PROTON-ELECTROTEX
RUSSIA

Low switching losses
Low reverse recovery charge
Distributed amplified gate for high di_T/dt

Fast Thyristor
Type TFI443-630-22

Mean on-state current	I_{TAV}	630 A	
Repetitive peak off-state voltage	V_{DRM}	2000...2200 V	
Repetitive peak reverse voltage	V_{RRM}		
Turn-off time	t_q	32.0, 40.0, 50.0, 63.0 µs	

V_{DRM}, V_{RRM}, V	2000	2200
Voltage code	20	22
T_j, °C	–60...+125	

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Mean on-state current	A	589 630 871	T_c= 85 °C; Double side cooled; T_c= 81 °C; Double side cooled; T_c= 55 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	989	T_c= 81 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	10.5 12.0	$T_j=T_{j\,max}$ T_j=25 °C	180° half-sine wave; t_p=10 ms; single pulse; $V_D=V_R$=0 V; Gate pulse:$I_G=I_{FGM}$; V_G=20 V; t_{GP}=50 µs; di_G/dt=1 A/µs
			11.0 12.5	$T_j=T_{j\,max}$ T_j=25 °C	180° half-sine wave; t_p=8.3 ms; single pulse; $V_D=V_R$=0 V; Gate pulse:$I_G=I_{FGM}$; V_G=20 V; t_{GP}=50 µs; di_G/dt=1 A/µs
I^2t	Safety factor	$A^2s\cdot10^3$	550 720	$T_j=T_{j\,max}$ T_j=25 °C	180° half-sine wave; t_p=10 ms; single pulse; $V_D=V_R$=0 V; Gate pulse:$I_G=I_{FGM}$; V_G=20 V; t_{GP}=50 µs; di_G/dt=1 A/µs
			500 640	$T_j=T_{j\,max}$ T_j=25 °C	180° half-sine wave; t_p=8.3 ms; single pulse; $V_D=V_R$=0 V; Gate pulse:$I_G=I_{FGM}$; V_G=20 V; t_{GP}=50 µs; di_G/dt=1 A/µs
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	2000...2200	$T_{j\,min}$< T_j <$T_{j\,max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2100...2300	$T_{j\,min}$< T_j <$T_{j\,max}$; 180° half-sine wave; single pulse; Gate open	
V_D, V_R	Direct off-state and Direct reverse voltages	V	$0.6\cdot V_{DRM}$ $0.6\cdot V_{RRM}$	$T_j=T_{j\,max}$; Gate open	

TRIGGERING				
I_{FGM}	Peak forward gate current	A	8	$T_j=T_{j\,max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	8	$T_j=T_{j\,max}$ for DC gate current
SWITCHING				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive (f=1 Hz)	A/µs	2000	$T_j=T_{j\,max}$; $V_D=0.67{\cdot}V_{DRM}$; I_{TM}= 2500 A; Gate pulse: I_G=2 A; V_G=20 V; t_{GP}=50 µs; di_G/dt=2 A/µs
THERMAL				
T_{stg}	Storage temperature	°C	–60...+50	
T_j	Operating junction temperature	°C	–60...+125	
MECHANICAL				
F	Mounting force	kN	14.0...16.0	
a	Acceleration	m/s^2	50	Device clamped

CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions
ON-STATE				
V_{TM}	Peak on-state voltage, max	V	2.50	T_j=25 °C; I_{TM}=1978 A
$V_{T(TO)}$	On-state threshold voltage, max	V	1.397	$T_j=T_{j\,max}$; $0.5\ \pi\ I_{TAV} < I_T < 1.5\ \pi\ I_{TAV}$
r_T	On-state slope resistance, max	mΩ	0.600	
I_H	Holding current, max	mA	500	T_j=25 °C; V_D=12 V; Gate open
BLOCKING				
I_{DRM}, I_{RRM}	Repetitive peak off-state and Repetitive peak reverse currents, max	mA	100	$T_j=T_{j\,max}$; $V_D=V_{DRM}$; $V_R=V_{RRM}$
$(dv_D/dt)_{crit}$	Critical rate of rise of off-state voltage[1], min	V/µs	200, 320, 500, 1000, 1600, 2000, 2500	$T_j=T_{j\,max}$; $V_D=0.67{\cdot}V_{DRM}$; Gate open
TRIGGERING				
V_{GT}	Gate trigger direct voltage, max	V	3.00 2.50 1.50	$T_j= T_{j\,min}$ T_j=25 °C $T_j= T_{j\,max}$ V_D=12 V; I_D=3 A; Direct gate current
I_{GT}	Gate trigger direct current, max	mA	500 300 150	$T_j= T_{j\,min}$ T_j= 25 °C $T_j= T_{j\,max}$
V_{GD}	Gate non-trigger direct voltage, min	V	0.35	$T_j=T_{j\,max}$; $V_D=0.67{\cdot}V_{DRM}$; Direct gate current
I_{GD}	Gate non-trigger direct current, min	mA	50.00	
SWITCHING				
t_{gd}	Delay time, max	µs	0.75	T_j=25 °C; V_D=1000 V; $I_{TM}=I_{TAV}$; di/dt=200 A/µs; Gate pulse: I_G=2 A; V_G=20 V; t_{GP}=50 µs; di_G/dt=2 A/µs
t_{gt}	Turn-on time[2], max	µs	1.60, 2.00, 2.50, 3.20	
t_q	Turn-off time[3] max	µs	32.0, 40.0, 50.0, 63.0	dv_D/dt=50 V/µs; $T_j=T_{j\,max}$; $I_{TM}= I_{TAV}$; di_R/dt=-10 A/µs; V_R=100V; $V_D=0.67{\cdot}V_{DRM}$
			40.0, 50.0, 63.0, 80.0	dv_D/dt=200 V/µs;
Q_{rr}	Total recovered charge, max	µC	350	$T_j=T_{j\,max}$; $I_{TM}= I_{TAV}$; di_R/dt=-50 A/µs; V_R=100 V
t_{rr}	Reverse recovery time, typ	µs	5.0	
I_{rrM}	Peak reverse recovery current, max	A	155	

THERMAL					
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0300	Direct current	Double side cooled
$R_{thjc\text{-}A}$			0.0660		Anode side cooled
$R_{thjc\text{-}K}$			0.0540		Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0060	Direct current	
MECHANICAL					
w	Weight, max	g	180		
D_s	Surface creepage distance	mm (inch)	7.86 (0.309)		
D_a	Air strike distance	mm (inch)	6.10 (0.240)		

PART NUMBERING GUIDE

TFI	443	630	22	A2	C3	K4	N
1	2	3	4	5	6	7	8

1. TFI — fast inverter thyristor
2. Design version
3. Mean on-state current, A
4. Voltage code
5. Critical rate of rise of off-state voltage
6. Group of turn-off time (dv_D/dt=50 V/µs)
7. Group of turn-on time
8. Ambient conditions: N – normal; T – tropical

NOTES

1) Critical rate of rise of off-state voltage

Symbol of Group	P2	K2	E2	A2	T1	P1	M1
$(dv_D/dt)_{crit}$, V/µs	200	320	500	1000	1600	2000	2500

2) Turn-on time

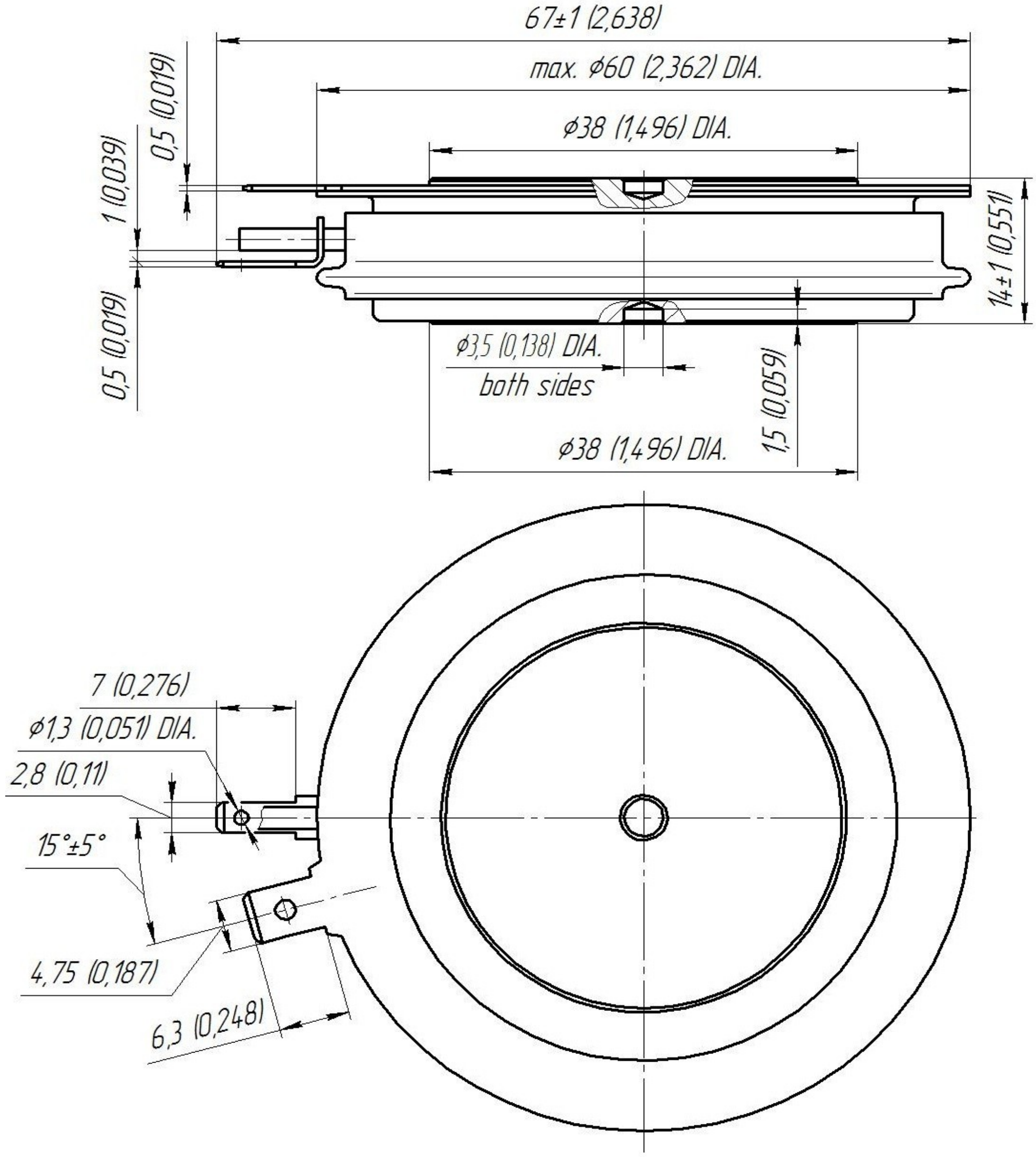
Symbol of group	T4	P4	M4	K4
t_{gt}, µs	1.60	2.00	2.50	3.20

