

Series
TFI333-320

High Frequency Inverter grade Capsule Thyristor Type TFI333-320

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

Maximum mean on-state current	I_{TAV} 320 A							
Maximum repetitive peak off-state and reverse voltage	U_{DRM} 1200 ÷ 2200 V							
Turn-off time	U_{RRM} 20; 25; 32 μs							
U_{DRM}, U_{RRM}, V	1200	1300	1400	1500	1600	1800	2000	2200
Voltage code	12	13	14	15	16	18	20	22
$T_{vj}, ^\circ C$	- 60 ÷ 125							

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	TFI333-320	Conditions
I_{TAV}	Mean on-state current	A	320 480	$T_c=85^\circ C$, $T_c=55^\circ C$, 180° half-sine wave, 50 Hz
I_{TRMS}	RMS on-state current	A	502	$T_c=85^\circ C$
I_{TSM}	Surge on-state current	kA	6,3 7,0	$T_{vj}=125^\circ C$ $T_{vj}=25^\circ C$ tp=10 ms
I^2t	Limiting load integral	kA^2s	198 245	$T_{vj}=125^\circ C$ $T_{vj}=25^\circ C$ $U_R=0$
U_{DRM}, U_{RRM}	Repetitive peak off-state and reverse voltage	V	1200÷2200	$T_j \min \leq T_{vj} \leq T_{jM}$ 180° half-sine wave, 50 Hz Gate open
U_{DSM}, U_{RSM}	Non-repetitive peak off-state and reverse voltage	V	1300÷2300	$T_j \min \leq T_{vj} \leq T_{jM}$ 180° half-sine wave tp=10 ms, Single pulse Gate open
(di _T /dt) crit	Critical rate of rise of on-state current : non - repetitive repetitive	A/ μ s	1600 800	$T_{vj}=125^\circ C$; $U_D=0,67 U_{DRM}$, Gate pulse : 10V, 5 Ω , 1 μ s rise time, 10 μ s
U_{RGM}	Peak reverse gate voltage	V	5	$T_j \min \leq T_{vj} \leq T_{jM}$
T_{stg}	Storage temperature	$^\circ C$	-60÷80	
T_{vj}	Junction temperature	$^\circ C$	-60÷125	

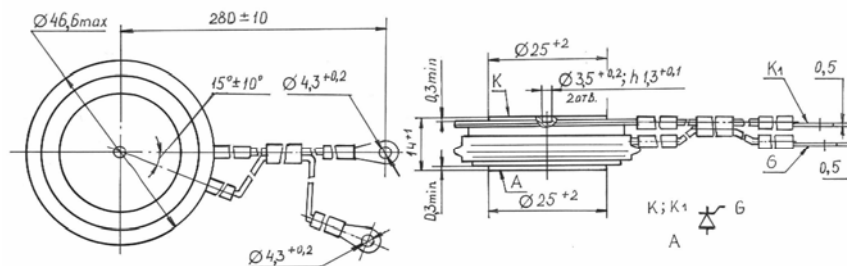
CHARACTERISTICS

U_{TM}	Peak on-state voltage	V	2,6	$T_{vj}=25^\circ C$, $I_{TM}=3,14 I_{TAV}$
$U_{T(To)}$	Threshold voltage	V	1,6	$T_{vj}=125^\circ C$
R_T	On-state slope resistance	m Ω	1,25	1,57 $I_{TAV} < I_T < 4,71 I_{TAV}$
I_{DRM} I_{RRM}	Repetitive peak off-state and reverse current	mA	50 50	$T_{vj}=125^\circ C$, $U_D = U_{DRM}$ $U_R = U_{RRM}$

CHARACTERISTICS				
Symbols and parameters		Units	TFI333-320	Conditions
I_L	Latching current	A	5	$T_{vj}=25^{\circ}\text{C}, U_D=12\text{V}$ Gate pulse : 10V, 5 μs , 1 μs rise time, 10 μs
I_H	Holding current	A	0,5	$T_{vj}=25^{\circ}\text{C}, U_D=12\text{V}$, Gate open
U_{GT}	Gate trigger direct voltage	V	2,5 5,0	$T_{vj}=25^{\circ}\text{C}$, $T_{vj}=-60^{\circ}\text{C}$
I_{GT}	Gate trigger direct current	A	0,3 0,85	$T_{vj}=25^{\circ}\text{C}$, $T_{vj}=-60^{\circ}\text{C}$
U_{GD}	Gate non-trigger direct voltage	V	0,25	$T_{vj}=125^{\circ}\text{C}$, $U_D = 0,67 U_{DRM}$
I_{GD}	Gate non-trigger direct current	mA	10	Direct gate current
t_{gd}	Delay time	μs	1,6	$T_{vj}=25^{\circ}\text{C}, U_D=500\text{V}$ $I_{TM} = 320 \text{ A}$
t_{gt}	Turn-on time	μs	2,5	Gate pulse : 10V, 5 μs , 1 μs rise time, 10 μs
t_q	Turn-off time	μs	20÷32 25÷40	$T_{vj}=125^{\circ}\text{C}$, $I_{TM}=320 \text{ A}$ $di_R/dt = 10 \text{ A}/\mu\text{s}$, $U_R=100\text{V}$ $U_D = 0,67 U_{DRM}$ $du_D/dt=50 \text{ V}/\mu\text{s}$ $du_D/dt=200 \text{ V}/\mu\text{s}$
Q_{rr}	Recovered charge	μC	300	$T_{vj}=125^{\circ}\text{C}$, $I_{TM}=320 \text{ A}$ $di_R/dt=50 \text{ A}/\mu\text{s}$, $U_R=100\text{V}$
t_{rr}	Reverse recovery time	μs	4,6	
I_{rrm}	Peak reverse recovery current	A	130	
$(du_D/dt)_{crit}$	Critical rate of rise of off-state voltage	V/ μs	500 1000	$T_{vj}=125^{\circ}\text{C}$, $U_D = 0,67 U_{DRM}$ Gate open
R_{thjc}	Thermal resistance junction to case	$^{\circ}\text{C}/\text{W}$	0,045	Direct current, double side cooled

ORDERING							
	TFI	333	320	20	7	6	3
	1	2	3	4	5	6	7

1. Fast thyristor with interdigitated gate structure.
2. Design version.
3. Mean on-state current, A.
4. Voltage code (20=2000V).
5. Critical rate of rise of off-state voltage ($6 \geq 500 \text{ V}/\mu\text{s}$, $7 \geq 1000 \text{ V}/\mu\text{s}$)
6. Group of turn-off time ($du_D/dt=50 \text{ V}/\mu\text{s}$, $4 \leq 32 \mu\text{s}$, $5 \leq 25\mu\text{s}$, $6 \leq 20 \mu\text{s}$)
7. Group of turn-on time ($3 \leq 2,5 \mu\text{s}$).



