



PROTON-ELECTROTEX RUSSIA

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

Fast Thyristor Type TFI573-2000-12

Maximum allowable mean on-state current	I_{TAV}	2000 A
Repetitive peak off-state voltage	V_{DRM}	1000...1200 V
Repetitive peak reverse voltage	V_{RRM}	
Turn-off time	t_q	10.0, 12.5, 16.0, 20.0 μs
V_{DRM}, V_{RRM}, V	1000	1200
Voltage code	10	12
$T_{j, ^\circ C}$	-60...+125	

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	2000 2376 3644	$T_c=92\text{ }^{\circ}\text{C}$; Double side cooled; $T_c=85\text{ }^{\circ}\text{C}$; Double side cooled; $T_c=55\text{ }^{\circ}\text{C}$; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	3140	$T_c=92\text{ }^{\circ}\text{C}$; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	65.0 75.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=2\text{ A}/\mu\text{S}$
			68.0 78.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=2\text{ A}/\mu\text{S}$
I^2t	Safety factor	$A^2s\cdot 10^3$	21100 28100	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=2\text{ A}/\mu\text{S}$
			19100 25200	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=2\text{ A}/\mu\text{S}$
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	1000...1200	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	1100...1300	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 180° half-sine wave; single pulse; Gate open	
V_D, V_R	Direct off-state and Direct reverse voltages	V	$0.6\cdot V_{DRM}$ $0.6\cdot V_{RRM}$	$T_j=T_{j\text{ max}}$; Gate open	

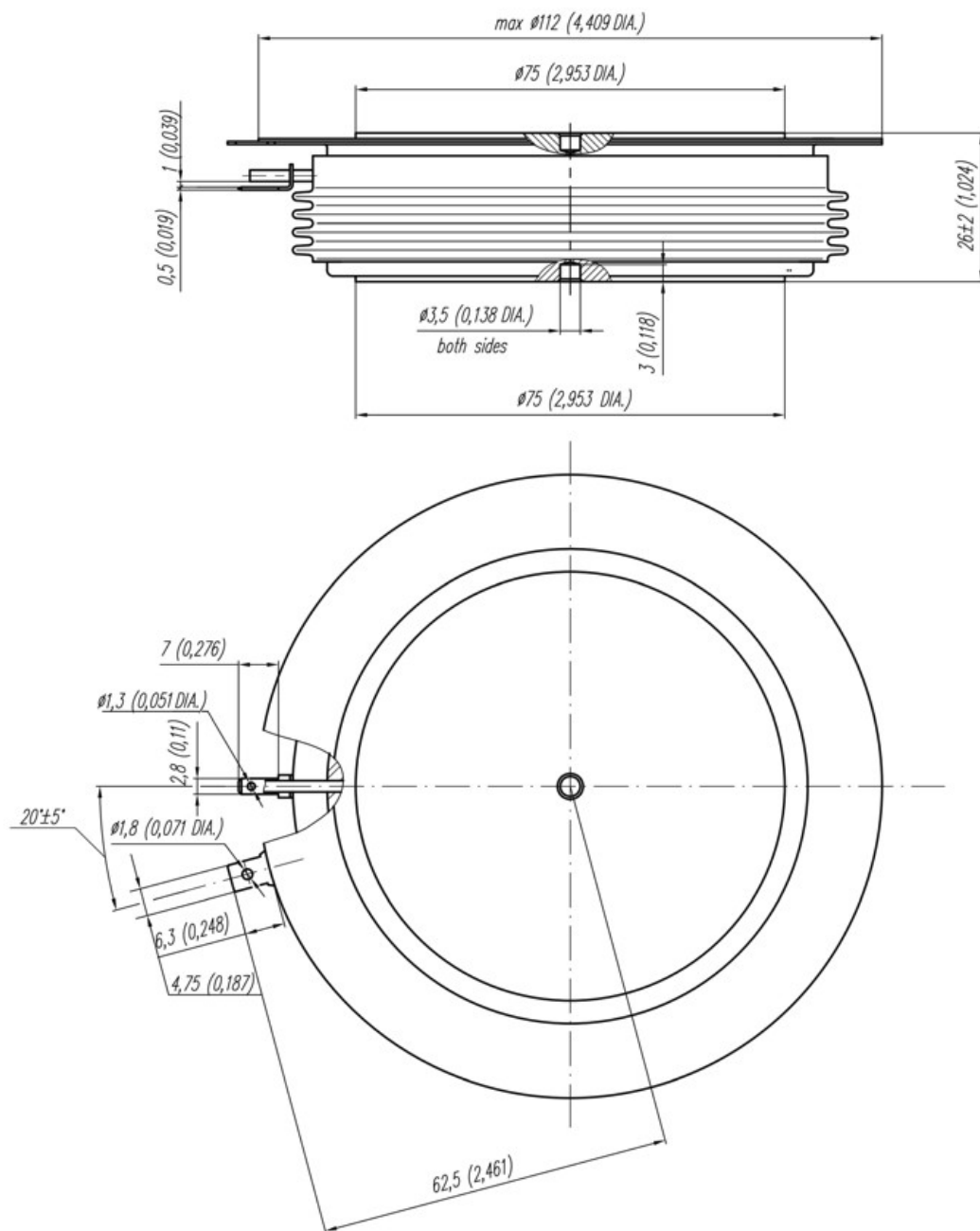
TRIGGERING				
I_FGM	Peak forward gate current	A	10	T _j =T _{j max}
V_RGM	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	8	T _j =T _{j max} for DC gate current
SWITCHING				
(di _T /dt) _{crit}	Critical rate of rise of on-state current non-repetitive (f=1 Hz)	A/μs	2500	T _j =T _{j max} ; V _D =0.67·V _{DRM} ; I _{TM} = 4000 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	40.0...50.0	
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	2.15	T _j =25 °C; I _{TM} =6280 A	
V _{T(TO)}	On-state threshold voltage, max	V	1.456	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.090	0.5 π I _{TAV} < I _T < 1.5 π I _{TAV}	
I _H	Holding current, max	mA	1000	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	300	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·V _{DRM} ; Gate open	
TRIGGERING					
V _{GT}	Gate trigger direct voltage, max	V	3.00 3.00 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·V _{DRM} ;	
I _{GD}	Gate non-trigger direct current, min	mA	65.00	Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	0.80	T _j =25 °C; V _D =600 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time ²⁾ , max	μs	1.60, 2.00, 2.50, 3.20	Gate pulse: I _G =2 A; V _G =20 V; t _{GP} =50 μs; di _G /dt=2 A/μs	
t _q	Turn-off time ³⁾ max	μs	10.0, 12.5, 16.0, 20.0	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 V _{DRM}
			12.5, 16.0, 20.0, 25.0	dv _D /dt=200 V/μs;	
Q _{rr}	Recovered charge, max	μC	220	T _j =T _{j max} ; I _{TM} =1000 A;	
t _{rr}	Reverse recovery time, max	μs	3.8	di _R /dt=-50 A/μs;	
I _{rr}	Reverse recovery current, max	A	115	V _R =100 V	

THERMAL					
R _{thjc}	Thermal resistance, junction to case, max	°C/W	0.0085	Direct current	Double side cooled
R _{thjc-A}			0.0187		Anode side cooled
R _{thjc-K}			0.0153		Cathode side cooled
R _{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0020	Direct current	
MECHANICAL					
m	Weight, max	g	1200		
D _s	Surface creepage distance	mm (inch)	36.60 (1.441)		
D _a	Air strike distance	mm (inch)	16.20 (0.638)		

PART NUMBERING GUIDE								NOTES																							
TFI	573	2000	12	A2	P3	K4	N	1) Critical rate of rise of off-state voltage																							
1	2	3	4	5	6	7	8	<table><tr><td>Symbol of Group</td><td>P2</td><td>K2</td><td>E2</td><td>A2</td><td>T1</td><td>P1</td><td>M1</td></tr><tr><td>(dv_D/dt)_{crit}, V/μs</td><td>200</td><td>320</td><td>500</td><td>1000</td><td>1600</td><td>2000</td><td>2500</td></tr></table>								Symbol of Group	P2	K2	E2	A2	T1	P1	M1	(dv _D /dt) _{crit} , V/μs	200	320	500	1000	1600	2000	2500
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(dv _D /dt) _{crit} , V/μs	200	320	500	1000	1600	2000	2500																								
1. TFI — fast inverter thyristor								2) Turn-on time																							
2. Design version								<table><tr><td>Symbol of group</td><td>T4</td><td>P4</td><td>M4</td><td>K4</td></tr><tr><td>t_{gt}, μs</td><td>1.60</td><td>2.00</td><td>2.50</td><td>3.20</td></tr></table>								Symbol of group	T4	P4	M4	K4	t _{gt} , μs	1.60	2.00	2.50	3.20						
Symbol of group	T4	P4	M4	K4																											
t _{gt} , μs	1.60	2.00	2.50	3.20																											
3. Mean on-state current, A								3) Turn-off time (dv _D /dt=50 V/μs)																							
4. Voltage code								<table><tr><td>Symbol of group</td><td>A4</td><td>X3</td><td>T3</td><td>P3</td></tr><tr><td>t_{qf}, μs</td><td>10.0</td><td>12.5</td><td>16.0</td><td>20.0</td></tr></table>								Symbol of group	A4	X3	T3	P3	t _{qf} , μs	10.0	12.5	16.0	20.0						
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t _{qf} , μs	10.0	12.5	16.0	20.0																											
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																															



