



DISCRETE POWER DIODES and THYRISTORS
DATA BOOK

INVERTER GRADE THYRISTORS
Stud Version
Features

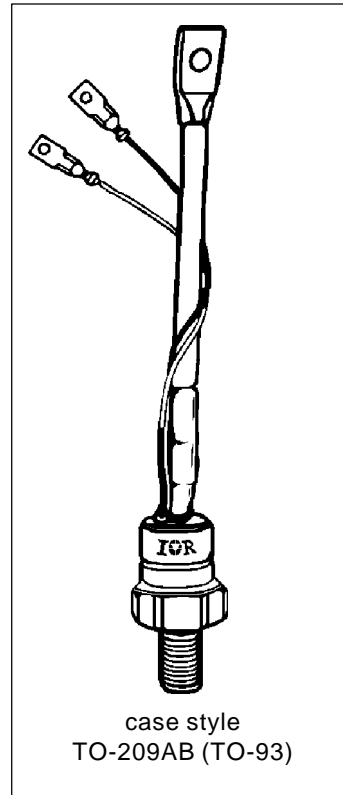
- All diffused design
- Center amplifying gate
- Guaranteed high dv/dt
- Guaranteed high di/dt
- High surge current capability
- Low thermal impedance
- High speed performance

220A
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 ² s
	@ 60Hz	156 KA ² s
V_{DRM}/V_{RRM}	400 to 800	V
t_q range	10 to 20	μs
T_J	- 40 to 125	°C



ST223S Series

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	
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 @ Case temperature	220	A	180° conduction, half sine wave		
	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 ² s	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 /s	t = 0.1 to 10ms, no voltage reapplied		