Mouting force : 9÷12 kN
Weight : 120 grams

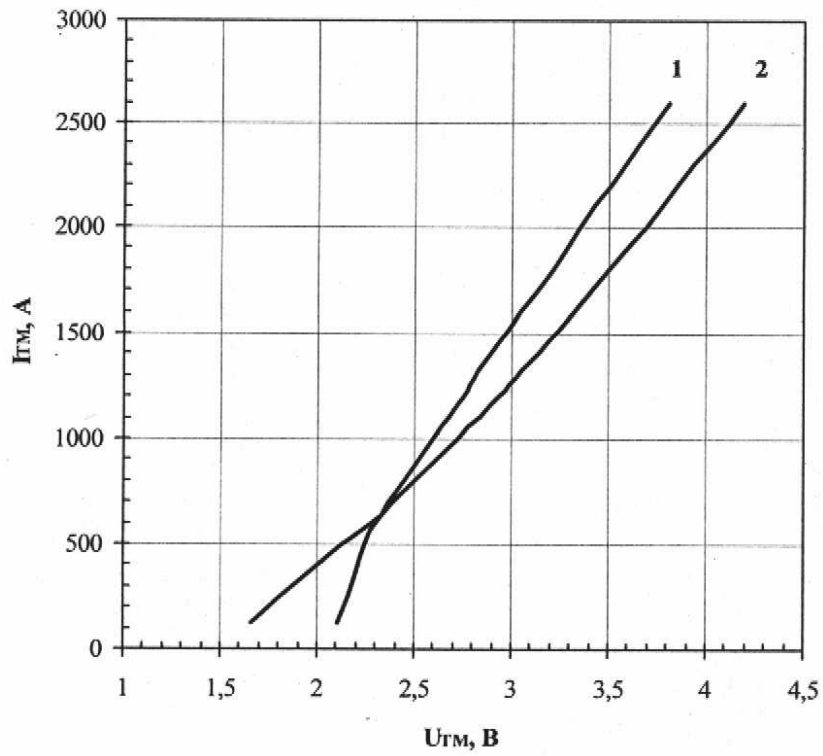
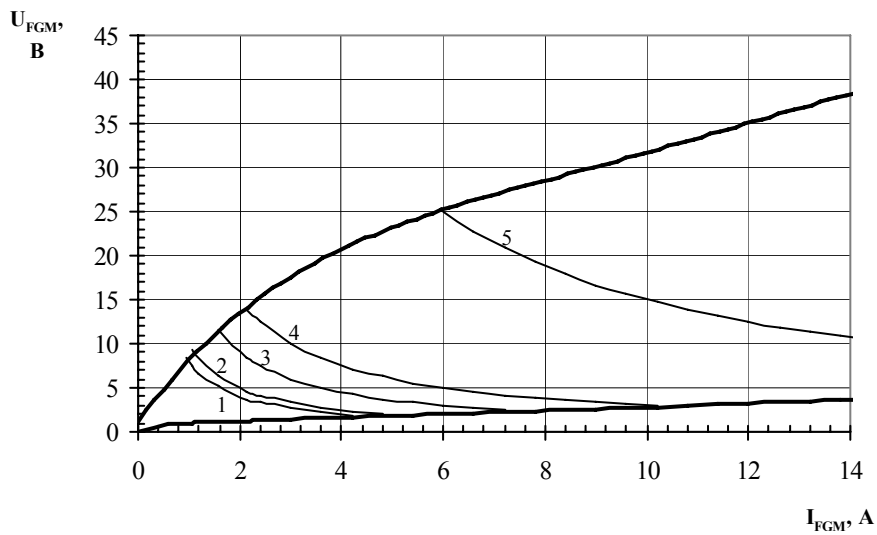


Fig. 1 On-state characteristics of Limit device

1 - $T_j = 25\text{ }^\circ\text{C}$

2 - $T_j = 125\text{ }^\circ\text{C}$



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

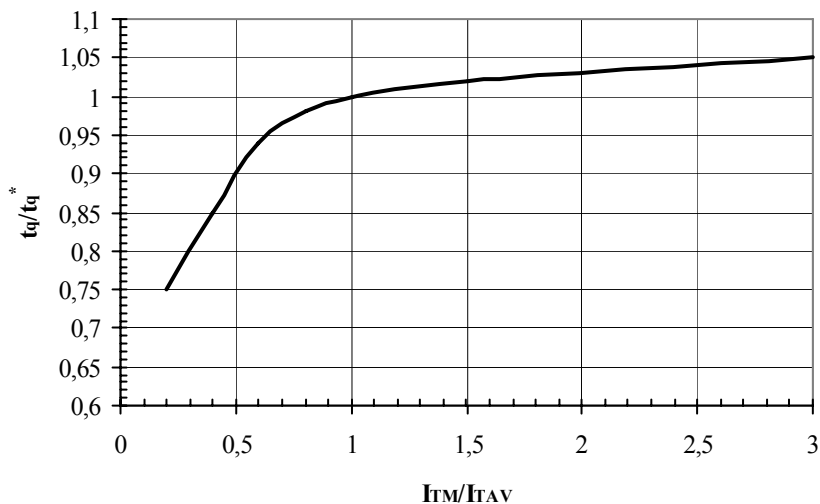


Fig. 3 Turn-off time t_q vs. On-state peak current I_{TM}

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

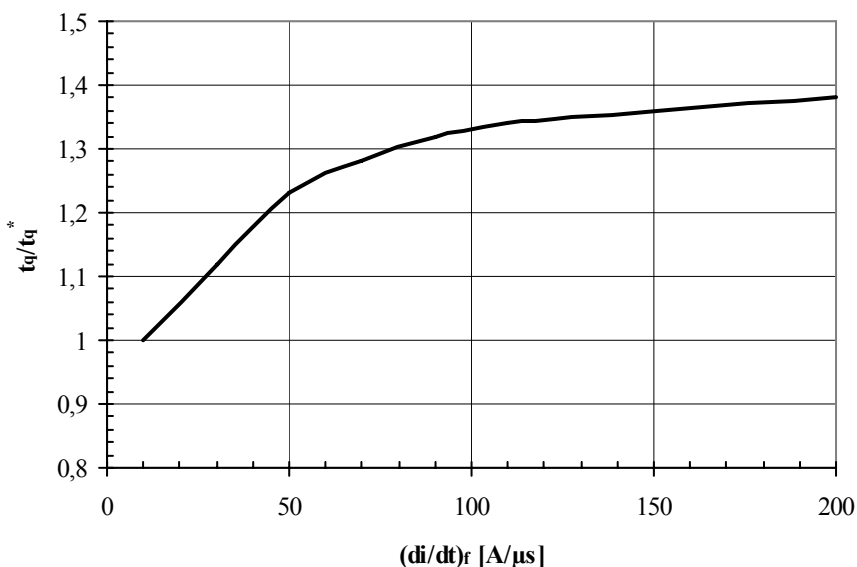


Fig. 4 Turn-off time t_q vs. Rate of fall of on-state current di_R/dt

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

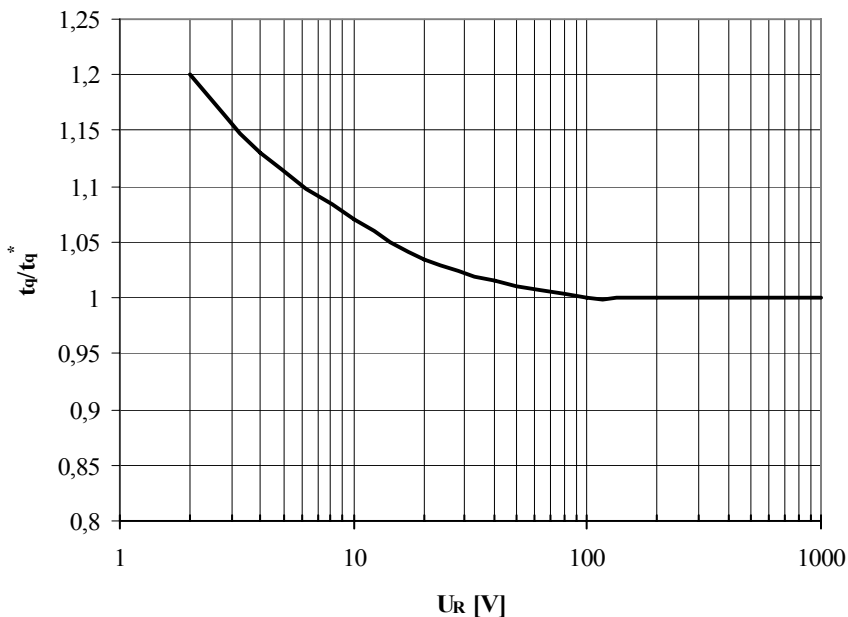


Fig. 5 Turn-off time t_q vs. Reverse voltage V_R

Conditions: $T_j=T_{j\max}$; $I_{TM}=I_{TAV}$; $di_R/dt=10\text{ A}/\mu\text{s}$; $dv_D/dt=50\text{ V}/\mu\text{s}$; $V_D=0.67\cdot V_{DRM}$

Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50 \text{ V}/\mu\text{s}$)

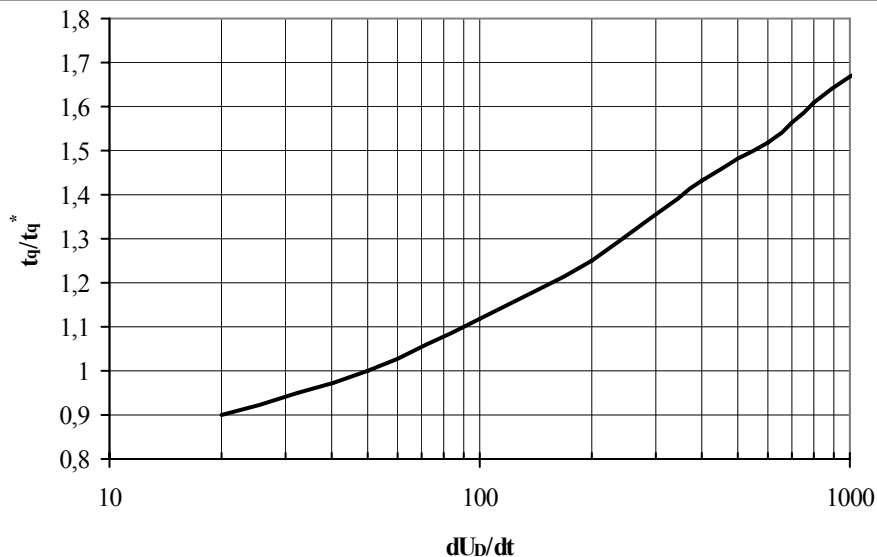


Fig. 6 Turn-off time t_q vs. Rate of rise of commutating voltage dv_D/dt

Conditions: $T_j=T_{j \max}$; $I_{TM}=I_{TAV}$; $di_R/dt=10 \text{ A}/\mu\text{s}$; $V_R=100 \text{ V}$; $V_D=0.67 \cdot V_{DRM}$

Typical changes of t_q are normalized to the t_q^* (t_q^* – see data sheet, $dv_D/dt=50 \text{ V}/\mu\text{s}$)

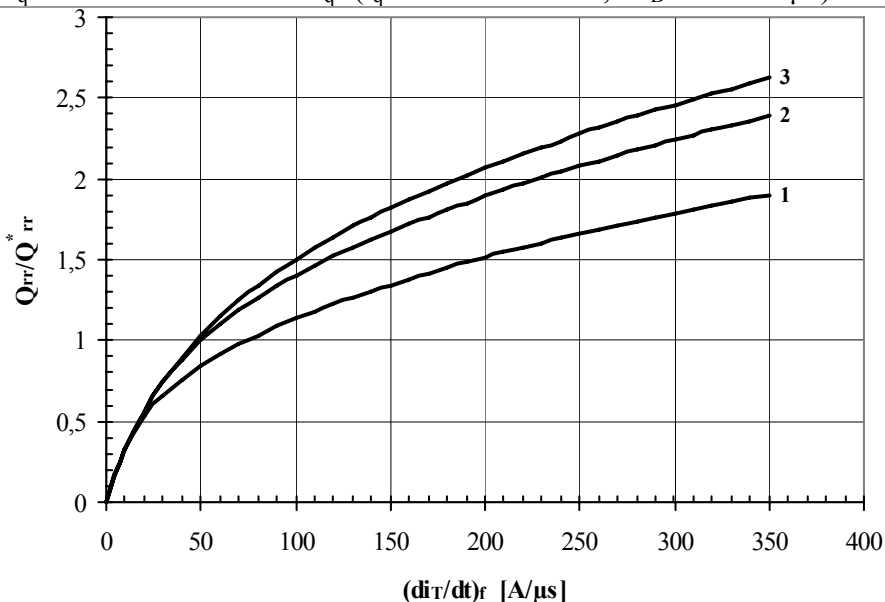


Fig. 7 Reverse recovery charge Q_{rr} , vs. Rate of fall of on-state current di_R/dt

1 – $I_{TM} = 0.5 I_{TAV}$

2 – $I_{TM} = I_{TAV}$,

3 – $I_{TM} = 1.5 I_{TAV}$

Conditions: $T_j=T_{j \max}$; $V_R=100 \text{ V}$

Typical changes of Q_{rr} are normalized to the Q_{rr}^* (Q_{rr}^* – see data sheet)

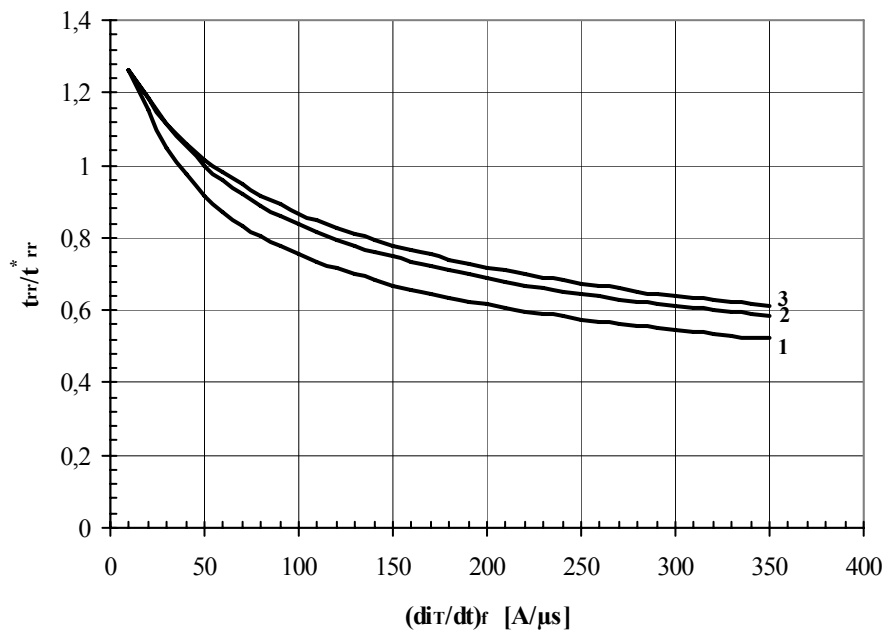


Fig. 8 Reverse recovery time t_{rr} vs. Rate of fall of on-state current di_R/dt

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)