All dimensions in millimeters (inches)

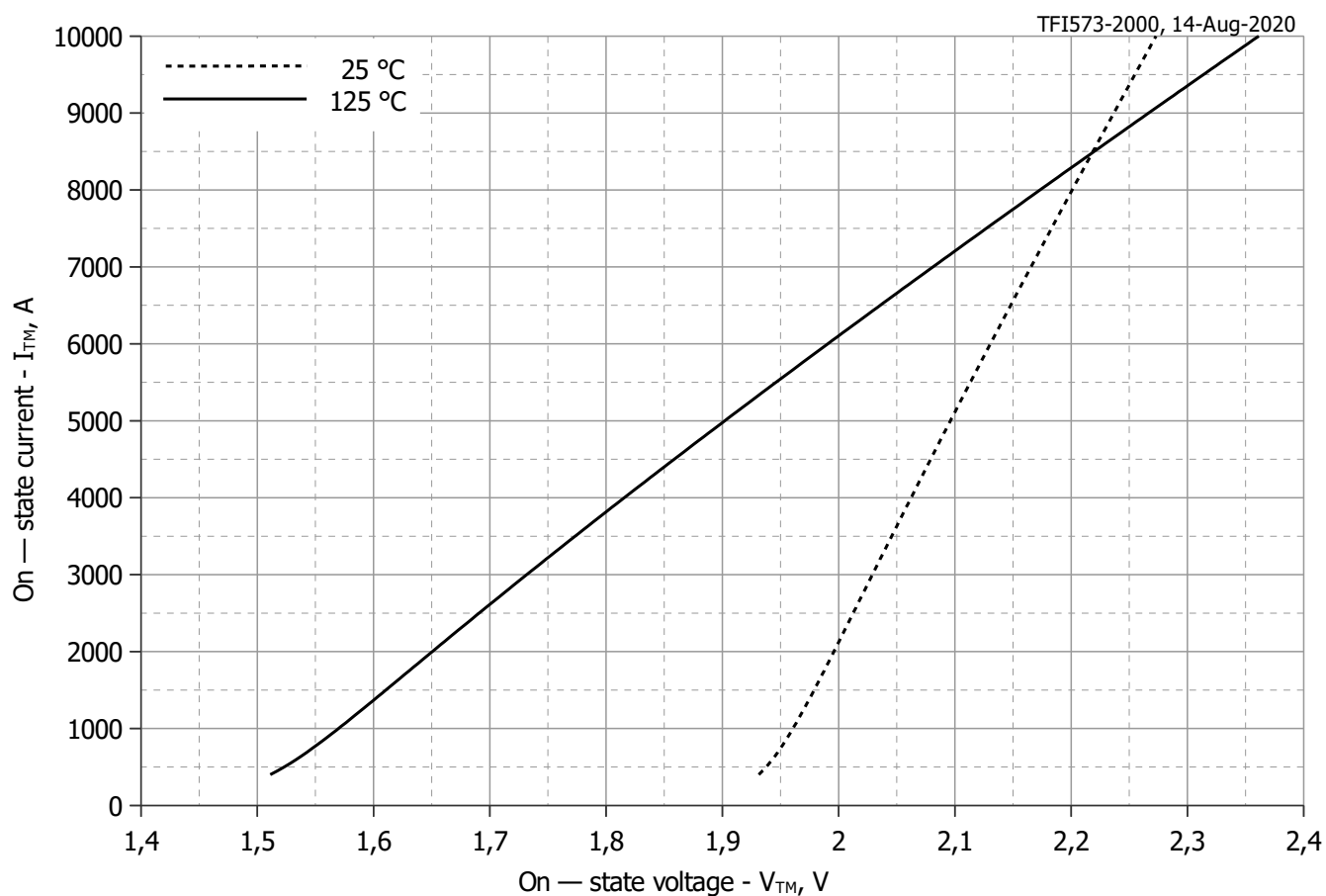


Fig 1 – On-state characteristics of Limit device

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	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\max}$
A	1.73646378	1.15209372
B	0.00004772	0.00012450
C	0.03947643	0.07620628
D	-0.00304265	-0.00737623

On-state characteristic model (see Fig. 1).

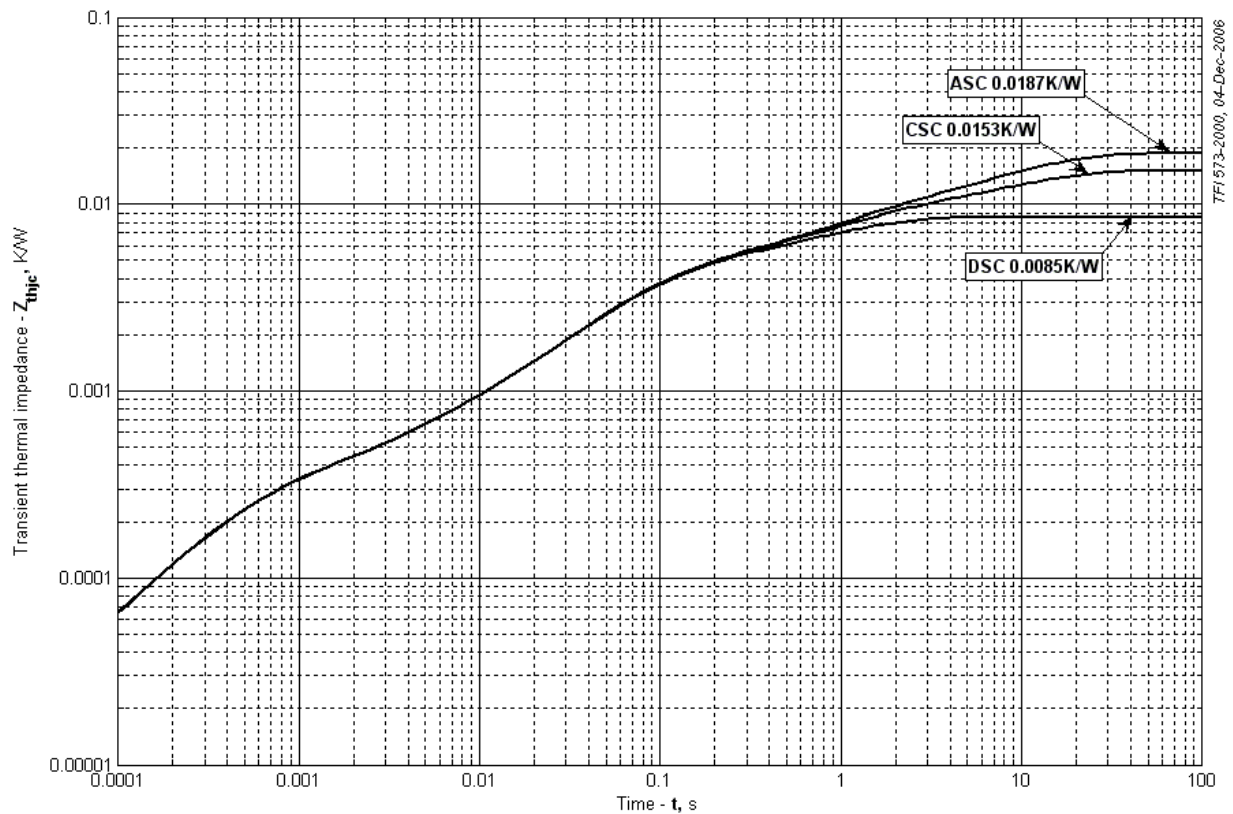


Fig 2 – Transient thermal impedance

Analytical function for Transient thermal impedance junction to case Z_{thjc} for DC:

$$Z_{thjc} = \sum_{i=1}^n R_i \left(1 - e^{-\frac{t}{\tau_i}} \right)$$

Where $i = 1$ to n , n is the number of terms in the series.

t = Duration of heating pulse in seconds.

Z_{thjc} = Thermal resistance at time t .

R_i = Amplitude of p_{th} term.

τ_i = Time constant of r_{th} term.

DC Double side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.0003136	0.003279	0.0001485	0.0007865	0.0002694	0.003703
τ_i, s	1.181	0.06771	0.003331	0.145	0.0004353	0.9499

DC Anode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.01013	0.004062	0.0009701	0.00306	0.000148	0.0002685
τ_i, s	9.747	1.058	0.1302	0.06675	0.003276	0.0004342

DC Cathode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.006619	0.004032	0.0008219	0.003231	0.000147	0.0002716
τ_i, s	9.745	1.026	0.143	0.06778	0.00342	0.0004396

Transient thermal impedance junction to case Z_{thjc} model (see Fig. 2).