3) Turn-off time (dv_D/dt=50 V/µs)

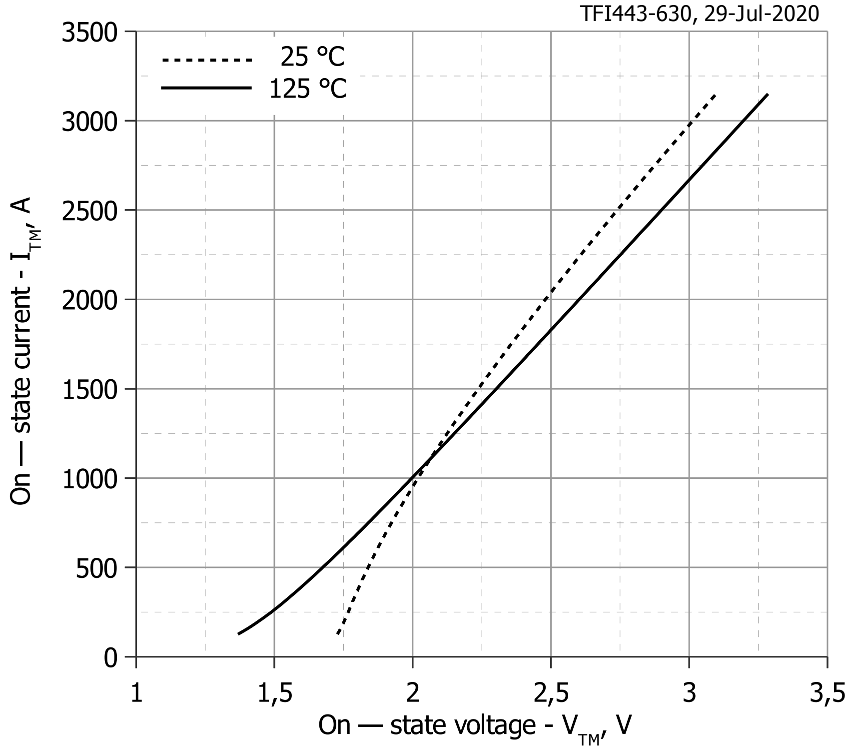
Symbol of group	K3	H3	E3	C3
t_q, µs	32.0	40.0	50.0	63.0

OVERALL DIMENSIONS

Package type: T.C1



All dimensions in millimeters (inches)

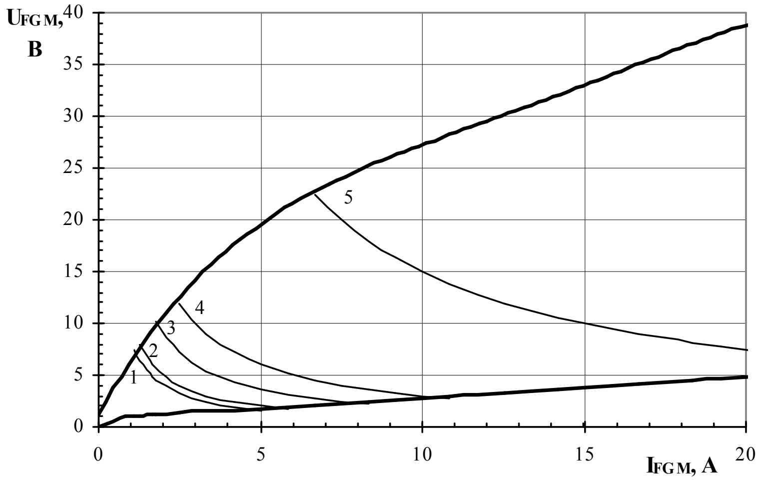


Analytical function for On-state characteristic:

$$V_T = A + B \cdot i_T + C \cdot \ln(i_T + 1) + D \cdot \sqrt{i_T}$$

	Coefficients for max curves	
	T_j = 25°C	$T_j = T_{j\ max}$
A	1.25444891	0.83427733
B	0.00086338	0.00061607
C	0.16693388	0.10947503
D	-0.03957676	-0.00662236

Fig. 1 On-state characteristics of Limit device



Maximum peak gate power loss

Position	On-Off time ratio	Gate pulse length, ms	Gate Pulse Power, W
1	1	DC	8
2	2	10	10
3	20	1	18
4	40	0.5	30
5	200	0.1	150

Fig. 2 Gate characteristics

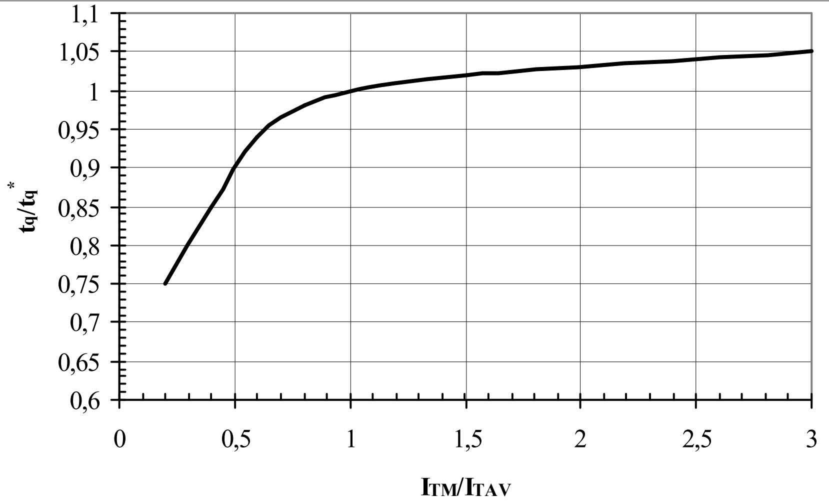


Fig. 3 Turn-off time t_q vs. On-state peak current I_{TM}

Conditions: $T_j=T_{j\,max}$; $di_R/dt=10$ A/µs; $V_R=100$ V; $dv_D/dt=50$ V/µs; $V_D=0.67 \cdot V_{DRM}$
Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50$ V/µs)

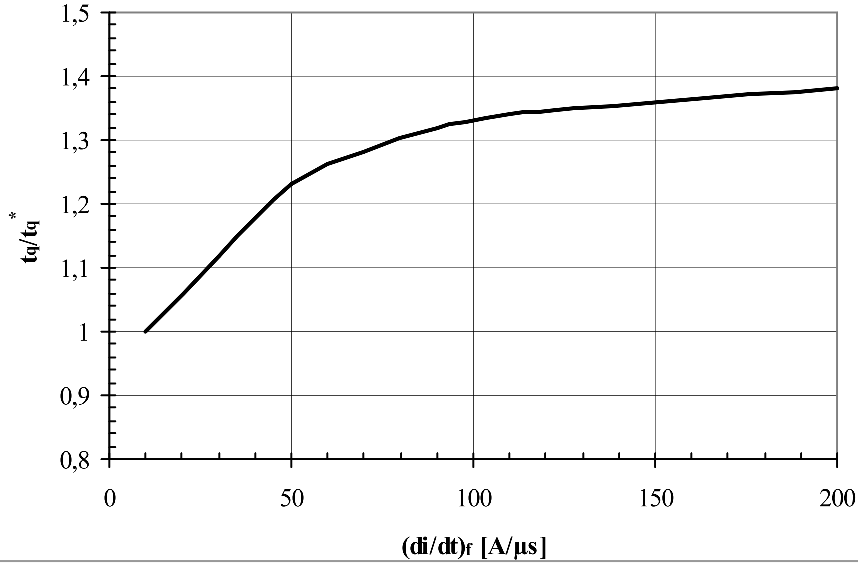


Fig. 4 Turn-off time t_q vs. Rate of fall of on-state current di_R/dt

Conditions: $T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; $V_R=100$ V; $dv_D/dt=50$ V/µs; $V_D=0.67 \cdot V_{DRM}$
Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50$ V/µs)