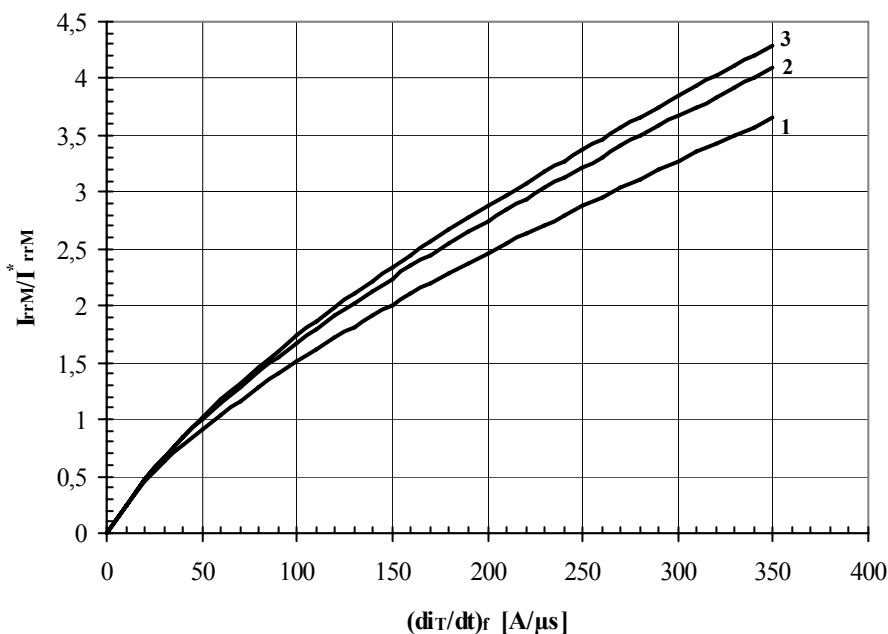


Fig. 9 Peak reverse recovery current I_{rrM} vs. Rate of fall of on-state current di_R/dt

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)

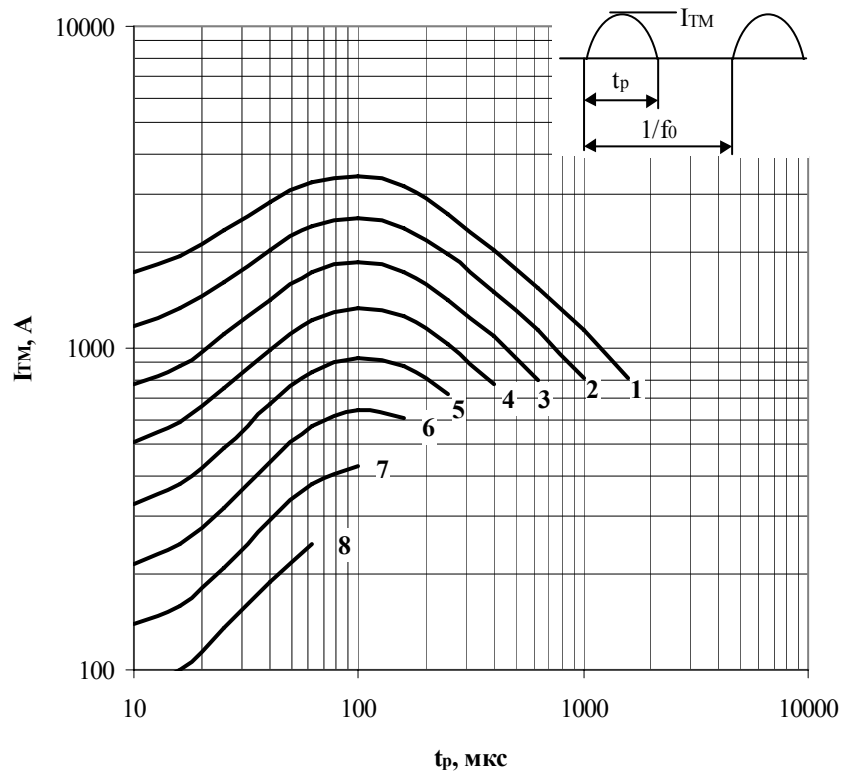


Fig. 10 Sine wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz; |
| 4 – 2500 Hz; | 8 – 16000 Hz. |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=65 \text{ }^\circ\text{C}$.

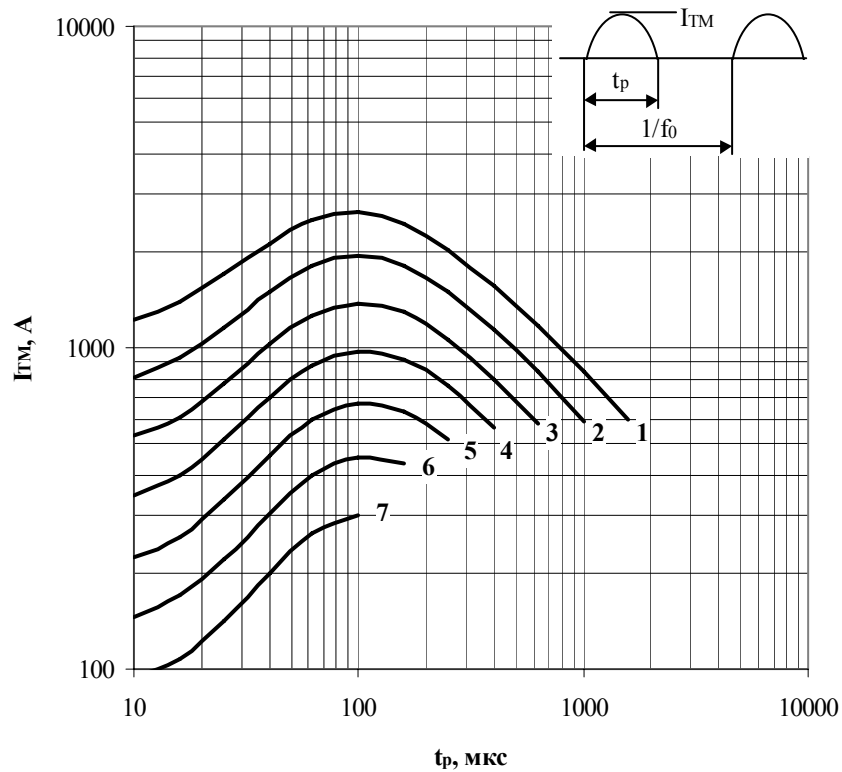


Fig. 11 Sine wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz. |
| 4 – 2500 Hz; | |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=85 \text{ }^\circ\text{C}$.

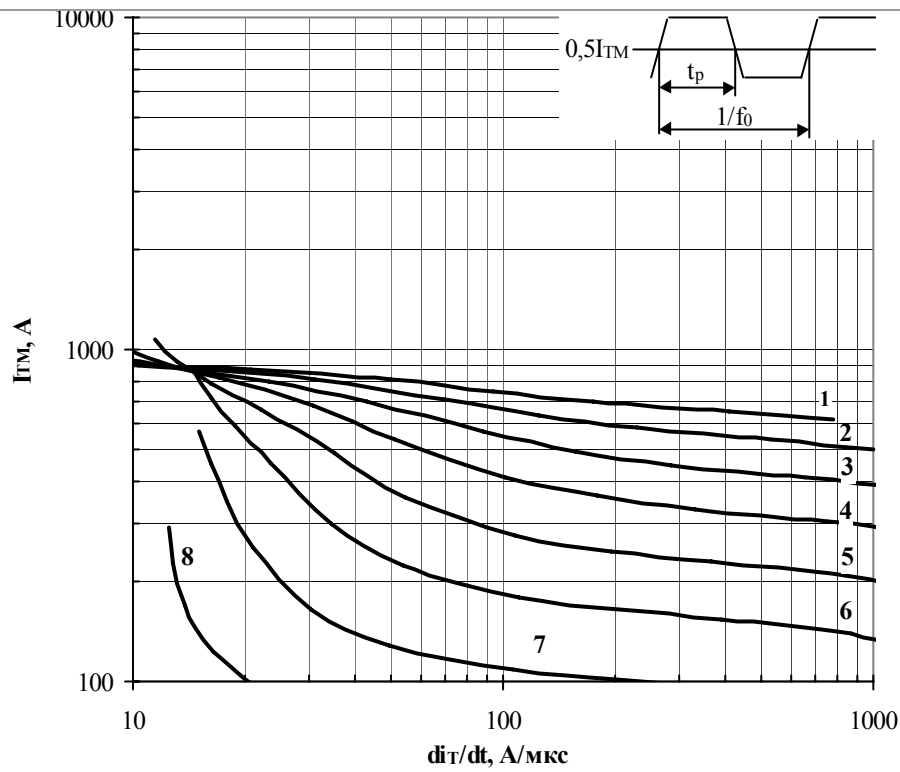


Fig. 12 Square wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz; |
| 4 – 2500 Hz; | 8 – 16000 Hz. |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=65^\circ\text{C}$ $t_p=1/2f_0$.