ST223S Series

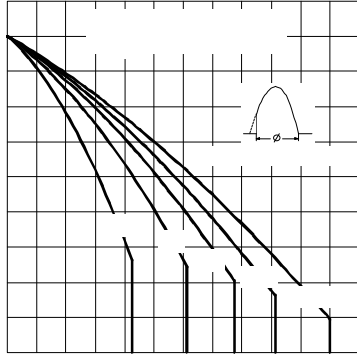


Fig. 1 - Current Ratings Characteristics

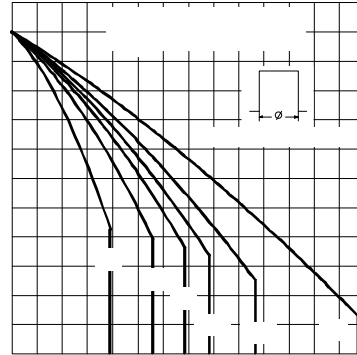


Fig. 2 - Current Ratings Characteristics

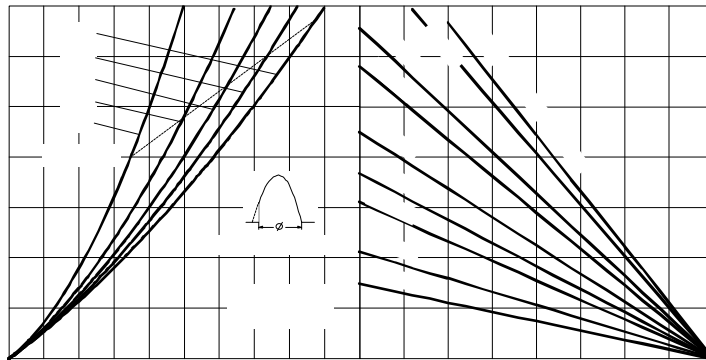


Fig. 3 - On-state Power Loss Characteristics

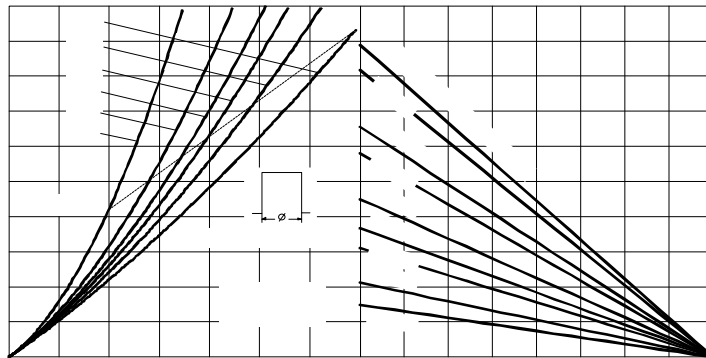


Fig. 4 - On-state Power Loss Characteristics

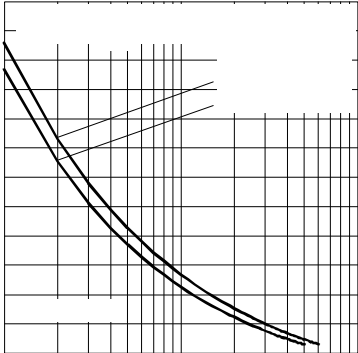


Fig. 5 - Maximum Non-repetitive Surge Current

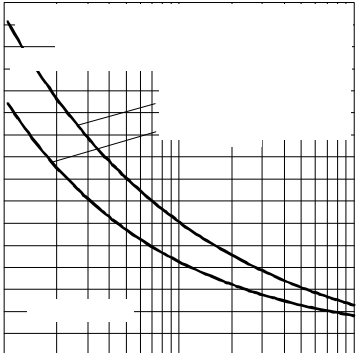


Fig. 6 - Maximum Non-repetitive Surge Current

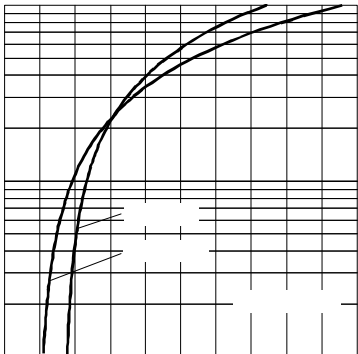


Fig. 7 - On-state Voltage Drop Characteristics

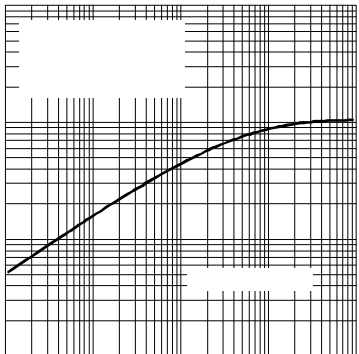


Fig. 8 - Thermal Impedance Z_{thJC} Characteristic

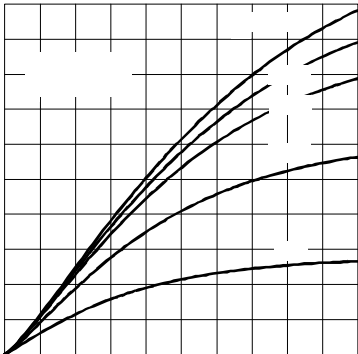


Fig. 9 - Reverse Recovered Charge Characteristics

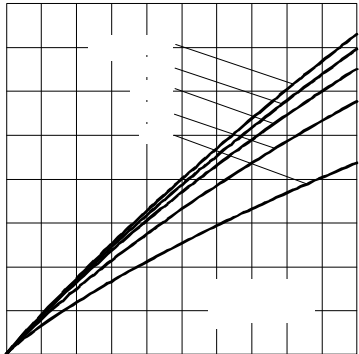


Fig. 10 - Reverse Recovery Current Characteristics

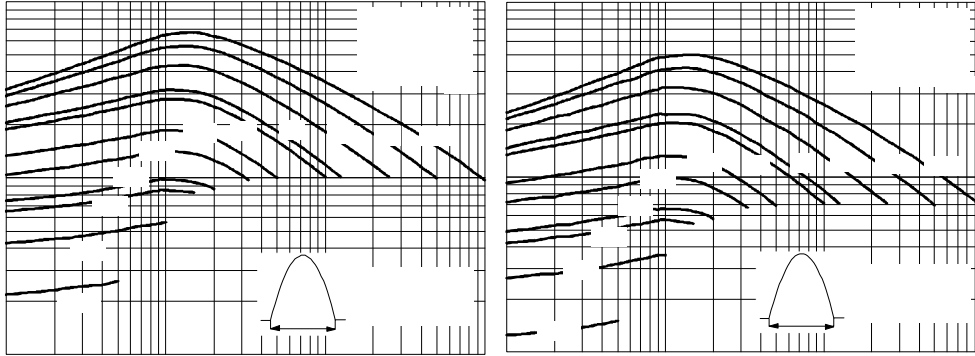


Fig. 11 - Frequency Characteristics

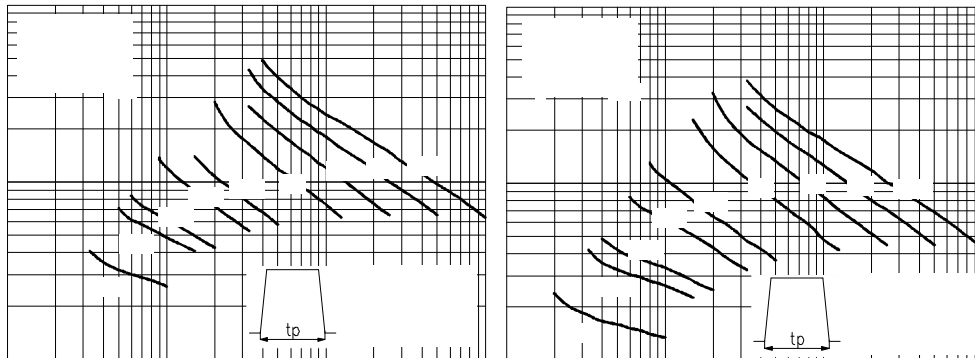


Fig. 12 - Frequency Characteristics

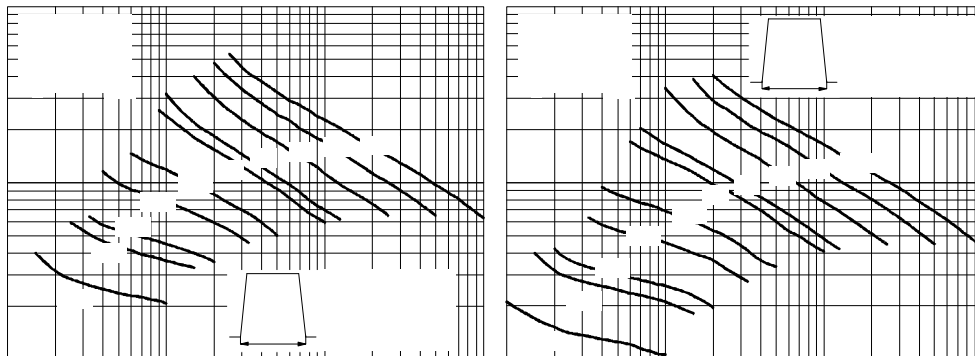


Fig. 13 - Frequency Characteristics

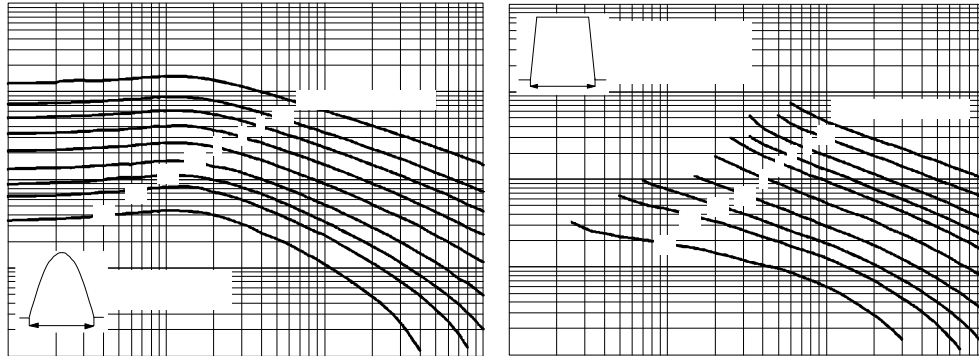


Fig. 14 - Maximum On-state Energy Power Loss Characteristics

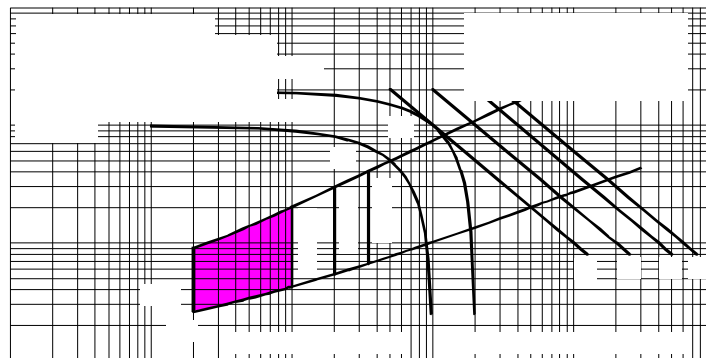


Fig. 15 - Gate Characteristics

On-state Conduction

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