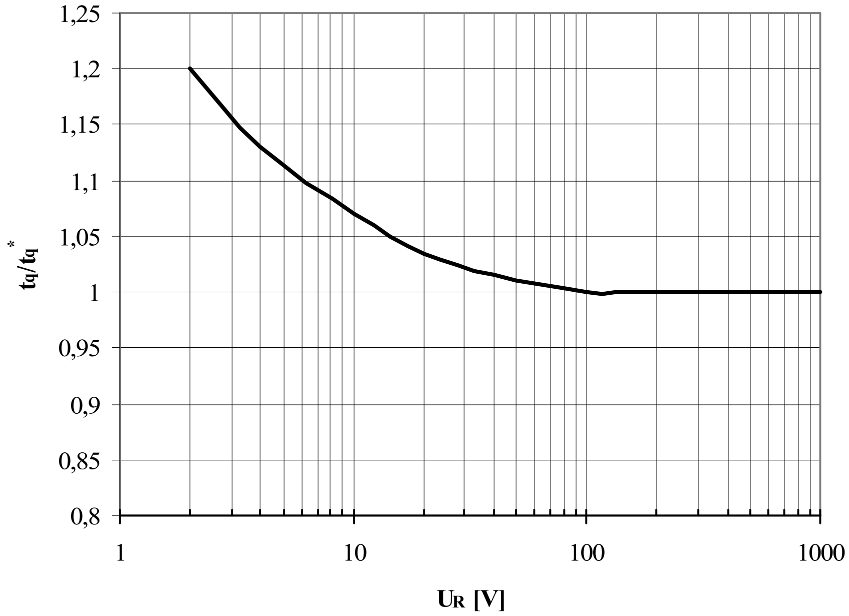


Fig. 5 Turn-off time t_q vs. Reverse voltage V_R

Conditions: $T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; $di_R/dt=10$ A/µs; $dv_D/dt=50$ V/µs; $V_D=0.67 \cdot V_{DRM}$
Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50$ V/µs)

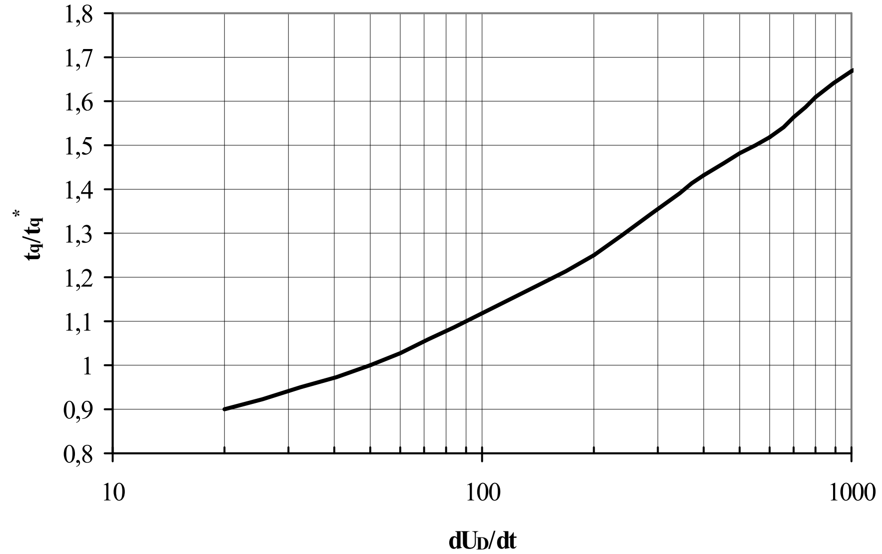


Fig. 6 Turn-off time t_q vs. Rate of rise of commutating voltage dv_D/dt

Conditions: $T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; $di_R/dt=10$ A/µs; $V_R=100$ V; $V_D=0.67 \cdot V_{DRM}$
Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50$ V/µs)

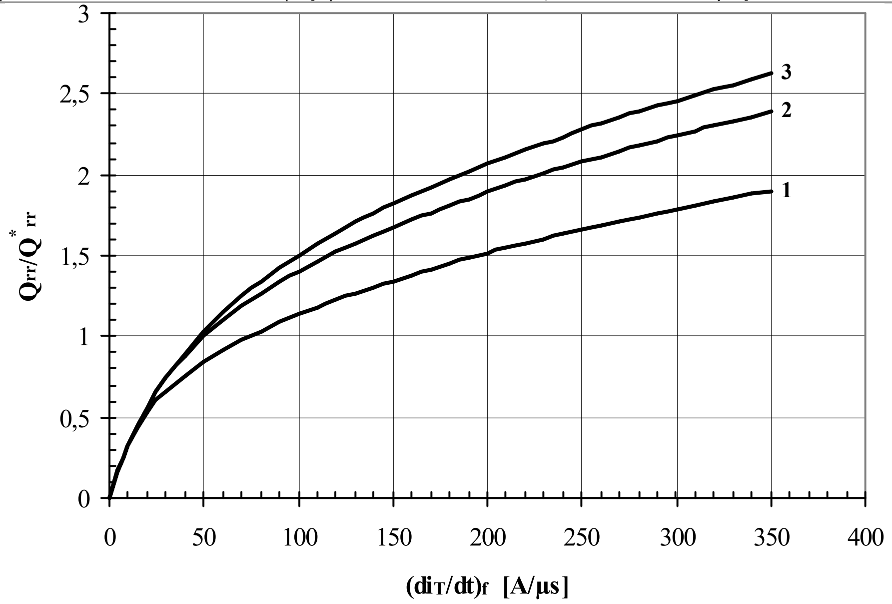


Fig. 7 Reverse recovery charge Q_{rr}, vs. Rate of fall of on-state current di_R/dt
1 – $I_{TM} = 0.5 \cdot I_{TAV}$
2 – $I_{TM} = I_{TAV}$,
3 – $I_{TM} = 1.5 \cdot I_{TAV}$

Conditions: $T_j=T_{j\,max}$; $V_R=100$ V
Typical changes of Q_{rr} are normalized to the Q_{rr}^* (Q_{rr}^* – see data sheet)

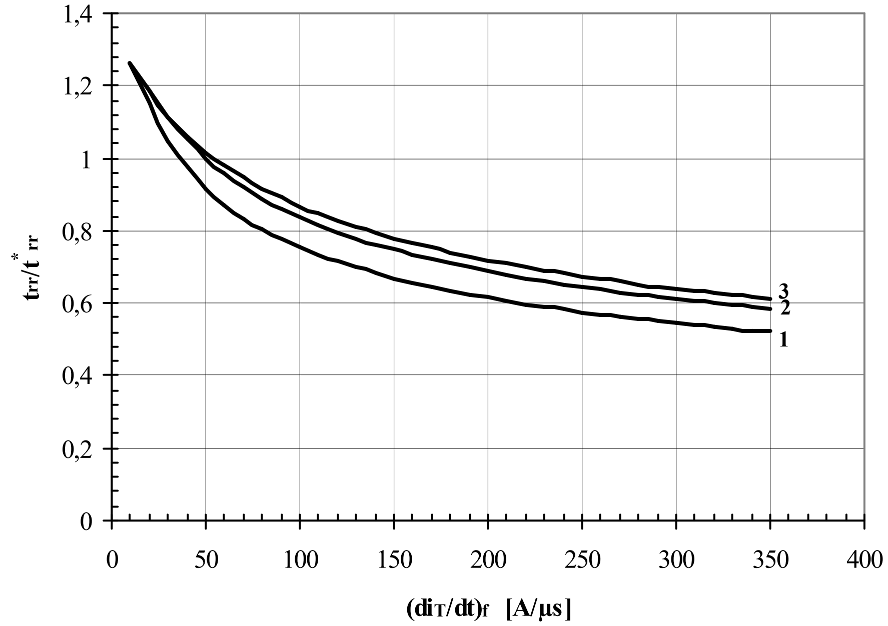


Fig. 8 Reverse recovery time t_{rr} vs. Rate of fall of on-state current di_R/dt
1 – $I_{TM} = 0.5 \cdot I_{TAV}$
2 – $I_{TM} = I_{TAV}$,
3 – $I_{TM} = 1.5 \cdot I_{TAV}$

Conditions: $T_j = T_{j\,max}$; V_R=100 V
Typical changes of t_{rr} are normalized to the t_{rr}^* (t_{rr}^* – see data sheet)

