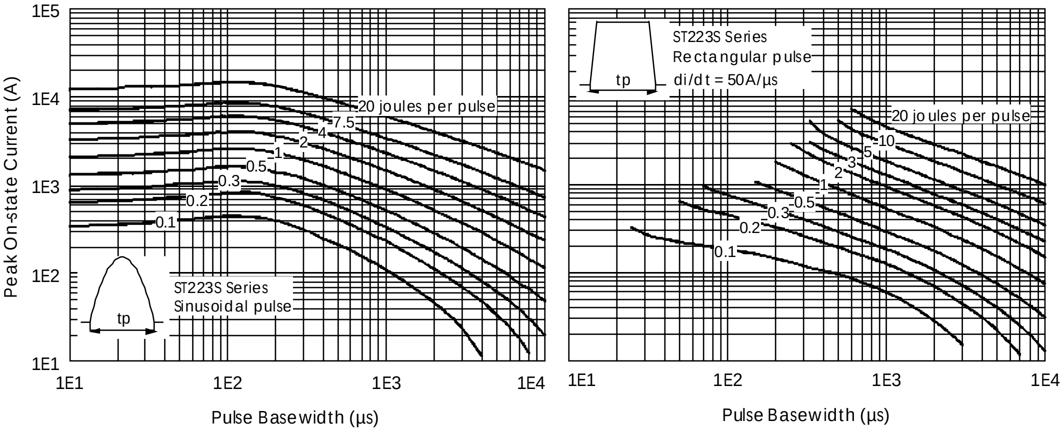


Fig. 14 - Maximum On-state Energy Power Loss Characteristics

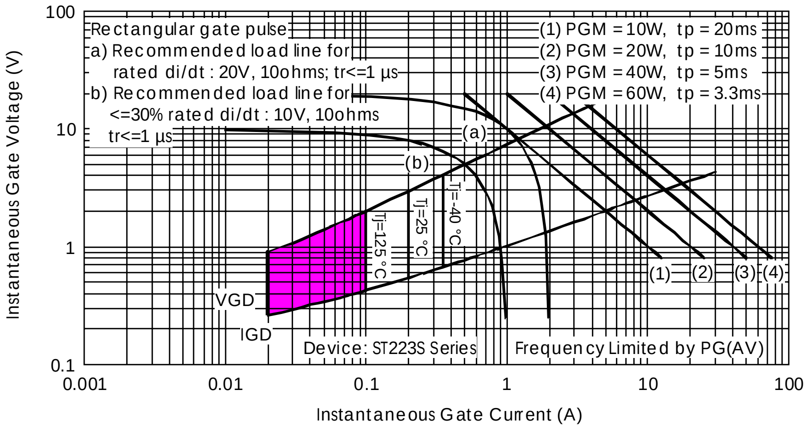


Fig. 15 - Gate Characteristics