Switching

Parameter	ST223S	Units	Conditions
di/dt Max. non-repetitive rate of rise of turned-on current	1000	A/ μs	$T_J = T_J \text{ max}$, $V_{DRM} = \text{rated } V_{DRM}$ $I_{TM} = 2 \times di/dt$
t_d Typical delay time	0.78	μs	$T_J = 25^\circ\text{C}$, $V_{DM} = \text{rated } V_{DRM}$, $I_{TM} = 50A$ DC, $t_p = 1\mu\text{s}$ Resistive load, Gate pulse: 10V, 5 Ω source
t_q Max. turn-off time	Min 10 Max 20		$T_J = T_J \text{ max}$, $I_{TM} = 300A$, commutating $di/dt = 20A/\mu\text{s}$ $V_R = 50V$, $t_p = 500\mu\text{s}$, 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	$T_J = T_J \text{ max}$., linear to 80% V_{DRM} , higher value available on request
I_{RRM} I_{DRM} Max. peak reverse and off-state leakage current	40	mA	$T_J = T_J \text{ max}$., rated V_{DRM}/V_{RRM} applied

Triggering

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

ST223S Series

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, $\pm 10\%$	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 resistance 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	$T_J = T_J \text{ max.}$
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																																																																
ST	22	3	S	08	P	F	N	0																																																								
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩																																																							