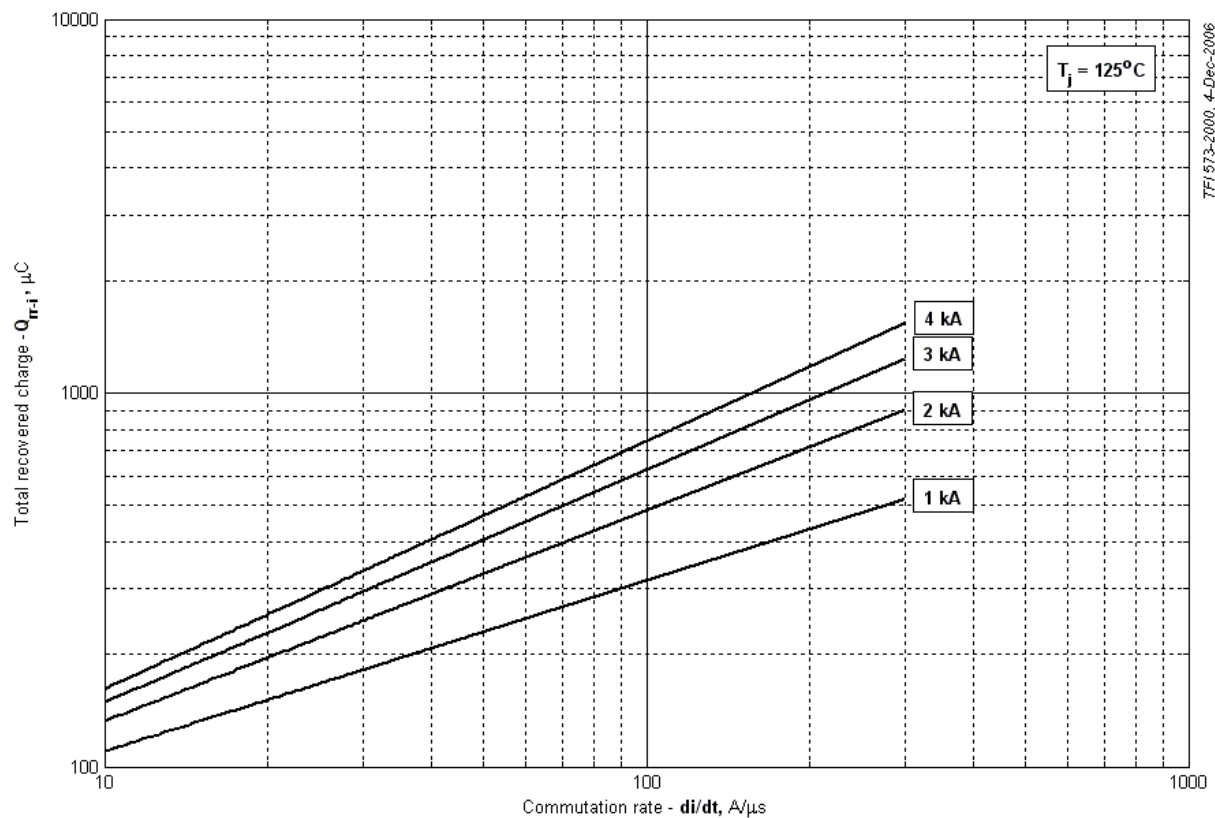


Fig 3 – Total recovered charge, Q_{rr-i} (integral)

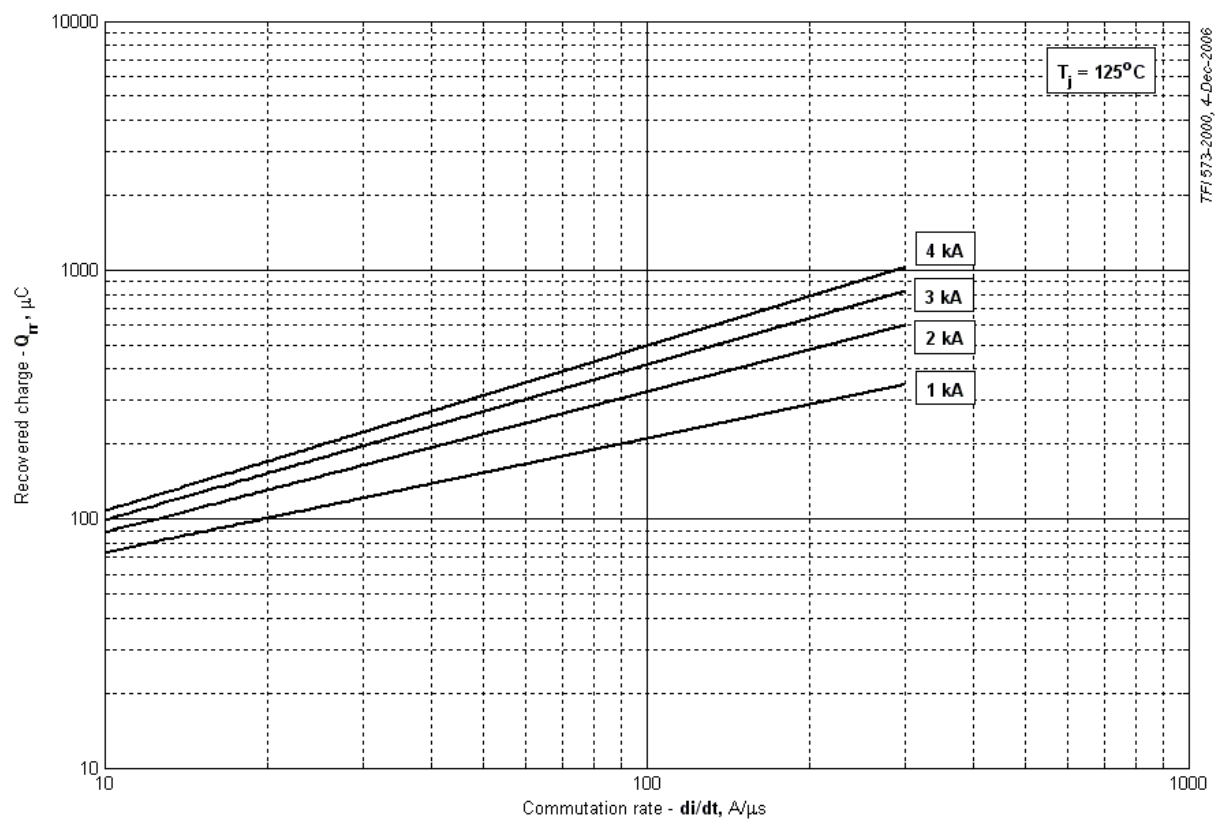


Fig 4 - Recovered charge, Q_{rr} (linear)