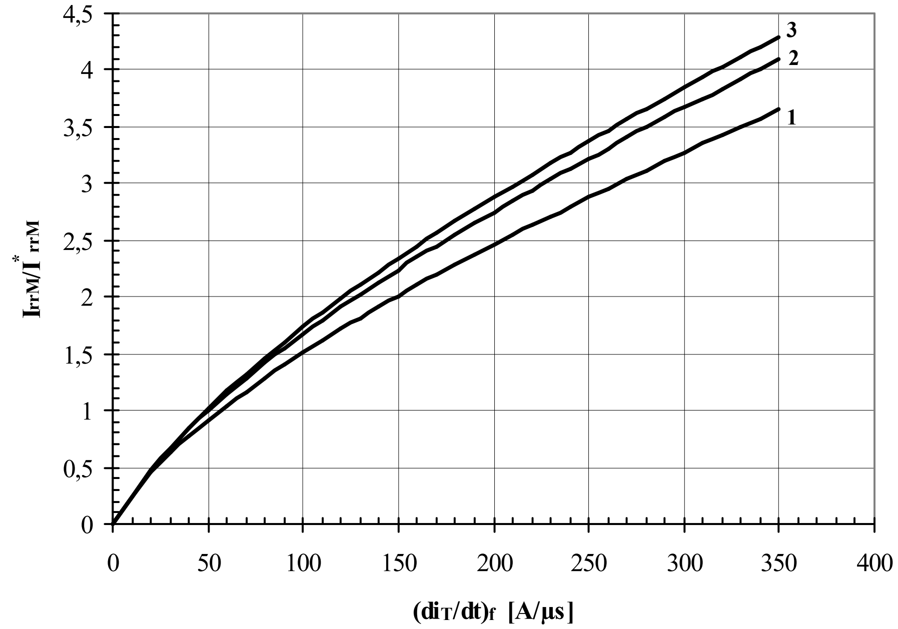


Fig. 9 Peak reverse recovery current I_{rrM} vs. Rate of fall of on-state current di_R/dt
1 – $I_{TM} = 0.5 \cdot I_{TAV}$
2 – $I_{TM} = I_{TAV}$,
3 – $I_{TM} = 1.5 \cdot I_{TAV}$

Conditions: $T_j = T_{j\,max}$; V_R=100 V
Typical changes of I_{rrM} are normalized to the I_{rrM}^* (I_{rrM}^* – see data sheet)

