



DISCRETE POWER DIODES and THYRISTORS
DATA BOOK

INVERTER GRADE THYRISTORS
Stud Version
Features

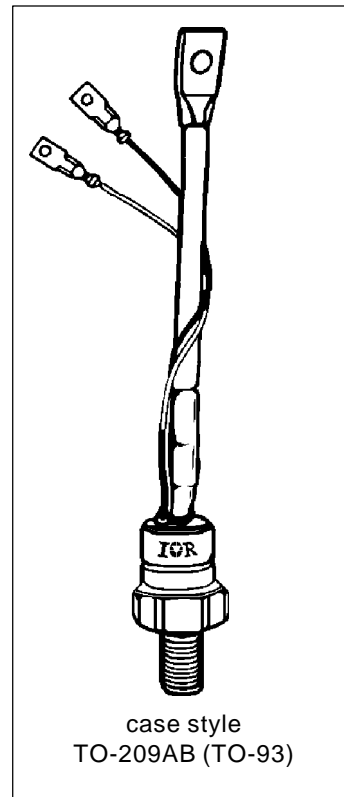
- All diffused design
- Center amplifying gate
- Guaranteed high dv/dt
- Guaranteed high di/dt
- High surge current capability
- Low thermal impedance
- High speed performance

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



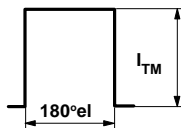
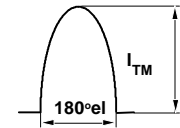
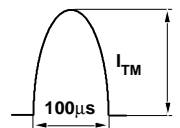
ST223S Series

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
	630	430	970	690	6450	4850	
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 @ 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 reappplied
	6120		t = 8.3ms	100% V_{RRM} reappplied
	4920		t = 10ms	Sinusoidal half wave, Initial $T_J = T_J$ max
5150	t = 8.3ms			
I^2t Maximum I^2t for fusing	171	KA ² s	t = 10ms	
	156		t = 8.3ms	
	121		t = 10ms	
	111		t = 8.3ms	
$I^2\sqrt{t}$ Maximum $I^2\sqrt{t}$ for fusing	1710	KA ² /s	t = 0.1 to 10ms, no voltage reappplied	