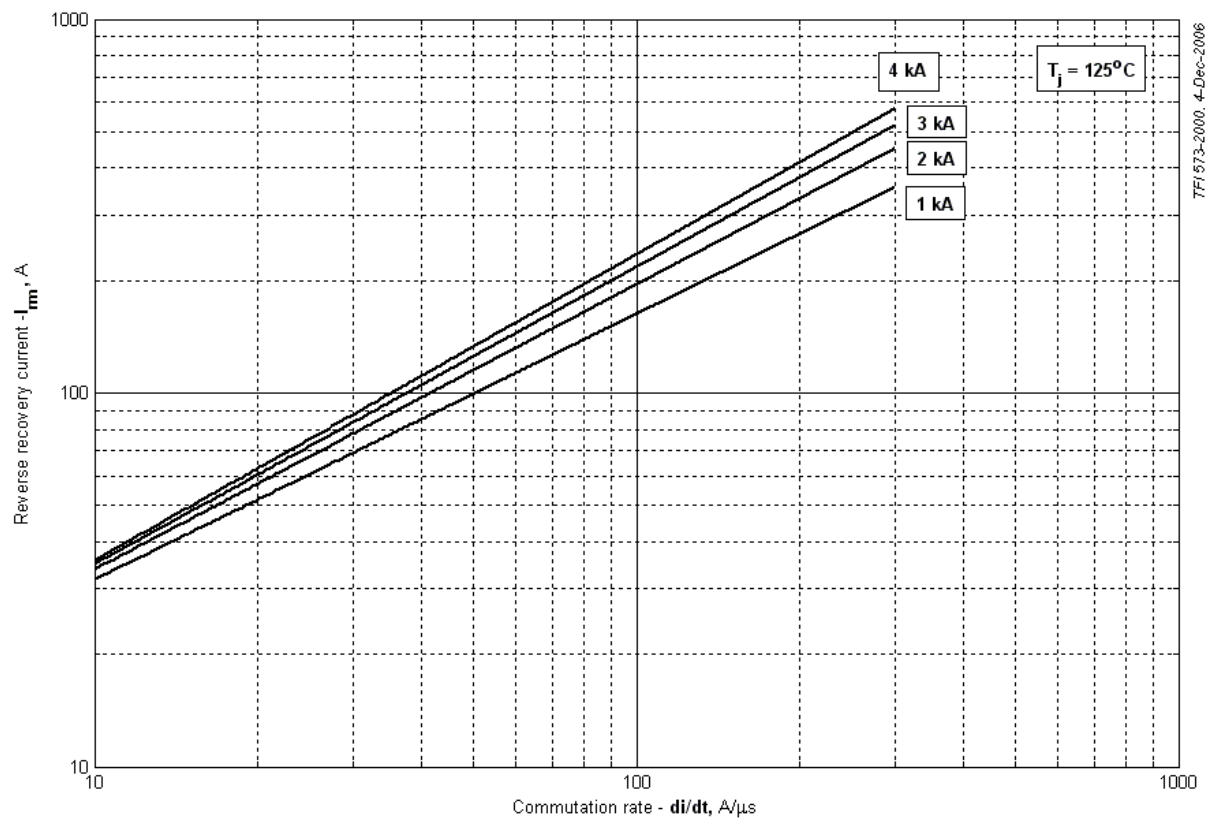


Fig 5 – Peak reverse recovery current, I_{rr}

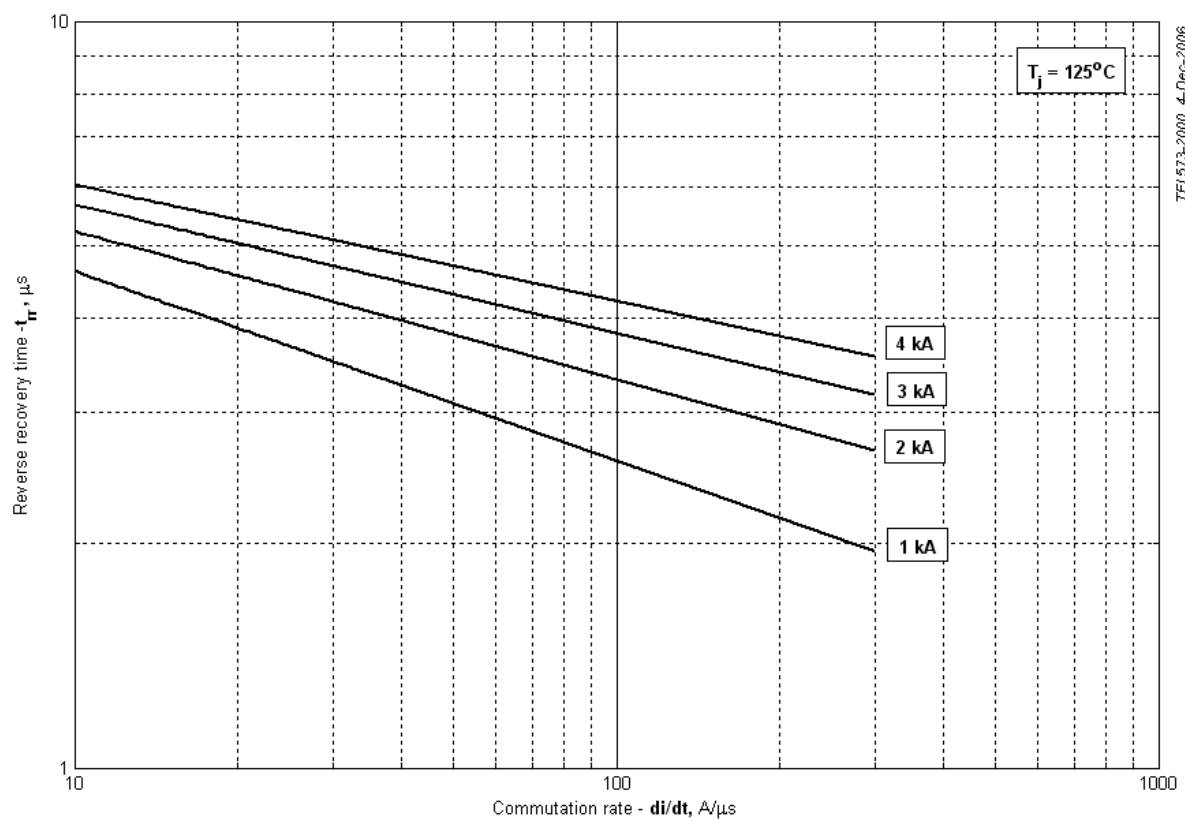


Fig 6 – Typical recovery time, t_{rr} (linear)