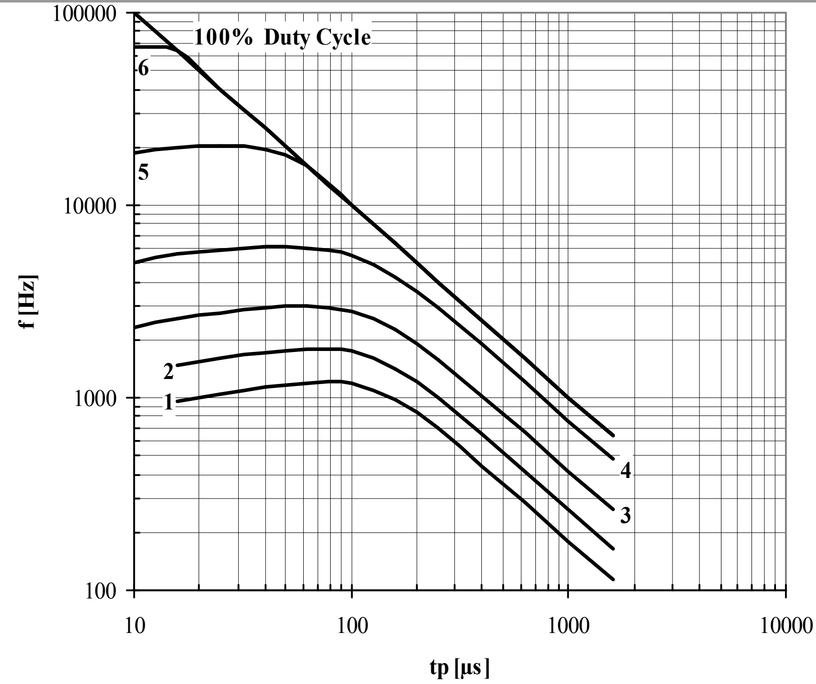


Fig. 10 Sine wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A

Conditions: $V_R \leq 3$ V; T_C=55 °C

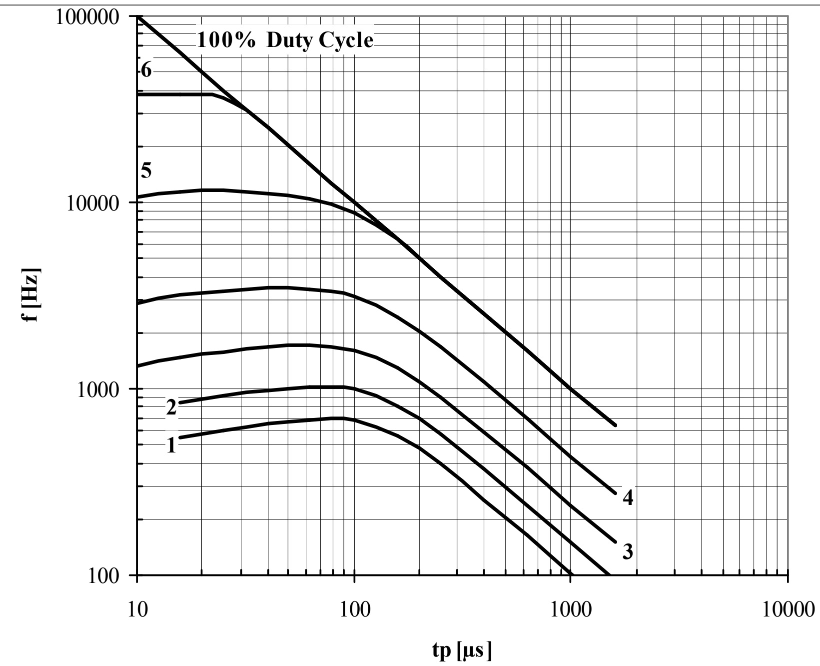


Fig. 11 Sine wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V; T_C=80 °C

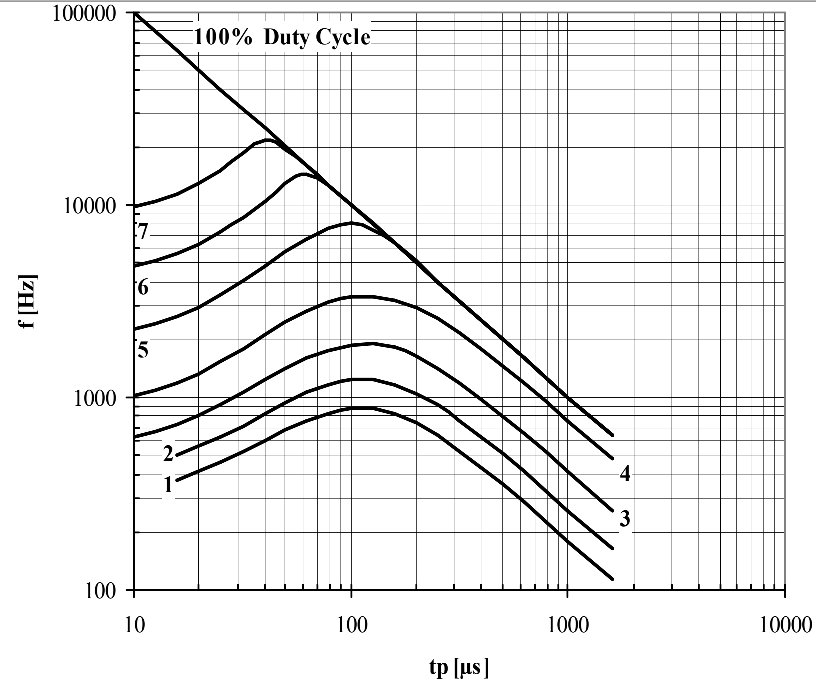


Fig. 12 Sine wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=55 °C

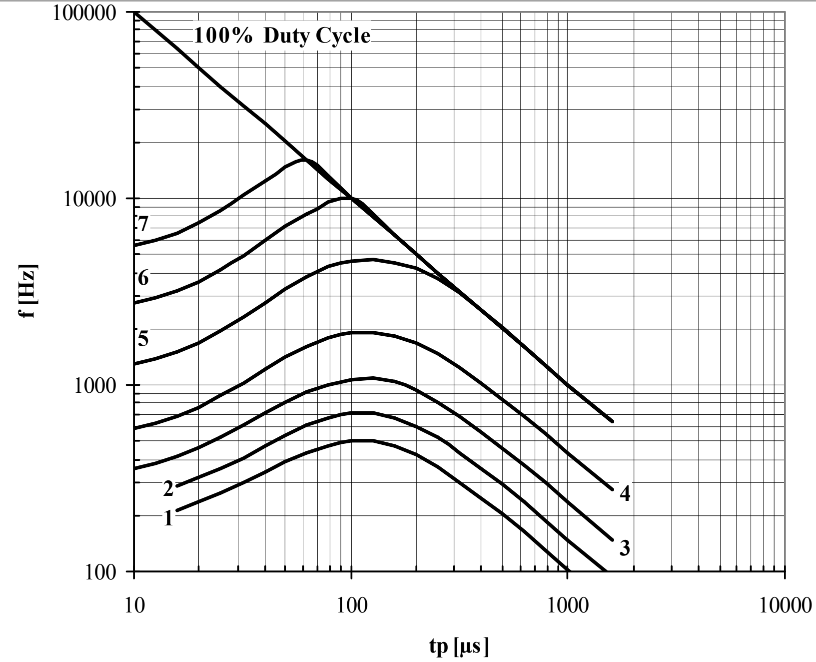


Fig. 13 Sine wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=80 °C

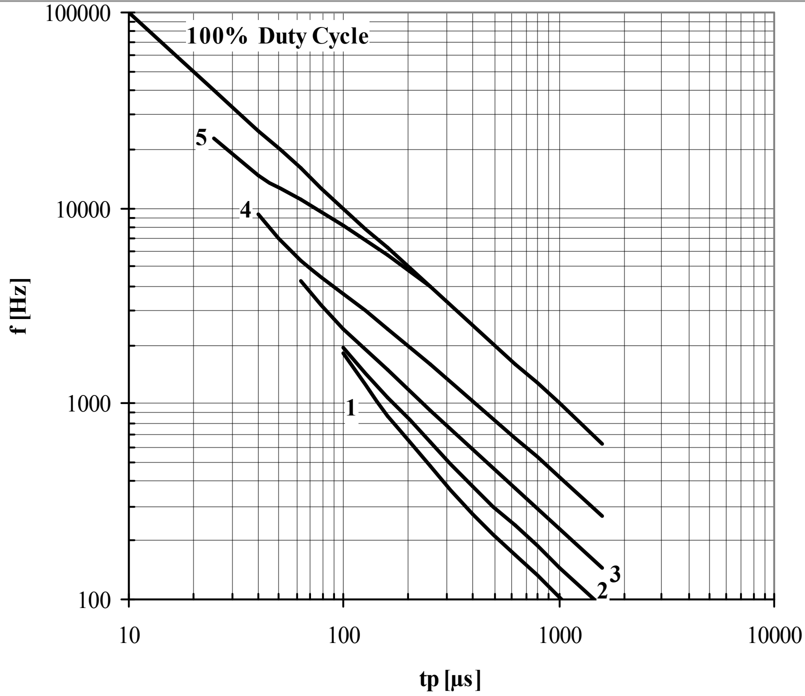


Fig. 14 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A

Conditions: $V_R \le 3$ V; T_C=55 °C; $di_F/dt=di_R/dt$=100 A/µs

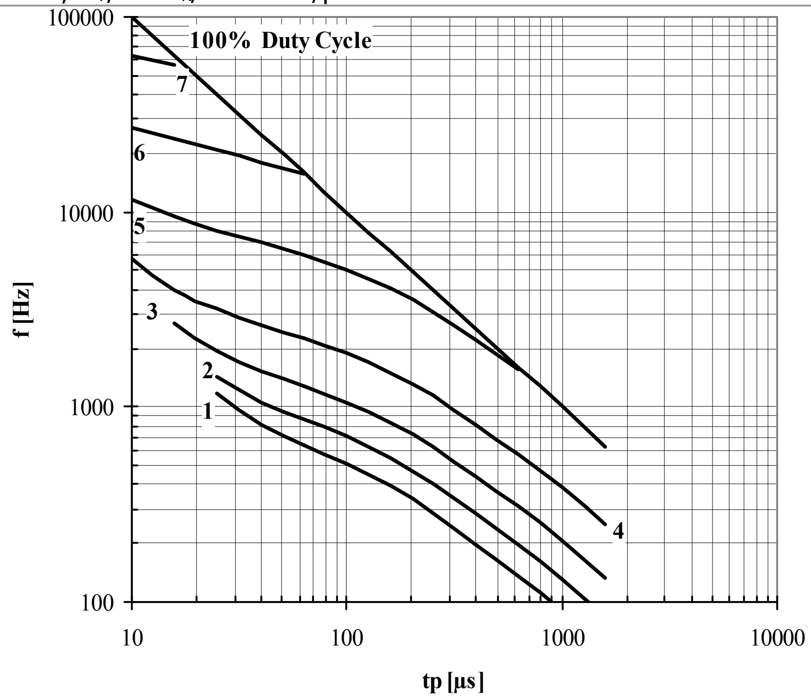


Fig. 15 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \le 3$ V; T_C=55 °C; $di_F/dt=di_R/dt$=500 A/µs

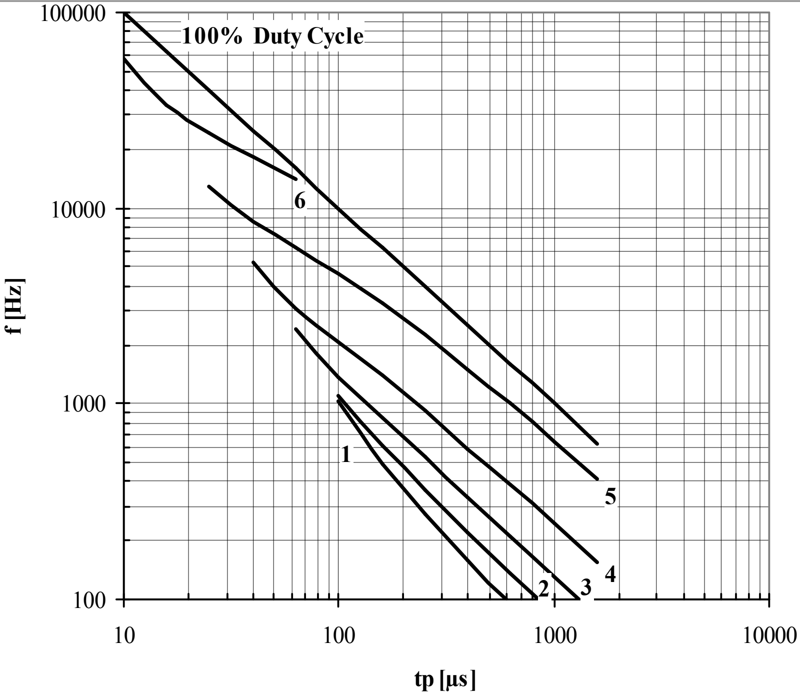


Fig. 16 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V; T_C=80 °C; $di_F/dt=di_R/dt$=100 A/µs

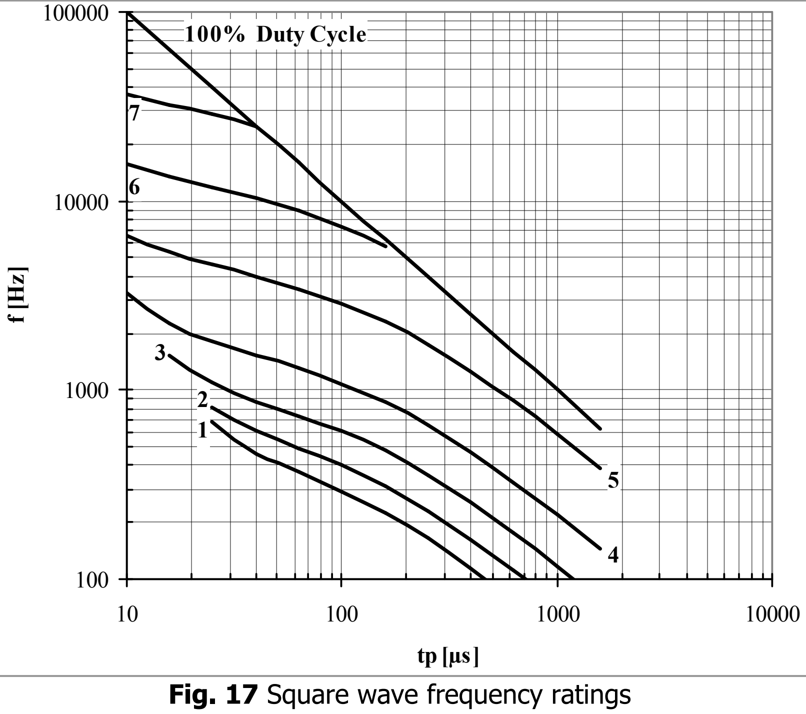


Fig. 17 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V; T_C=80 °C; $di_F/dt=di_R/dt$=500 A/µs