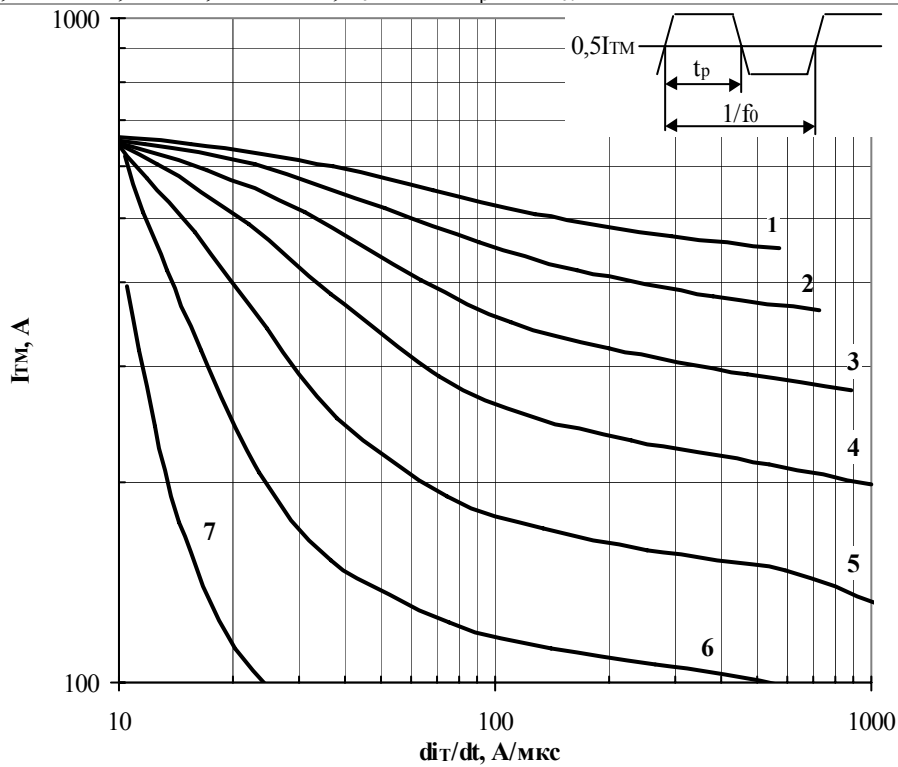


Fig. 13 Square wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz. |
| 4 – 2500 Hz; | |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=85 \text{ }^\circ\text{C}$; $t_p=1/2f_0$

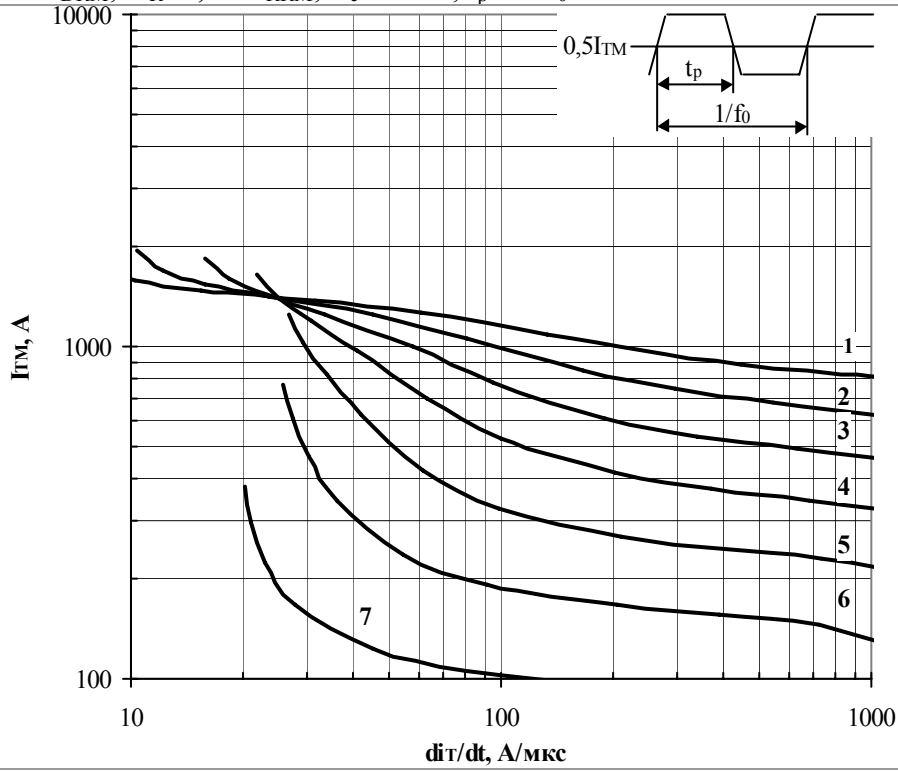


Fig. 14 Square wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz. |
| 4 – 2500 Hz; | |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=65 \text{ }^\circ\text{C}$; $t_p=1/4f_0$

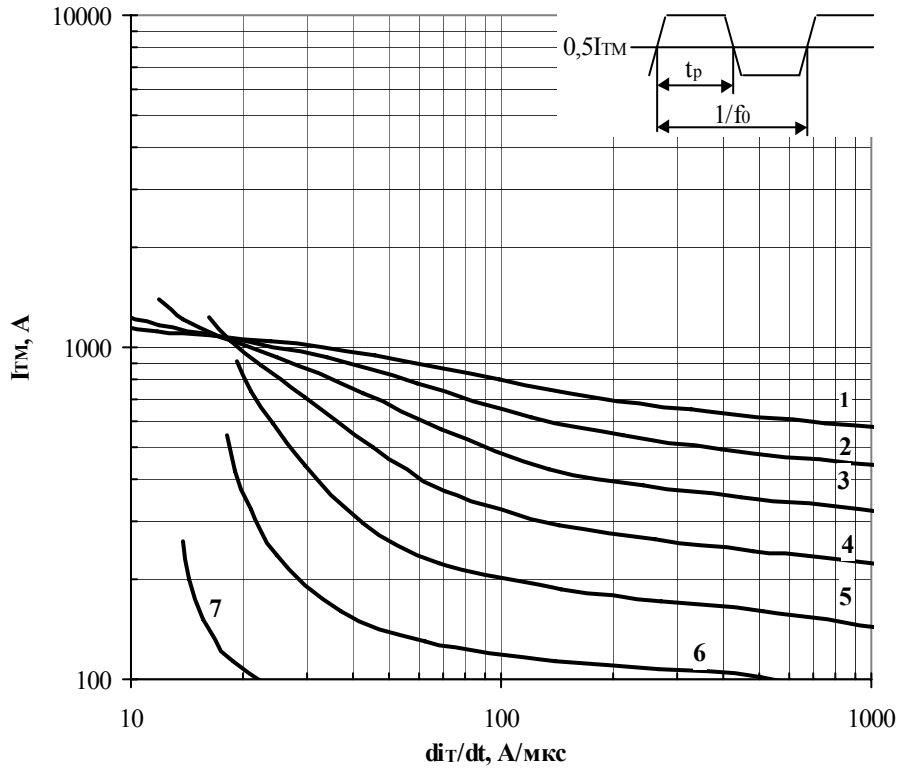


Fig.15 Square wave frequency ratings

- | | |
|--------------|---------------|
| 1 – 630 Hz; | 5 – 4000 Hz; |
| 2 – 1000 Hz; | 6 – 6300 Hz; |
| 3 – 1600 Hz; | 7 – 10000 Hz. |
| 4 – 2500 Hz; | |