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/ μ sec (Standard value) L = 1000V/ μ sec (Special selection)																																																															
<table border="1"> <thead> <tr> <th colspan="6">dv/dt - t_q combinations available</th> </tr> <tr> <th>dv/dt (V/μs)</th> <th>20</th> <th>50</th> <th>100</th> <th>200</th> <th>400</th> </tr> </thead> <tbody> <tr> <td rowspan="7">t_q (μs)</td> <td>10</td> <td>CN</td> <td>DN</td> <td>EN</td> <td>FN *</td> <td>--</td> </tr> <tr> <td>12</td> <td>CM</td> <td>DM</td> <td>EM</td> <td>FM</td> <td>--</td> </tr> <tr> <td>15</td> <td>CL</td> <td>DL</td> <td>EL</td> <td>FL *</td> <td>HL</td> </tr> <tr> <td>18</td> <td>CP</td> <td>DP</td> <td>EP</td> <td>FP</td> <td>HP</td> </tr> <tr> <td>20</td> <td>CK</td> <td>DK</td> <td>EK</td> <td>FK</td> <td>HK</td> </tr> <tr> <td>25</td> <td>--</td> <td>--</td> <td>--</td> <td>--</td> <td>HJ</td> </tr> <tr> <td>30</td> <td>--</td> <td>--</td> <td>--</td> <td>--</td> <td>HH</td> </tr> </tbody> </table>										dv/dt - t_q combinations available						dv/dt (V/ μ s)	20	50	100	200	400	t_q (μ s)	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
dv/dt - t_q combinations available																																																																
dv/dt (V/ μ s)	20	50	100	200	400																																																											
t_q (μ s)	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