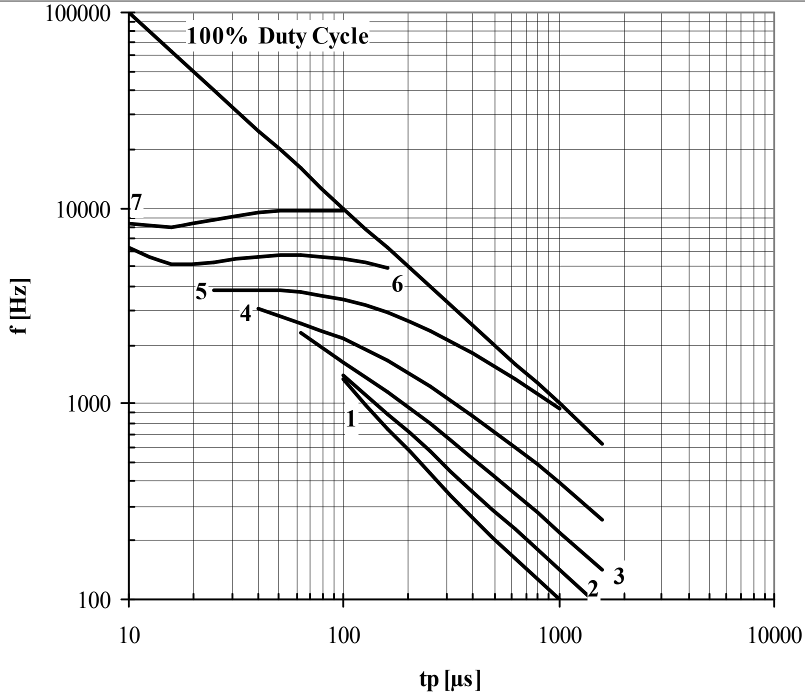


Fig. 18 Square wave frequency ratings

1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=55 °C; di_F/dt=di_R/dt=100 A/µs

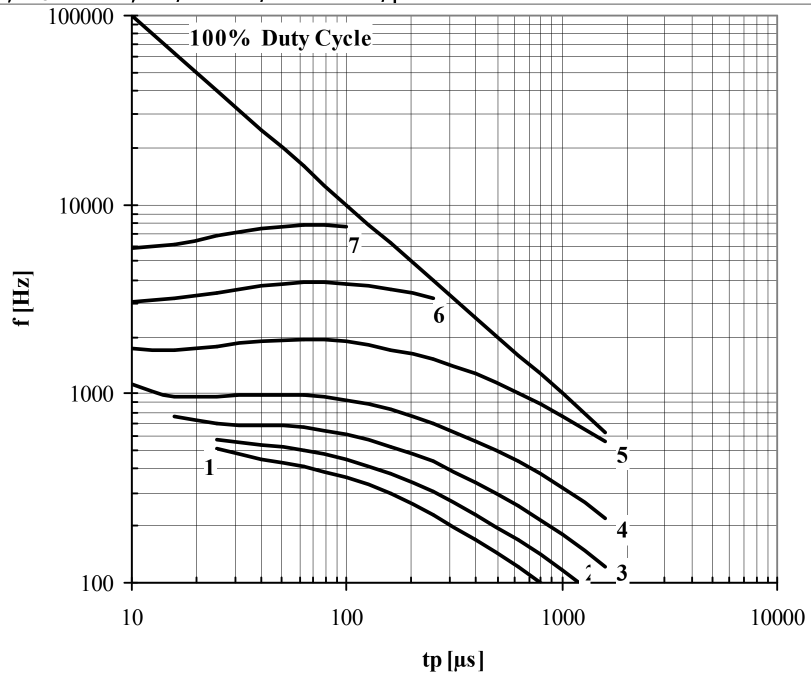


Fig. 19 Square wave frequency ratings

1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=55 °C; di_F/dt=di_R/dt=500 A/µs

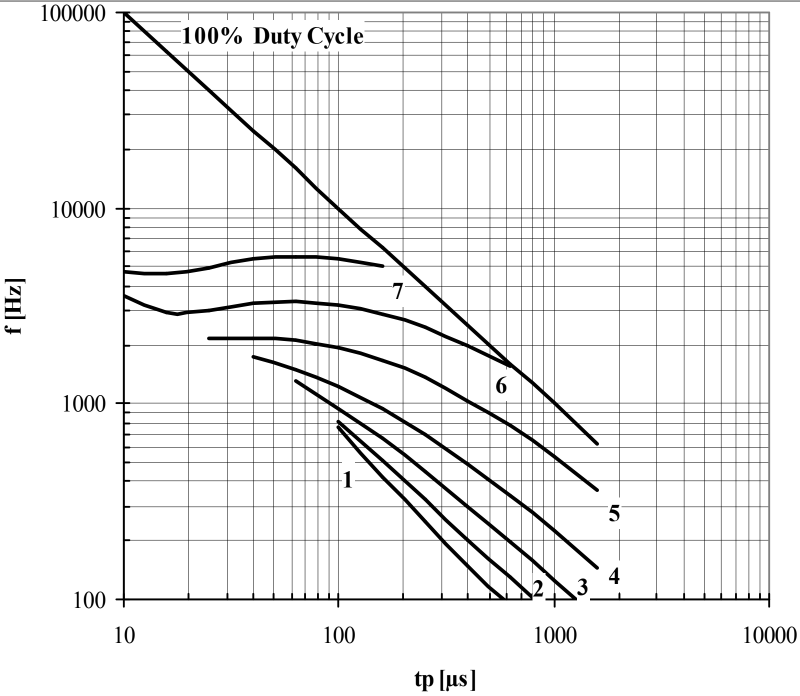


Fig. 20 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=80 °C; di_F/dt=di_R/dt=100 A/μs

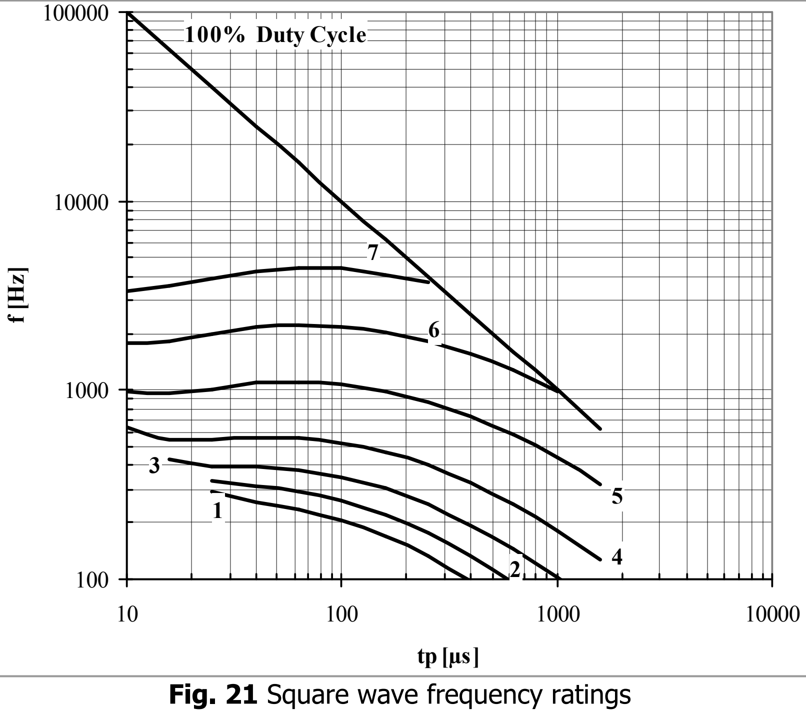


Fig. 21 Square wave frequency ratings
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: V_R=0.67·V_{RRM}; T_C=80 °C; di_F/dt=di_R/dt=500 A/μs

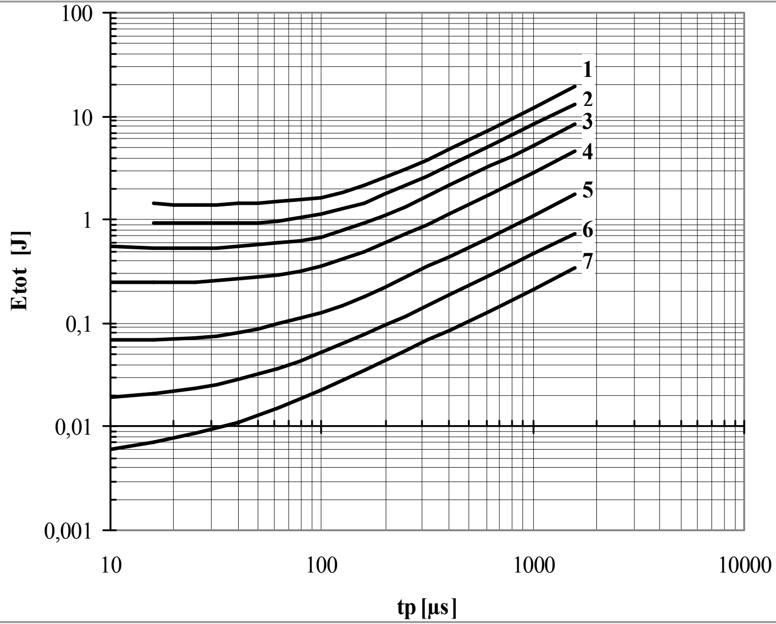


Fig. 22 Sine wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V

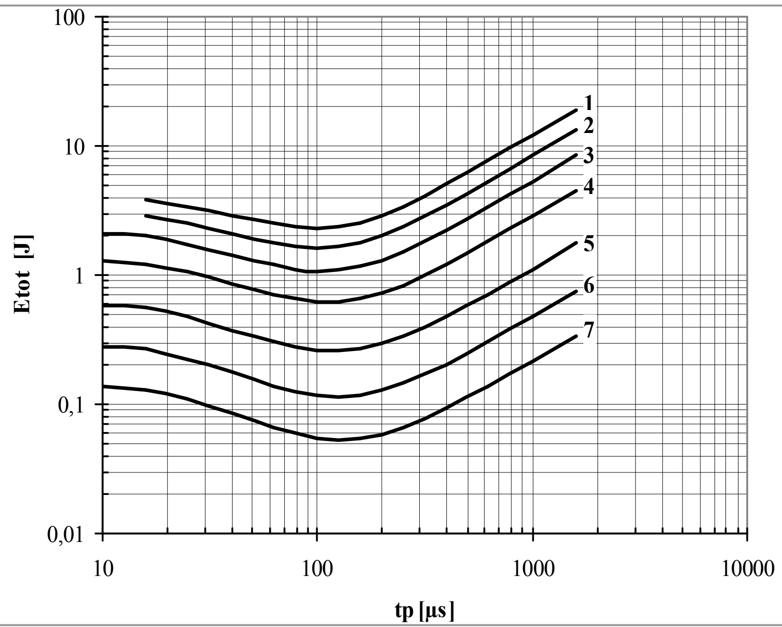


Fig. 23 Sine wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R = 0.67 \cdot V_{RRM}$