ST223S Series

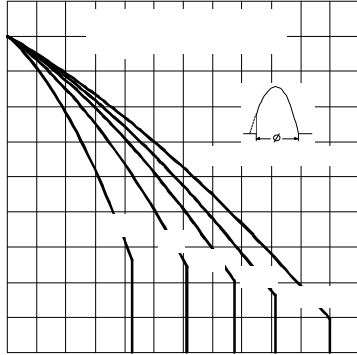


Fig. 1 - Current Ratings Characteristics

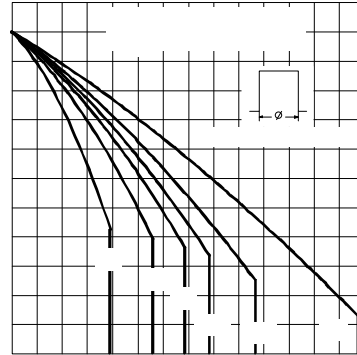


Fig. 2 - Current Ratings Characteristics

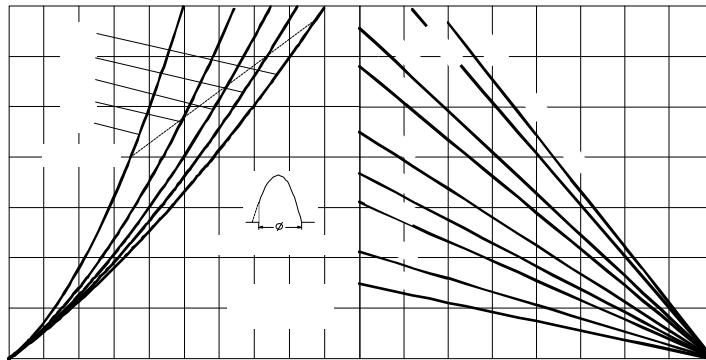


Fig. 3 - On-state Power Loss Characteristics

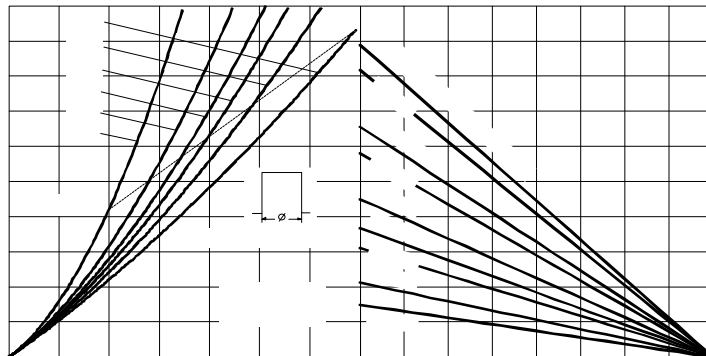


Fig. 4 - On-state Power Loss Characteristics

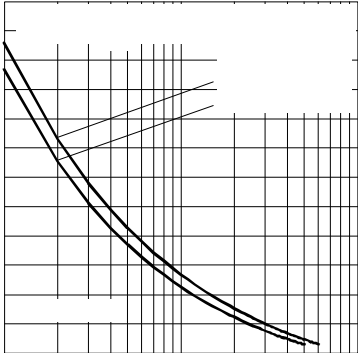


Fig. 5 - Maximum Non-repetitive Surge Current

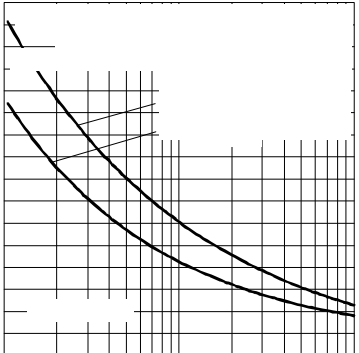


Fig. 6 - Maximum Non-repetitive Surge Current

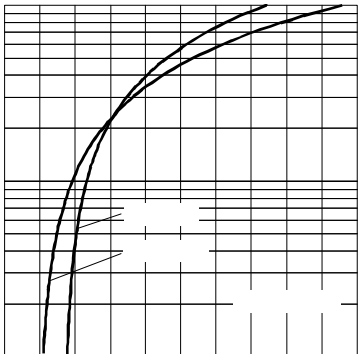


Fig. 7 - On-state Voltage Drop Characteristics

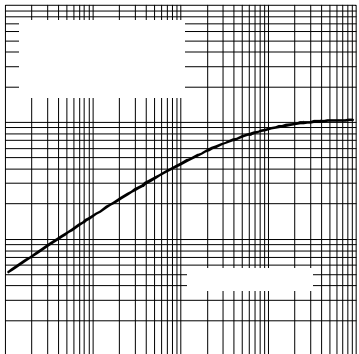


Fig. 8 - Thermal Impedance Z_{thJC} Characteristic

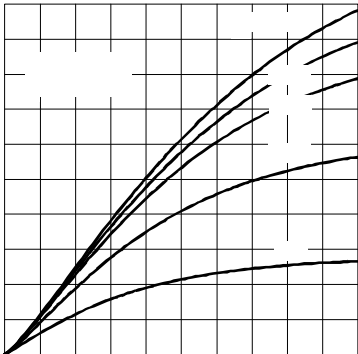


Fig. 9 - Reverse Recovered Charge Characteristics

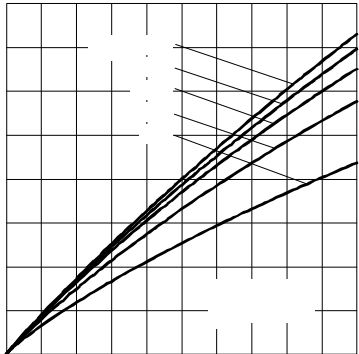


Fig. 10 - Reverse Recovery Current Characteristics

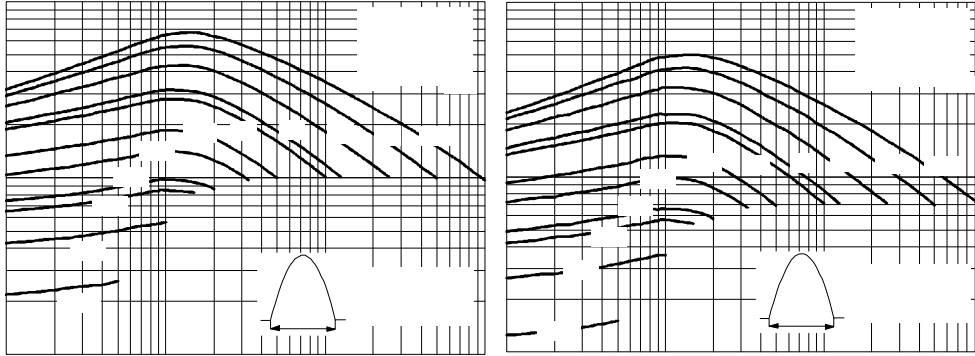


Fig. 11 - Frequency Characteristics

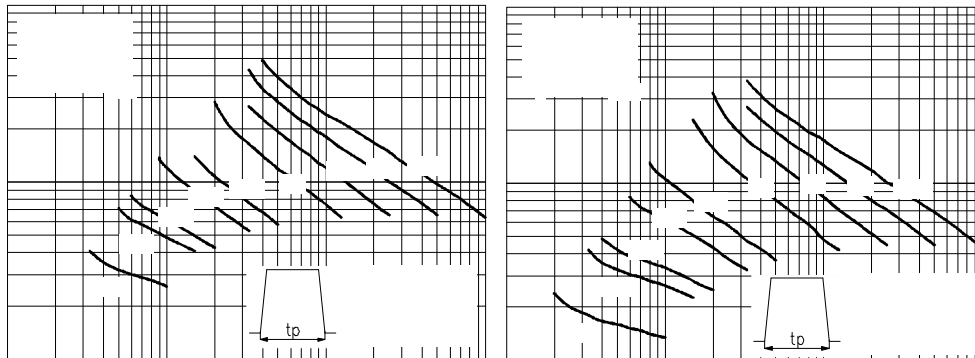


Fig. 12 - Frequency Characteristics

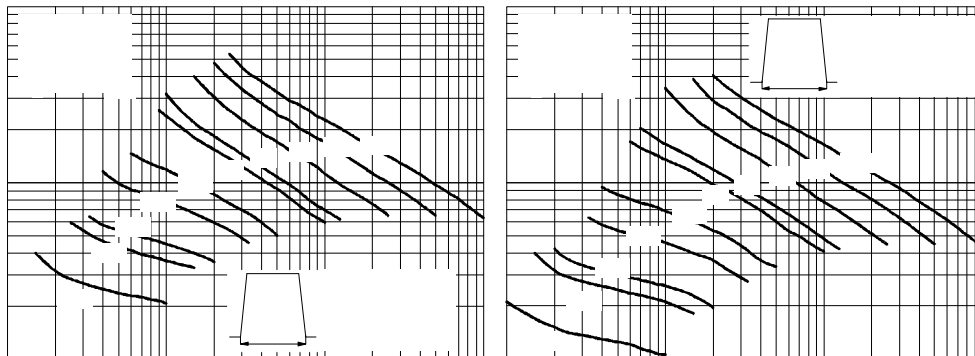