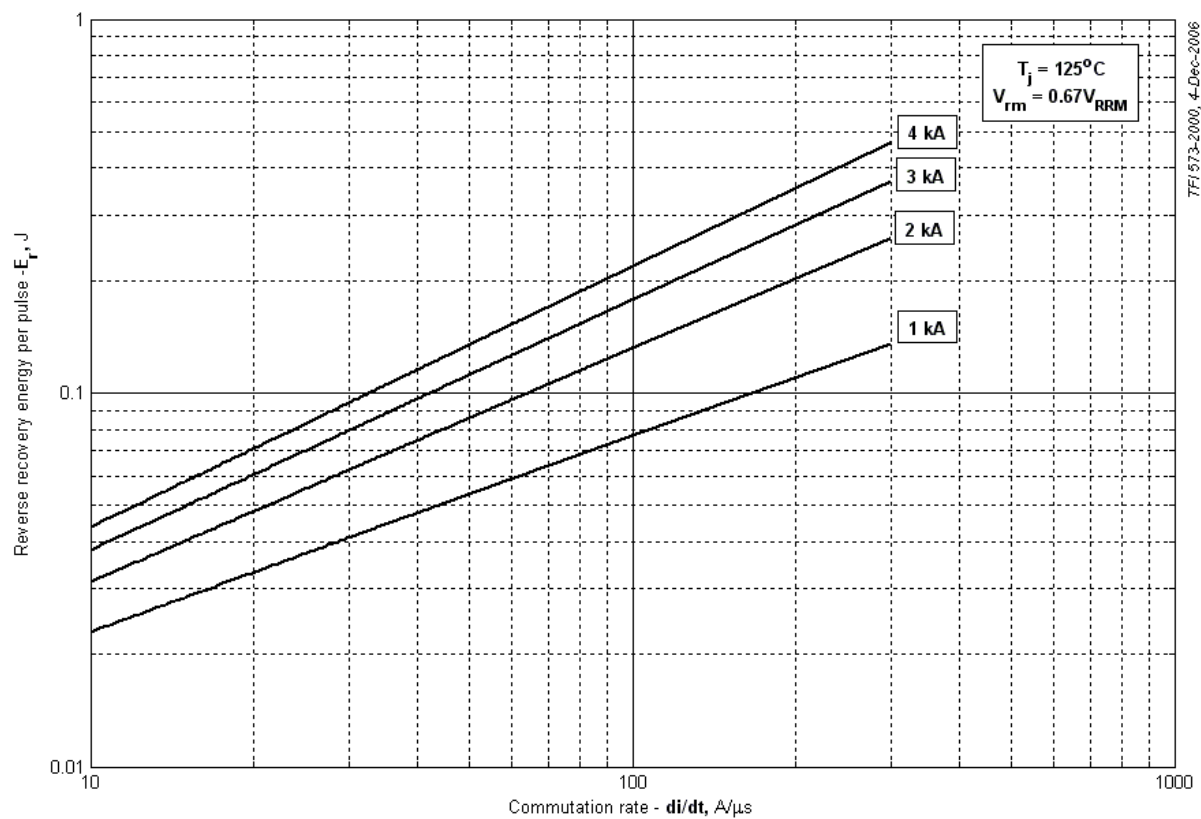


Fig 7 – Reverse recovery energy per pulse

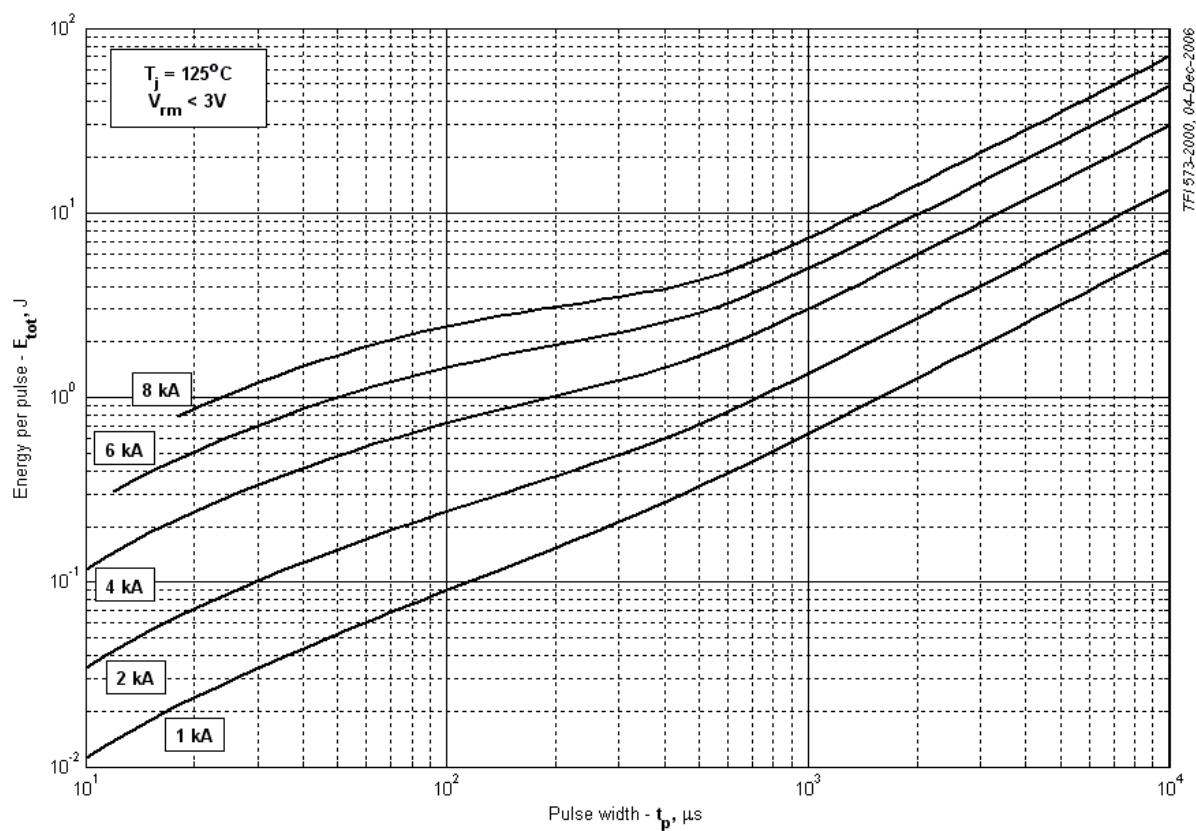


Fig 8 – Sine wave energy per pulse

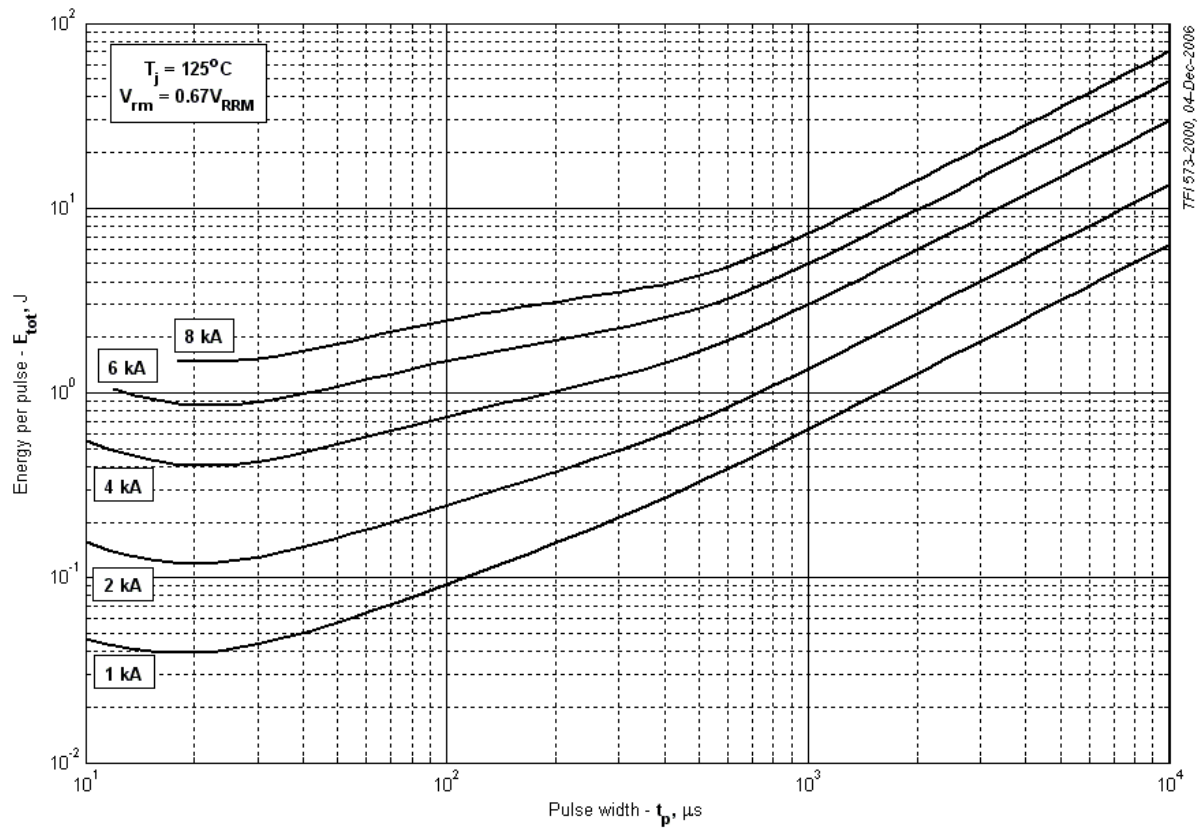


Fig 9 – Sine wave energy per pulse

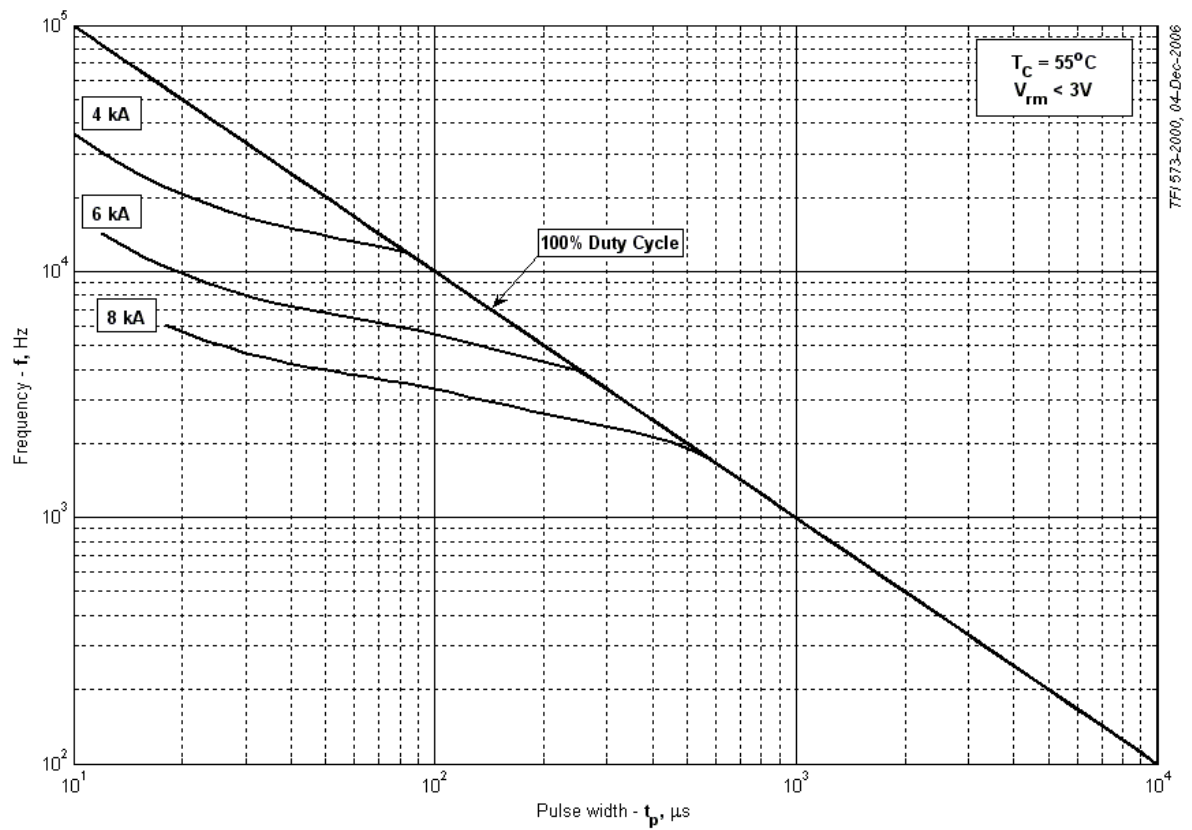