Conditions : $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=85 \text{ }^\circ\text{C}$; $t_p=1/4f_0$

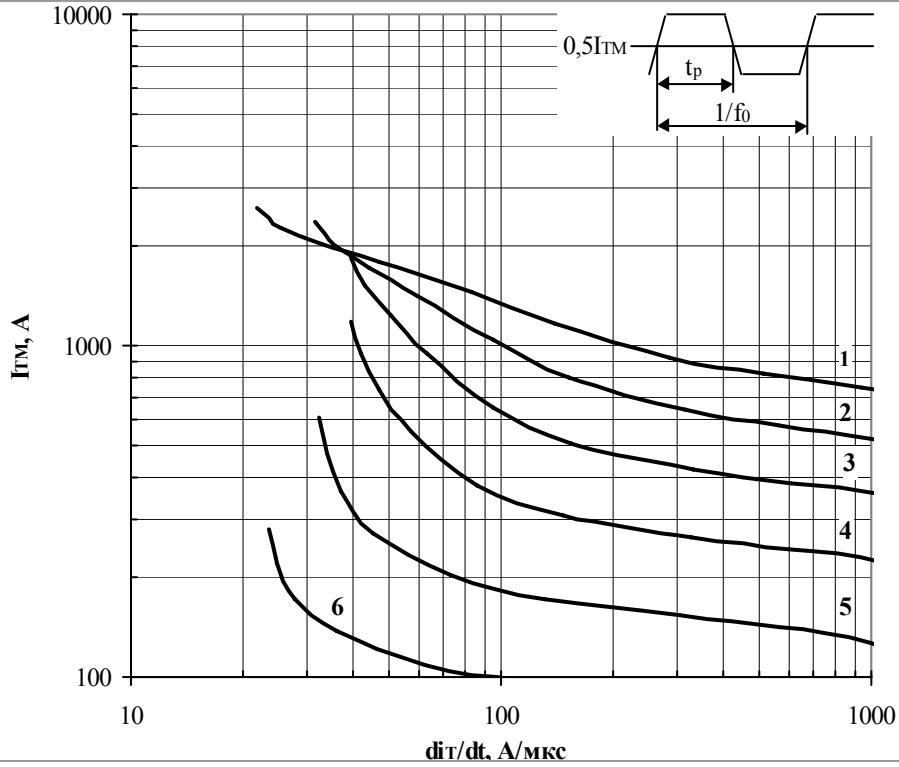


Fig. 16 Square wave frequency ratings

- | | |
|--------------|--------------|
| 1 – 630 Hz; | 4 – 2500 Hz; |
| 2 – 1000 Hz; | 5 – 4000 Hz; |
| 3 – 1600 Hz; | 6 – 6300 Hz. |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=85 \text{ }^\circ\text{C}$; $t_p=1/10f_0$

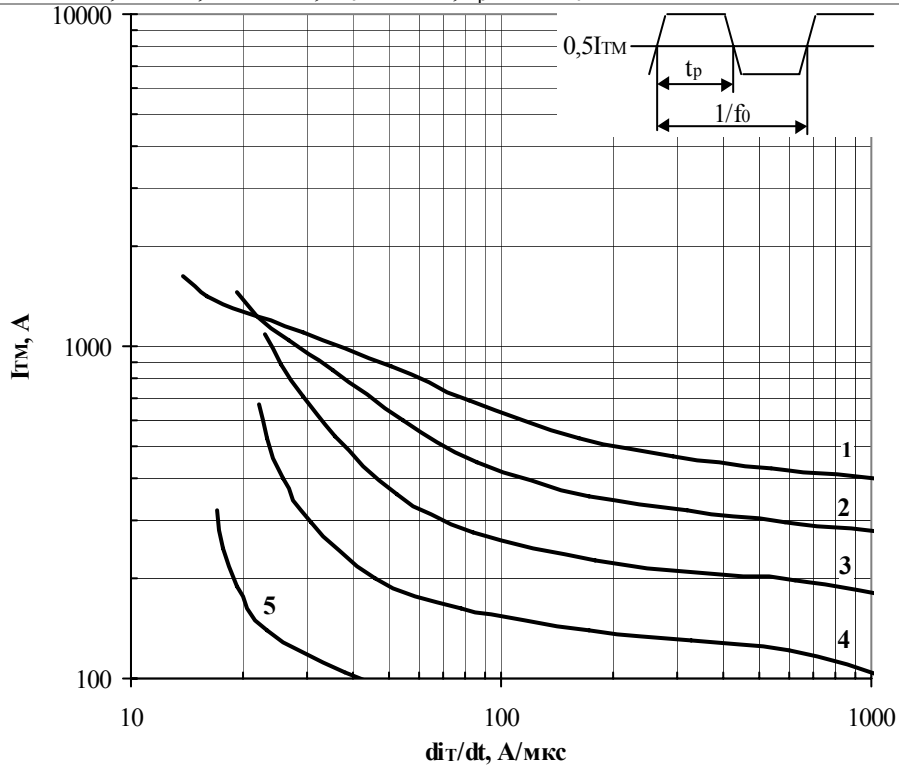


Fig. 17 Square wave frequency ratings

- | | |
|--------------|--------------|
| 1 – 630 Hz; | 4 – 2500 Hz; |
| 2 – 1000 Hz; | 5 – 4000 Hz. |
| 3 – 1600 Hz; | |

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$; $T_c=105 \text{ }^\circ\text{C}$; $t_p=1/10f_0$

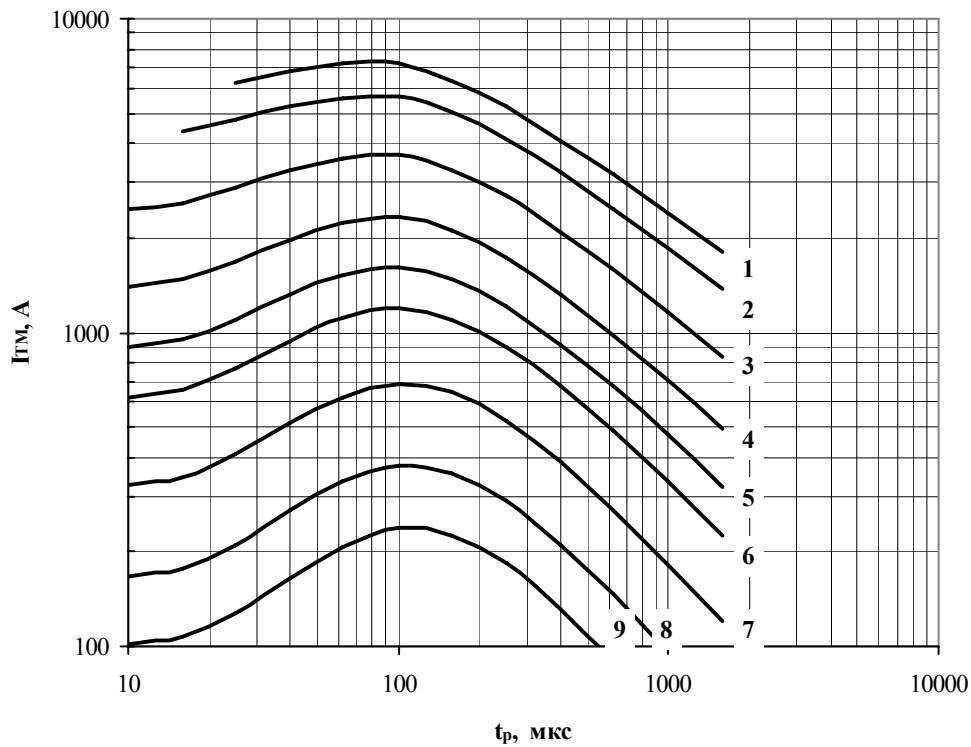


Fig. 18 Sine wave loss energy per pulse

- 1 – 6 J;
- 2 – 4 J;
- 3 – 2 J;
- 4 – 1 J;
- 5 – 0,6 J;
- 6 – 0,4 J;
- 7 – 0,2 J;
- 8 – 0,1 J;
- 9 – 0,06 J.