Fig. 13 - Frequency Characteristics

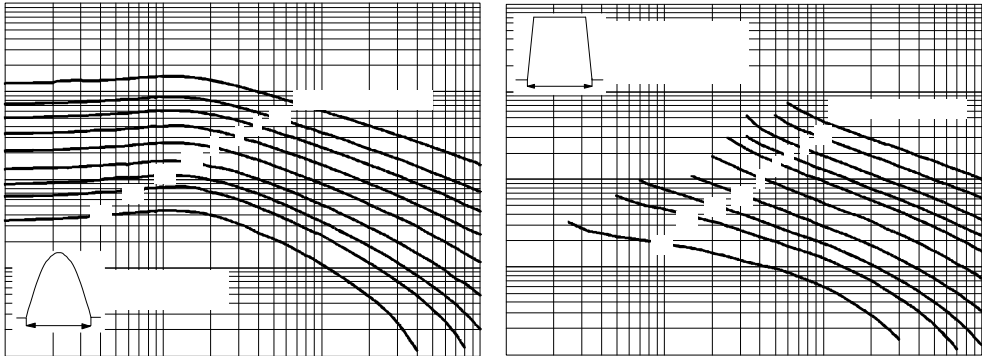


Fig. 14 - Maximum On-state Energy Power Loss Characteristics

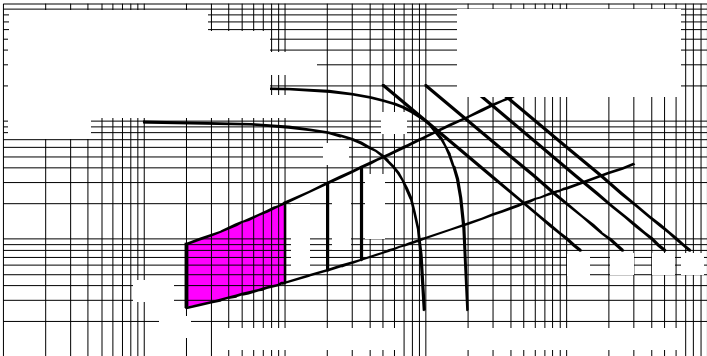


Fig. 15 - Gate Characteristics

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	$T_J = T_J \text{ max}, V_{DRM} = \text{rated } V_{DRM}$ $I_{TM} = 2 \times \text{di/dt}$
t_d Typical delay time	0.78	μs	$T_J = 25^\circ\text{C}, V_{DM} = \text{rated } V_{DRM}, I_{TM} = 50A \text{ DC}, t_p = 1\mu\text{s}$ Resistive load, Gate pulse: 10V, 5 Ω source
t_q Max. turn-off time	Min 10 Max 20		$T_J = T_J \text{ max}, I_{TM} = 300A, \text{commutating di/dt} = 20A/\mu\text{s}$ $V_R = 50V, t_p = 500\mu\text{s}, dv/dt: \text{see table in device code}$

Blocking

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

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		
I_{GD} Max. DC gate current not to trigger	20	mA	$T_J = T_J \text{ max}, \text{rated } V_{DRM} \text{ applied}$
V_{GD} Max. DC gate voltage not to trigger	0.25		

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

Outline Table