Fig 10 – Sine wave frequency ratings

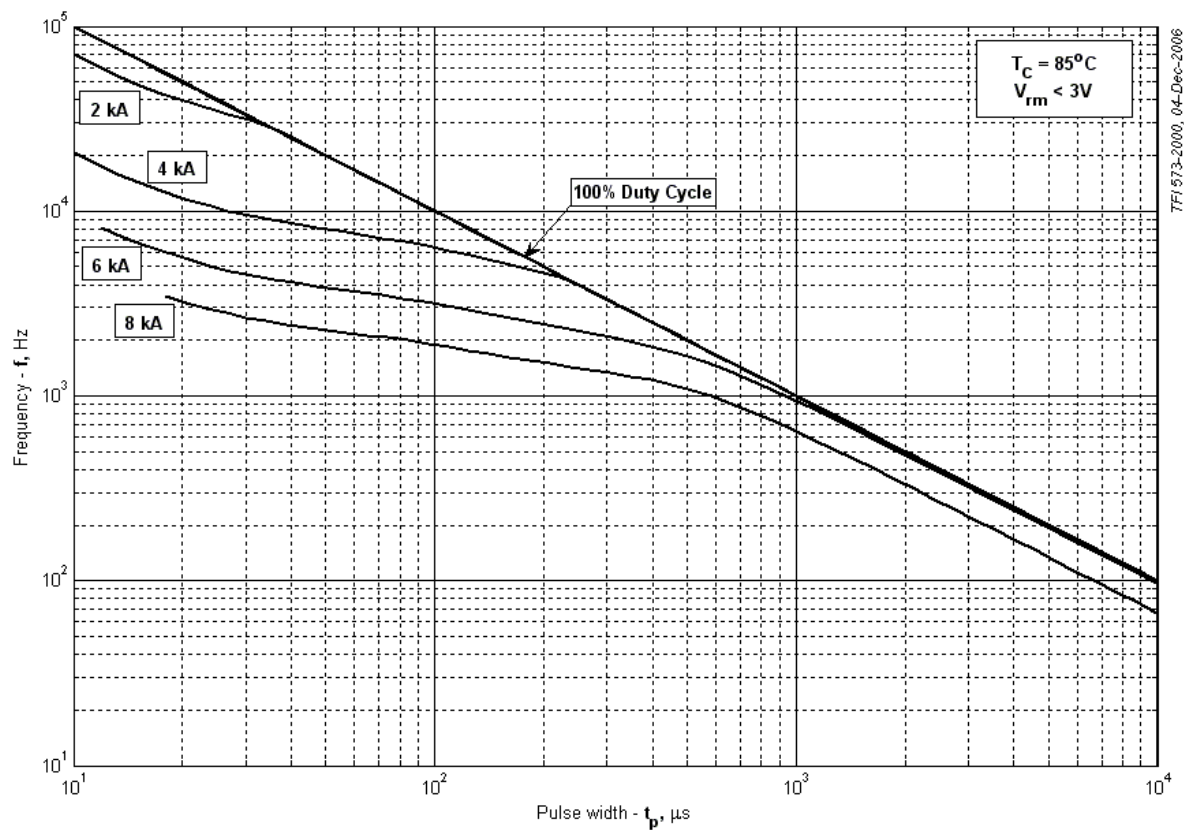


Fig 11 – Sine wave frequency ratings

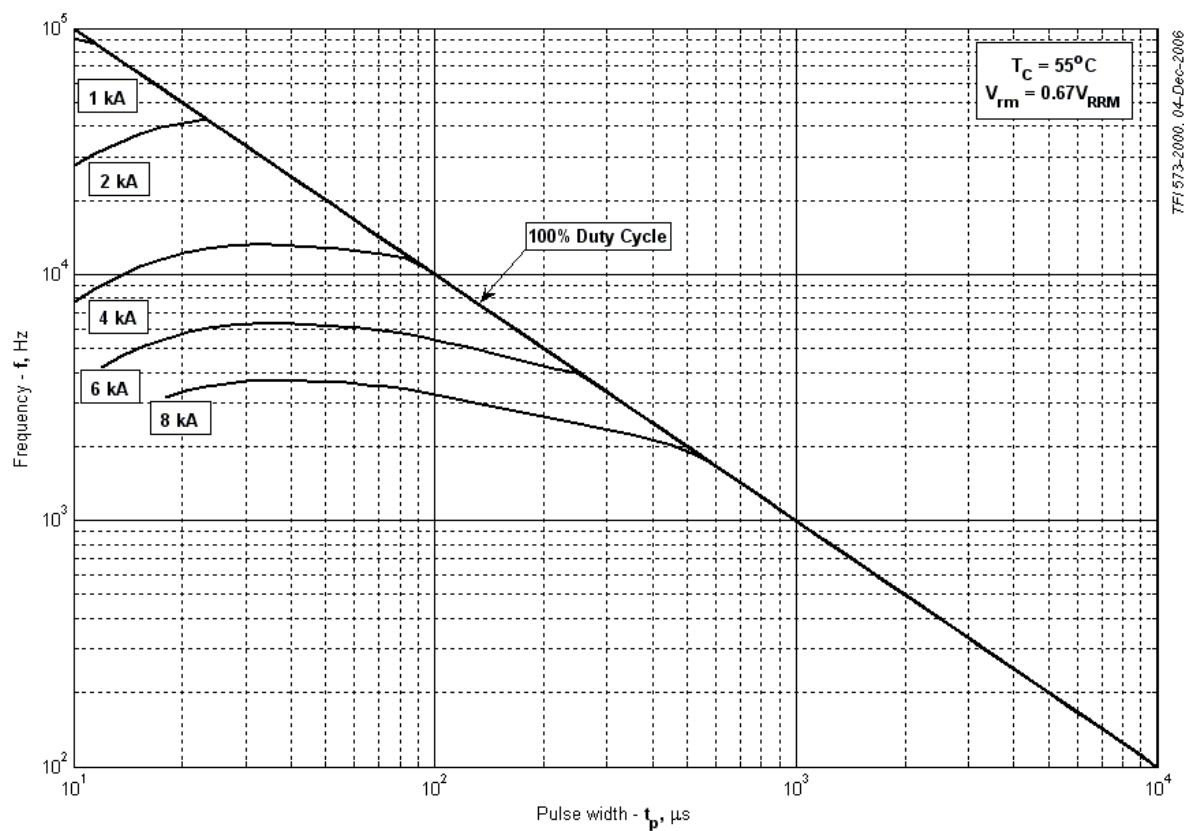


Fig 12 – Sine wave frequency ratings

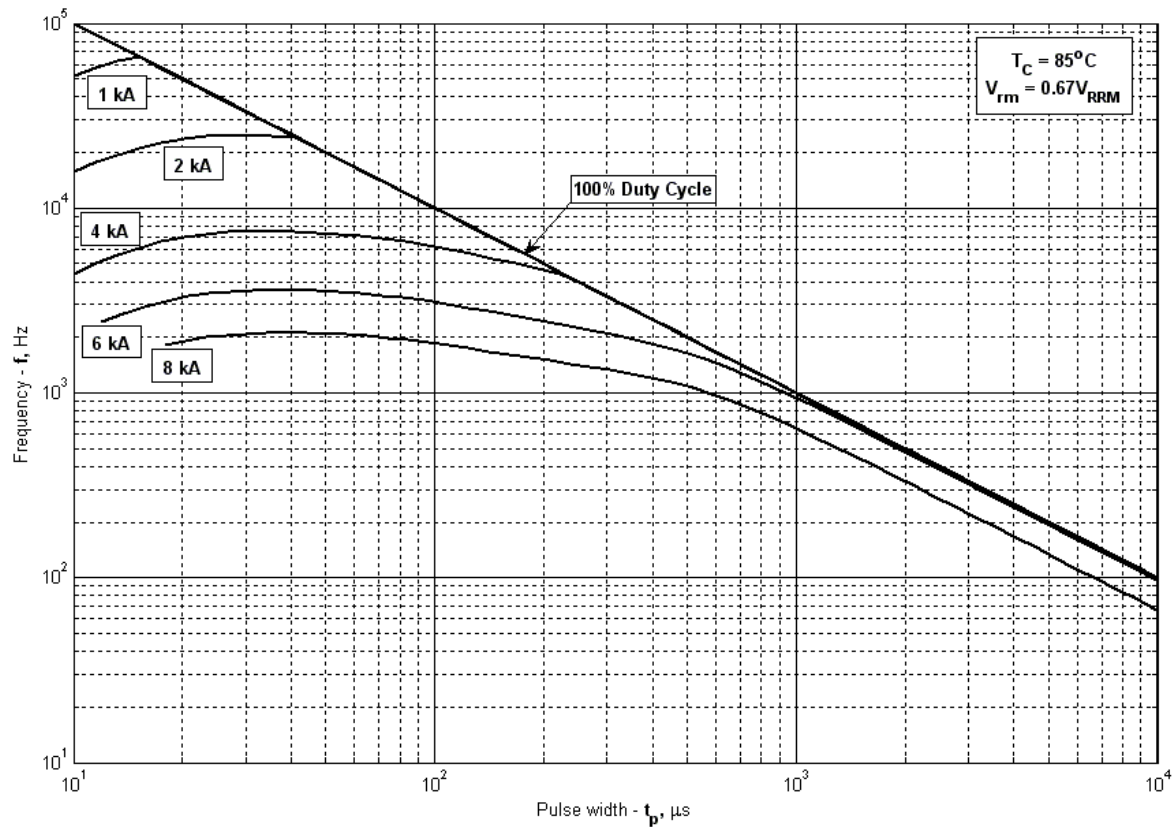