Conditions: $U_D=0,67 \cdot U_{DRM}$; $U_R=0,67 \cdot U_{RRM}$.

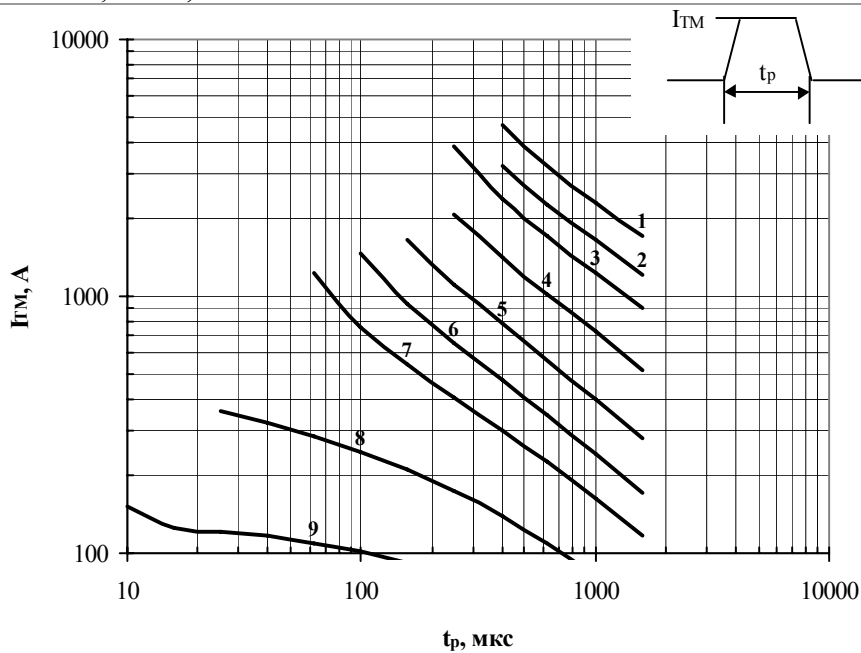


Fig. 19 Square wave loss energy per pulse

- 1 – 10 J; 6 – 0,6 J;

2 – 6 J; 7 – 0,4 J;
 3 – 4 J; 8 – 0,2 J;
 4 – 2 J; 9 – 0,1 J.
 5 – 1 J;

Conditions: $di_T/dt = 50 \text{ A/mkC}$; $U_D = 0,67 U_{DRM}$; $U_R = 0,67 U_{RRM}$.

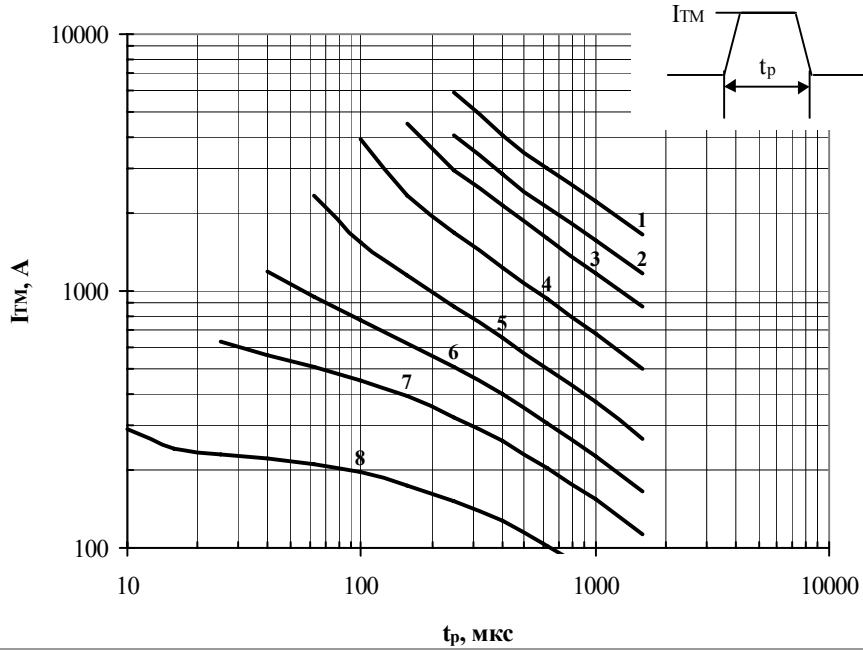


Fig. 20 Square wave loss energy per pulse

1 – 10 J;
 2 – 6 J;
 3 – 4 J;
 4 – 2 J;
 5 – 1 J;
 6 – 0,6 J;
 7 – 0,4 J;
 8 – 0,2 J.

Conditions: $di_T/dt = 100 \text{ A/mkC}$; $U_D = 0,67 U_{DRM}$; $U_R = 0,67 U_{RRM}$.

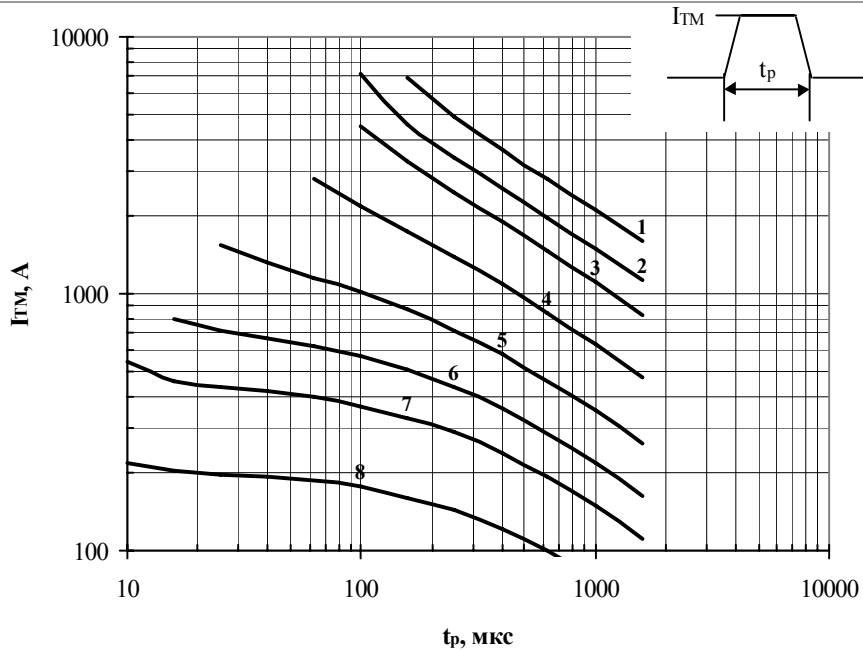


Fig. 21 Square wave loss energy per pulse

1 – 10 J;

- 2 – 6 J;
- 3 – 4 J;
- 4 – 2 J;
- 5 – 1 J;
- 6 – 0,6 J;
- 7 – 0,4 J;
- 8 – 0,2 J.

Conditions: $di_T/dt = 200 \text{ A/mkC}$; $U_D = 0,67 \cdot U_{DRM}$; $U_R = 0,67 \cdot U_{RRM}$.