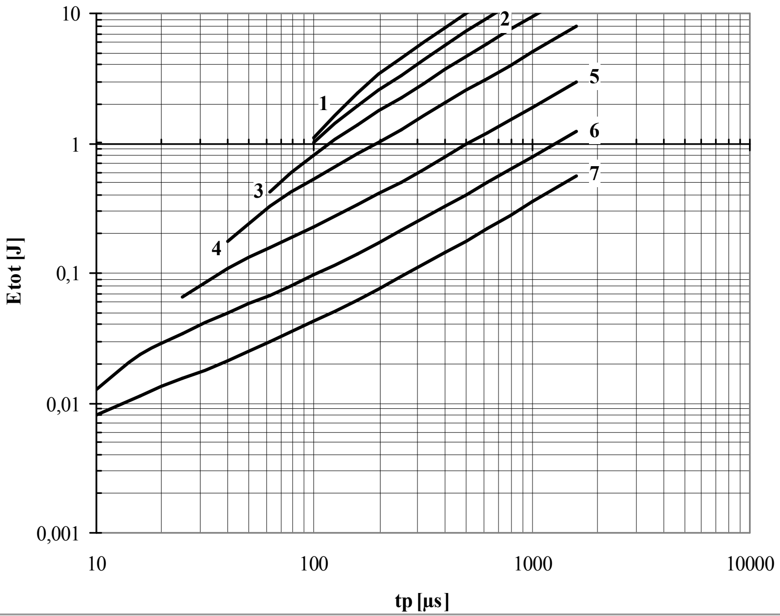


Fig. 24 Square wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V; $di_F/dt = di_R/dt = 100$ A/µs

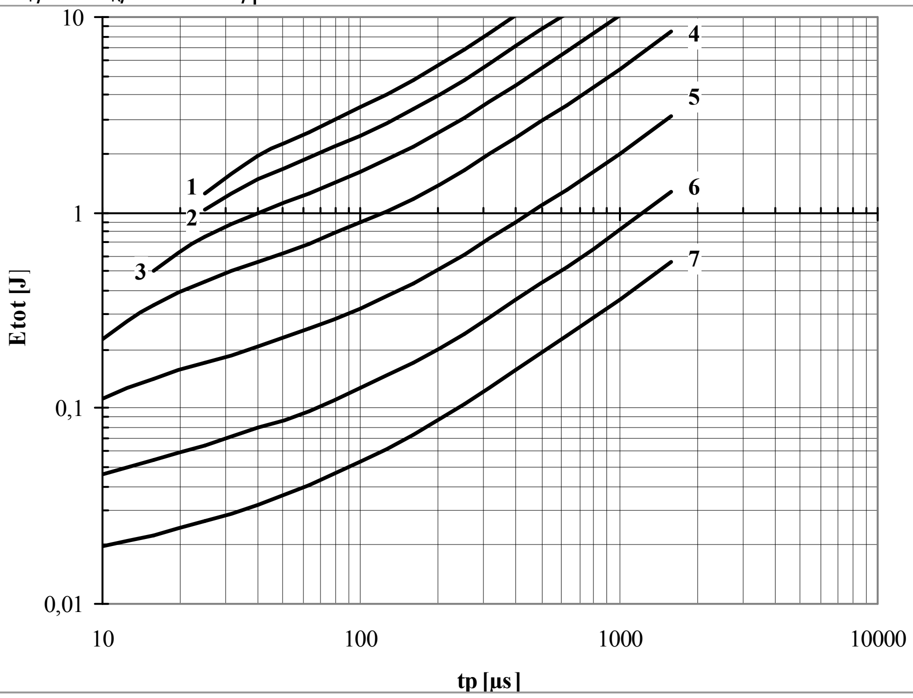


Fig. 25 Square wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R \leq 3$ V; $di_F/dt = di_R/dt = 500$ A/µs

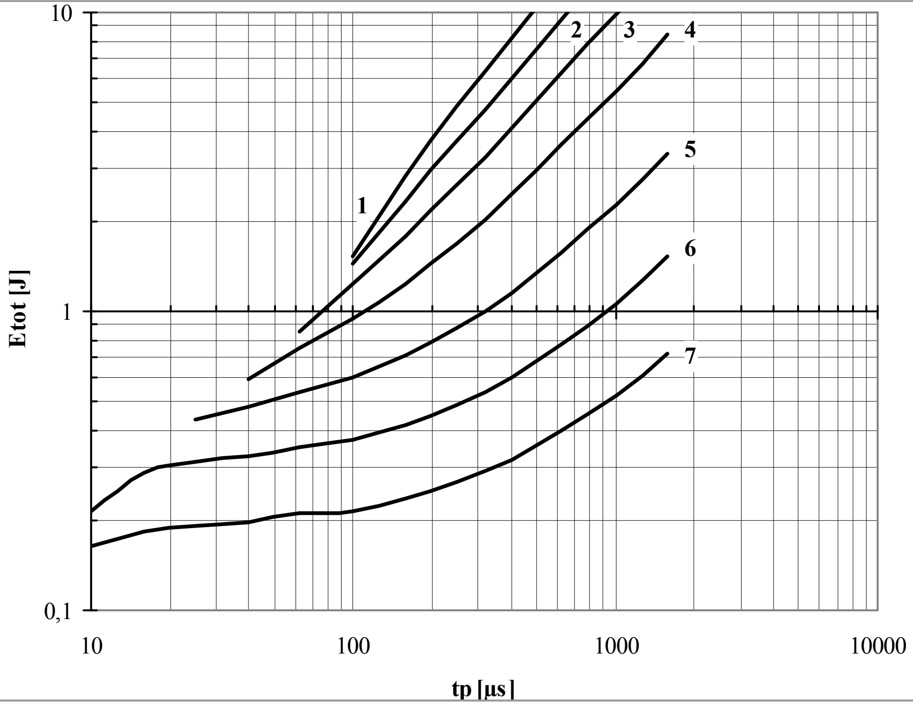


Fig. 26 Square wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R = 0.67 \cdot V_{RRM}$; $di_F/dt = di_R/dt = 100$ A/µs

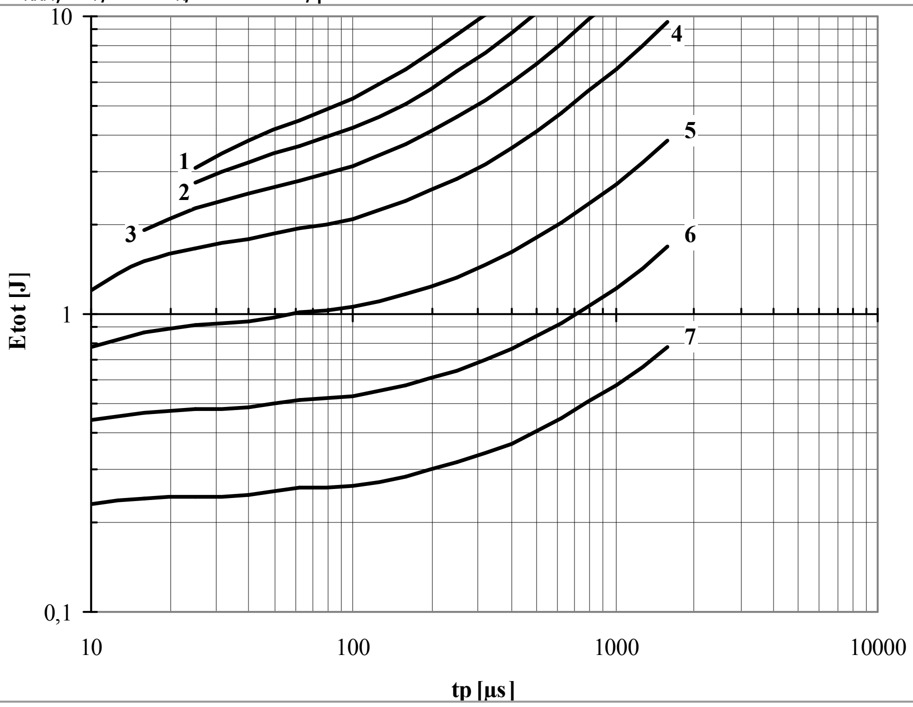


Fig. 27 Square wave loss energy per pulse
1 – I_{TM} = 5000 A
2 – I_{TM} = 4000 A
3 – I_{TM} = 3000 A
4 – I_{TM} = 2000 A
5 – I_{TM} = 1000 A
6 – I_{TM} = 500 A
7 – I_{TM} = 250 A