Fig 13 – Sine wave frequency ratings

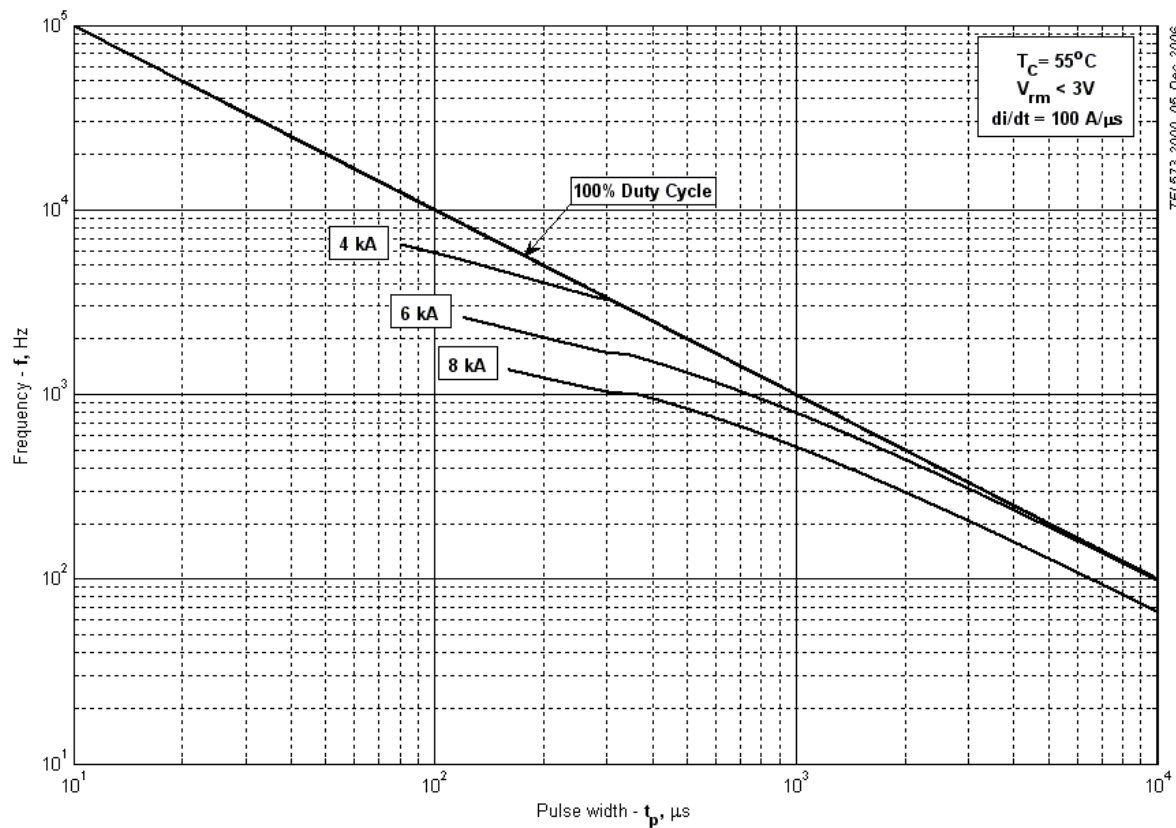


Fig 14 – Square wave frequency ratings

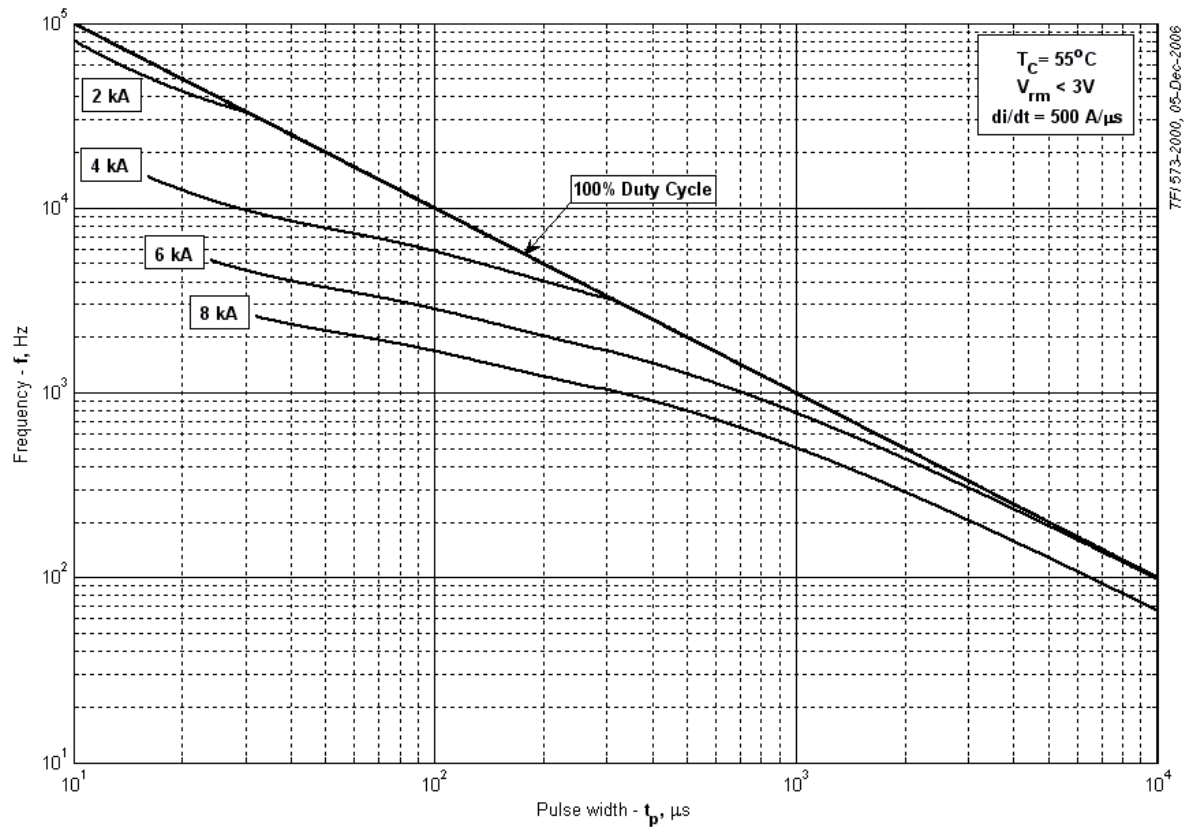


Fig 15 – Square wave frequency ratings

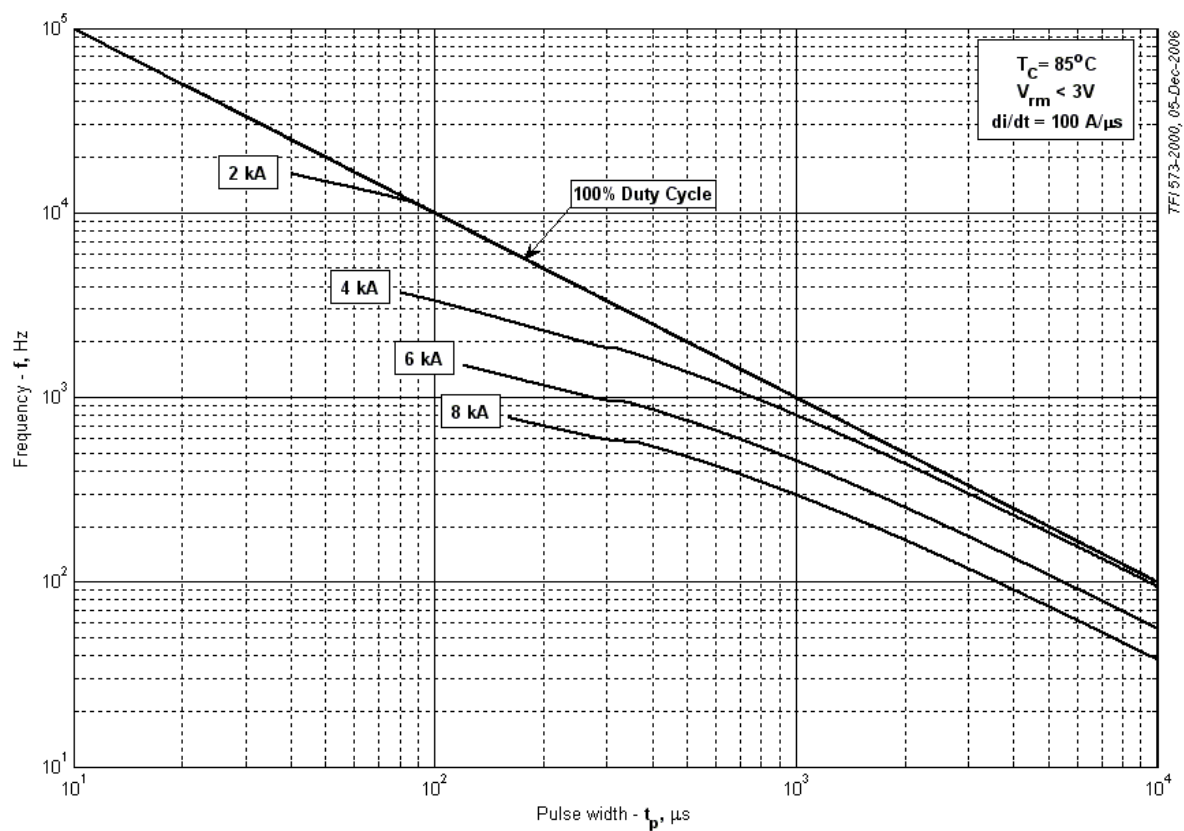


Fig 16 – Square wave frequency ratings