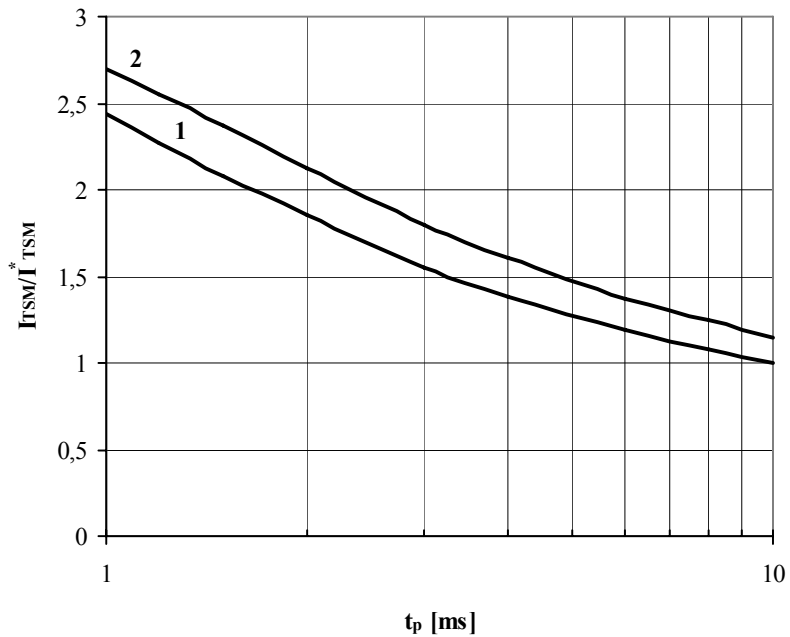


Fig. 22 The surge current I_{TSM} vs. Duration of surge t_p for a half-sine wave
 1 – $T_j = 125^\circ\text{C}$
 2 – $T_j = 25^\circ\text{C}$

Conditions: $V_R = 0 \text{ V}$ – 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, $T_j = T_{j \max}$)

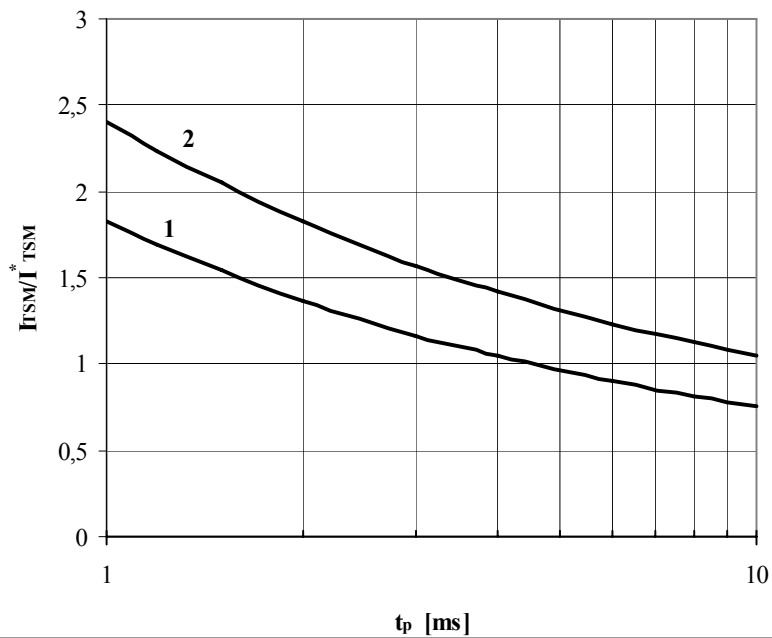


Fig. 23 The surge current I_{TSM} vs. Duration of surge t_p for a half-sine wave
 1 – $T_j = 125^\circ\text{C}$
 2 – $T_j = 25^\circ\text{C}$

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, $T_j = T_{j\max}$)

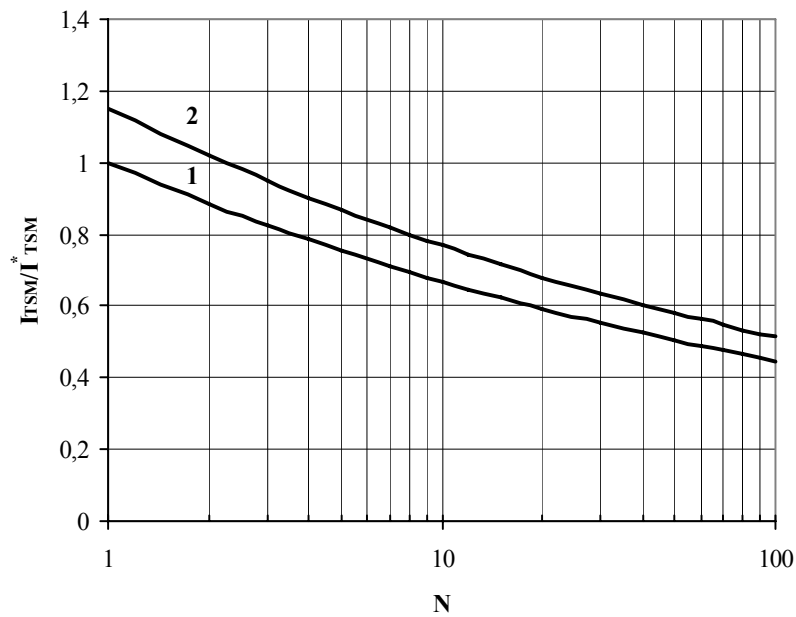


Fig. 24 The surge current I_{TSM} vs. Number of half-sine waves at 50 Hz
 1 – $T_j=125\text{ }^\circ\text{C}$
 2 – $T_j=25\text{ }^\circ\text{C}$

Conditions: $V_R=0\text{ V}$ – 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, $T_j=T_{j\text{ max}}$)

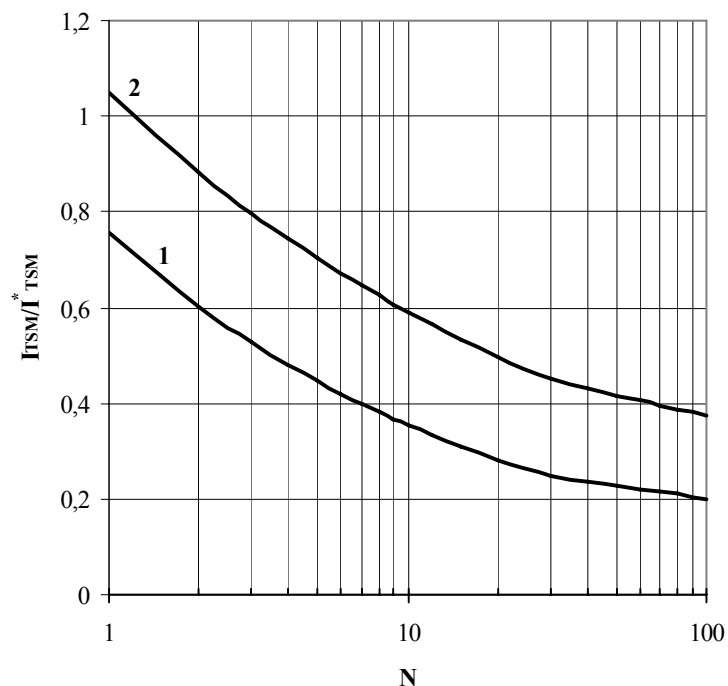


Fig. 25 The surge current I_{TSM} vs. Number of half-sine waves at 50 Hz
 1 – $T_j=125\text{ }^\circ\text{C}$
 2 – $T_j=25\text{ }^\circ\text{C}$

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, $T_j=T_{j\text{ max}}$)