Conditions: $V_R = 0.67 \cdot V_{RRM}$; $di_F/dt = di_R/dt = 500$ A/µs

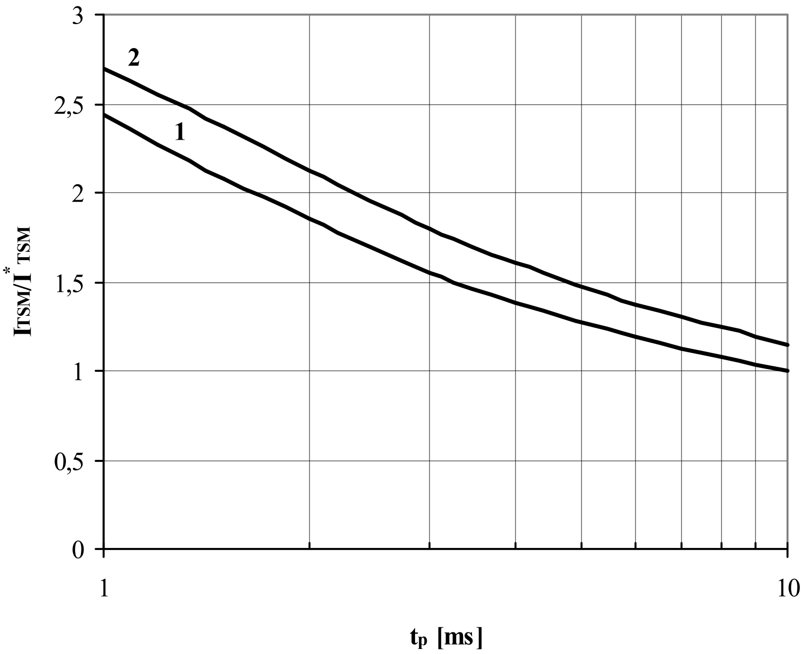


Fig. 28 The surge current I_{TSM} vs. Duration of surge t_p for a half-sine wave
1 – T_j=125 °C
2 – T_j=25 °C

Conditions: V_R=0 V – the peak value of reverse voltage which is applied immediately after the surge current
Typical changes of I_{TSM} are normalized to the I_{TSM}^* (I_{TSM}^* – see data sheet, $T_j=T_{j\,max}$)

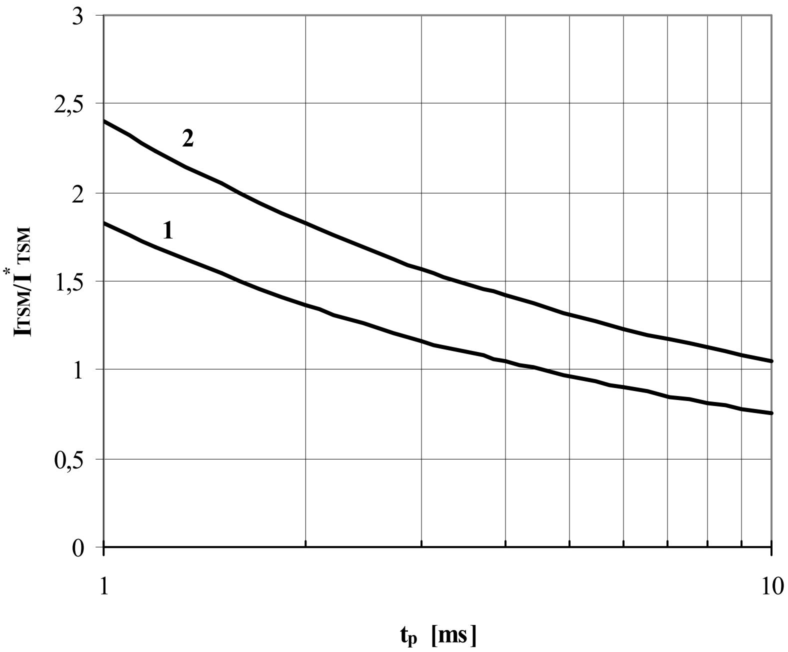


Fig. 29 The surge current I_{TSM} vs. Duration of surge t_p for a half-sine wave
1 – T_j=125 °C
2 – T_j=25 °C

Conditions: V_R=0.8·V_{RRM} – the peak value of reverse voltage which is applied immediately after the surge current
Typical changes of I_{TSM} are normalized to the I_{TSM}^* (I_{TSM}^* – see data sheet, $T_j=T_{j\,max}$)

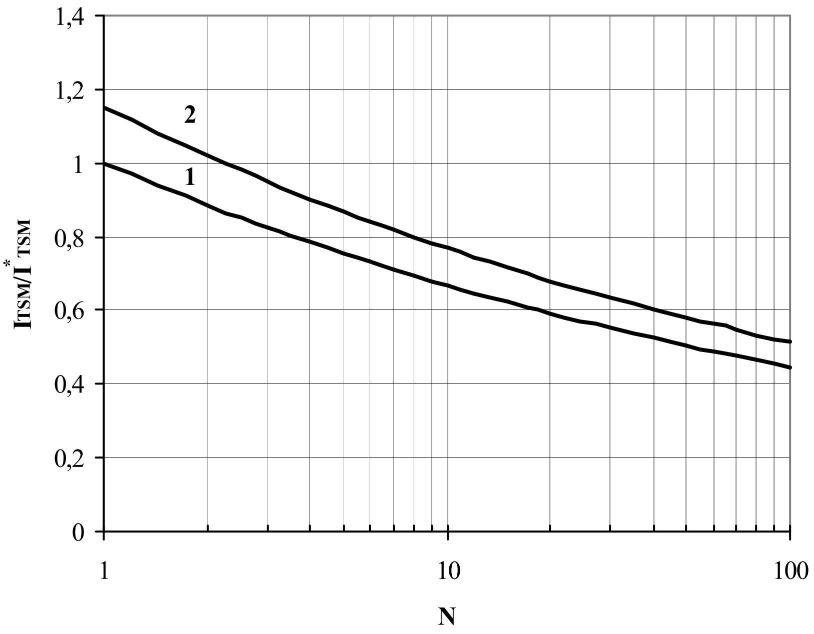


Fig. 30 The surge current I_{TSM} vs. Number of half-sine waves at 50 Hz
1 – T_j=125 °C
2 – T_j=25 °C

Conditions: V_R=0 V – the peak value of reverse voltage which is applied immediately after the surge current
Typical changes of I_{TSM} are normalized to the I_{TSM}^* (I_{TSM}^* – see data sheet, $T_j=T_{j\,max}$)

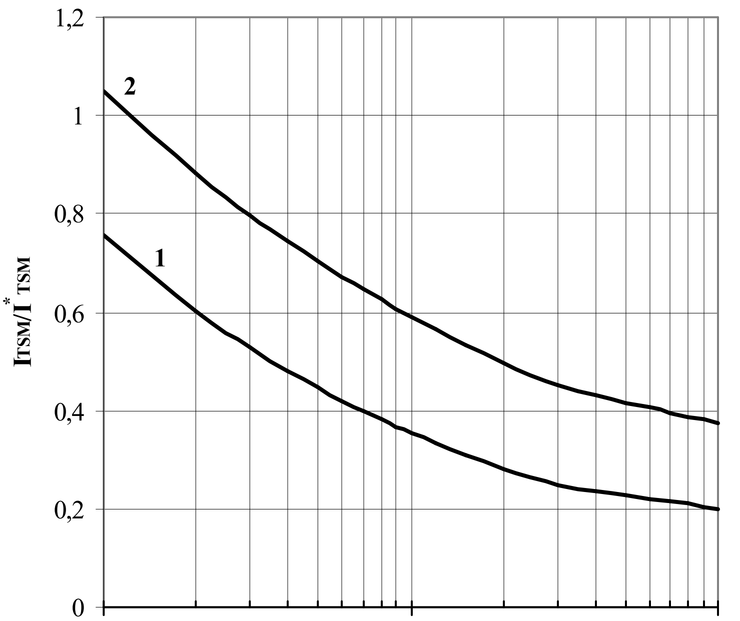


Fig. 31 The surge current I_{TSM} vs. Number of half-sine waves at 50 Hz
1 – T_j=125°C
2 – T_j=25°C

Conditions: $V_R=0.8 \cdot V_{RRM}$ – the peak value of reverse voltage which is applied immediately after the surge current
Typical changes of I_{TSM} are normalized to the I_{TSM}^* (I_{TSM}^* – see data sheet, $T_j=T_{j\,max}$)