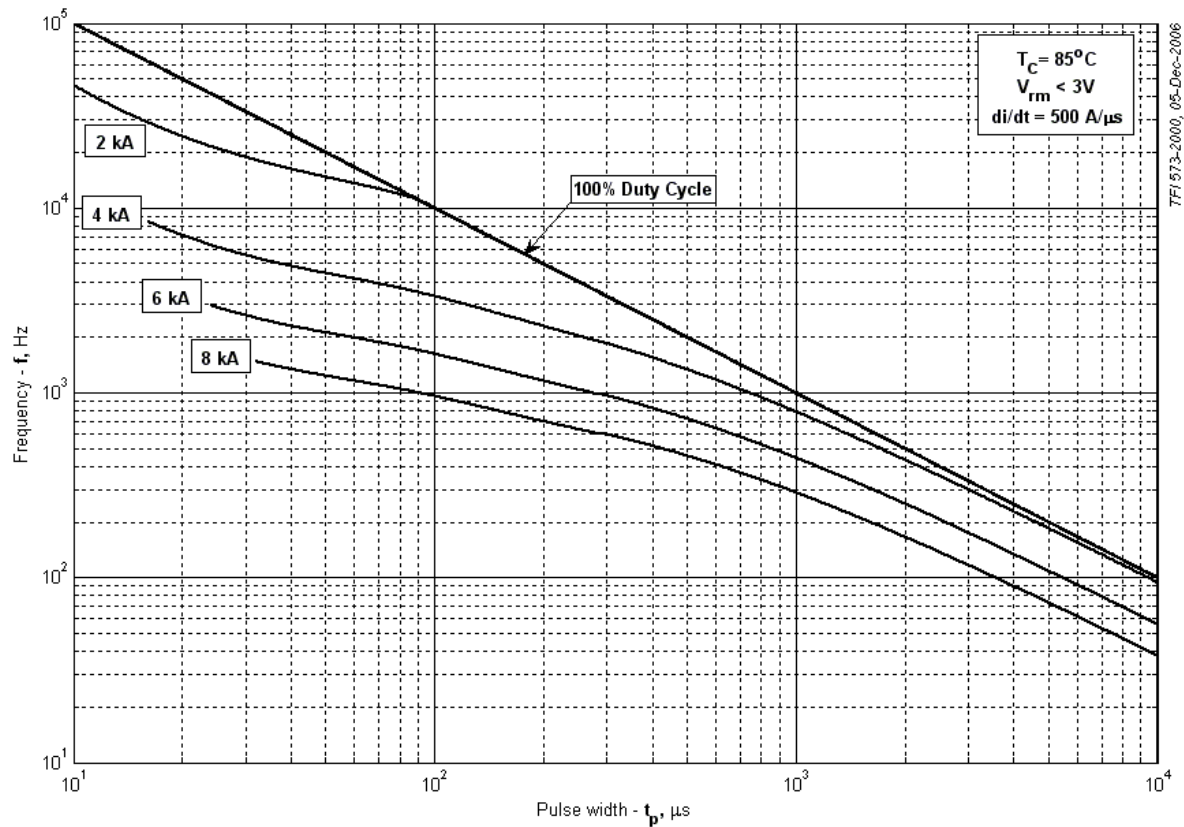


Fig 17 – Square wave frequency ratings

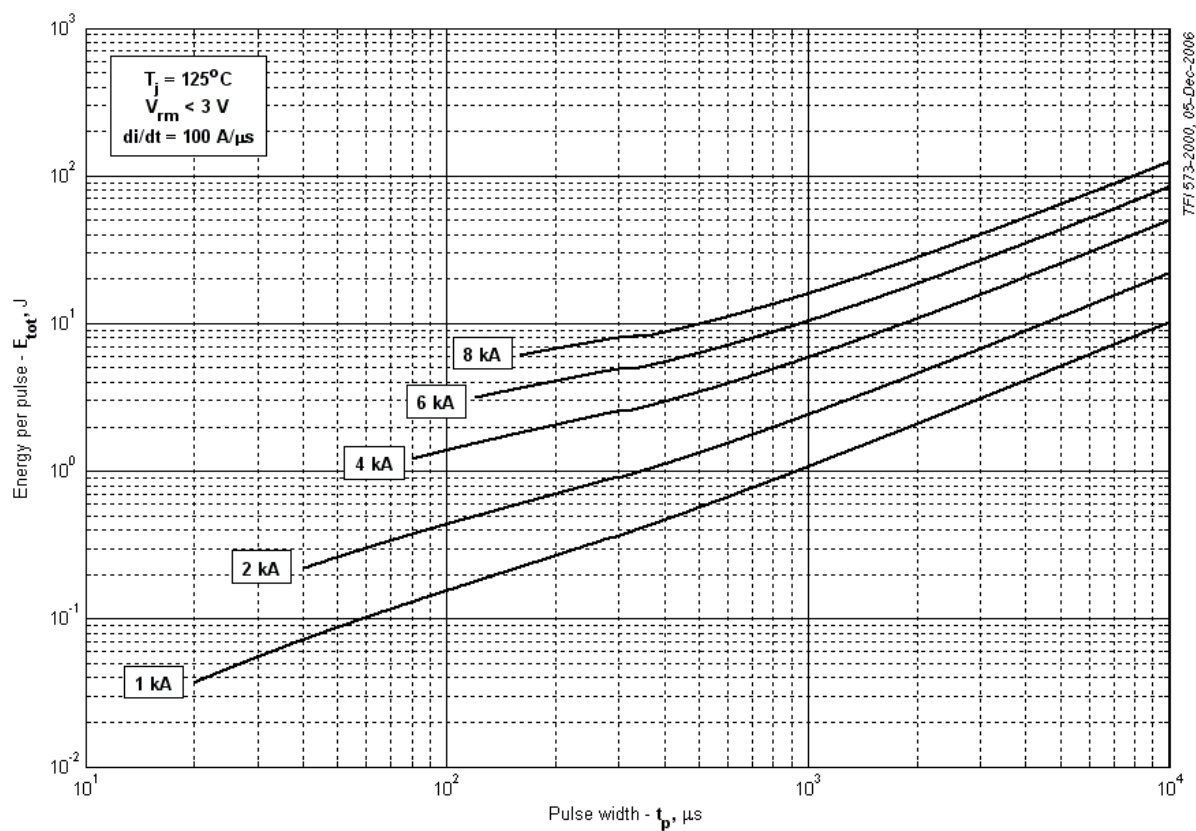


Fig 18 – Square wave energy per pulse

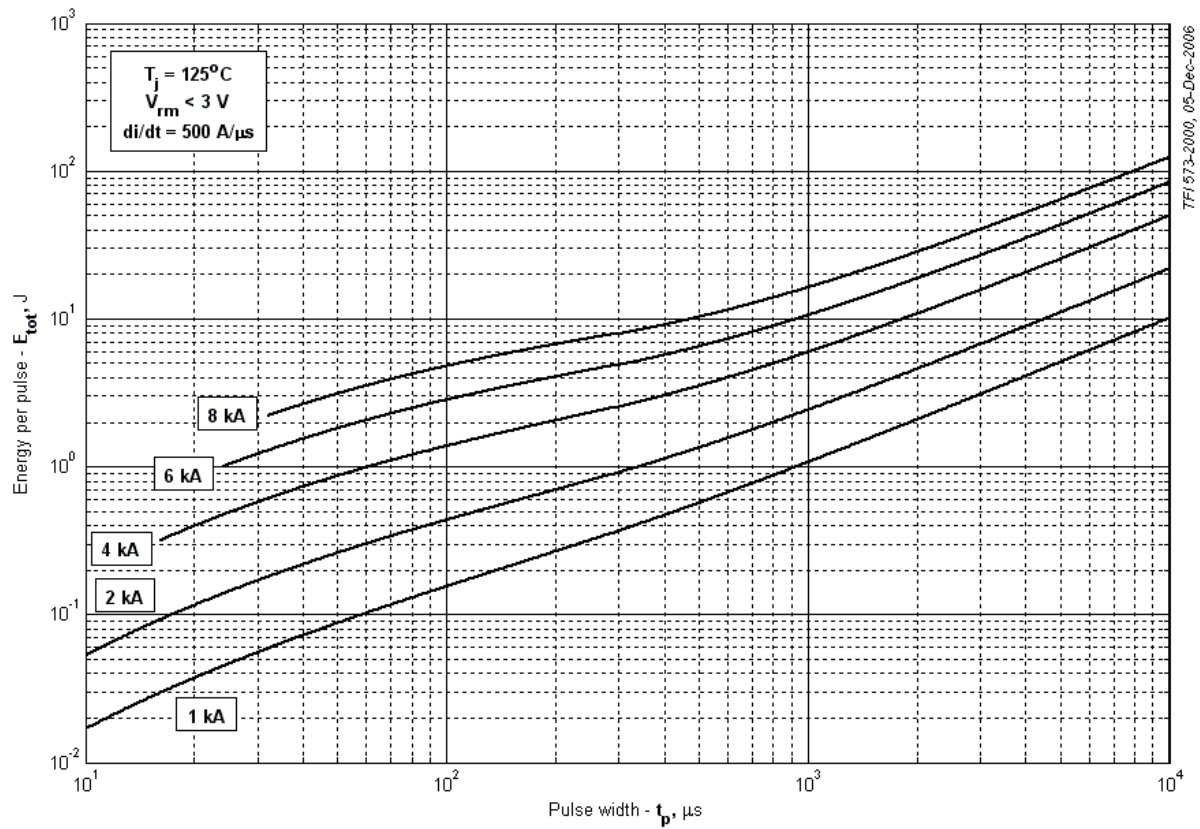


Fig 19 – Square wave energy per pulse

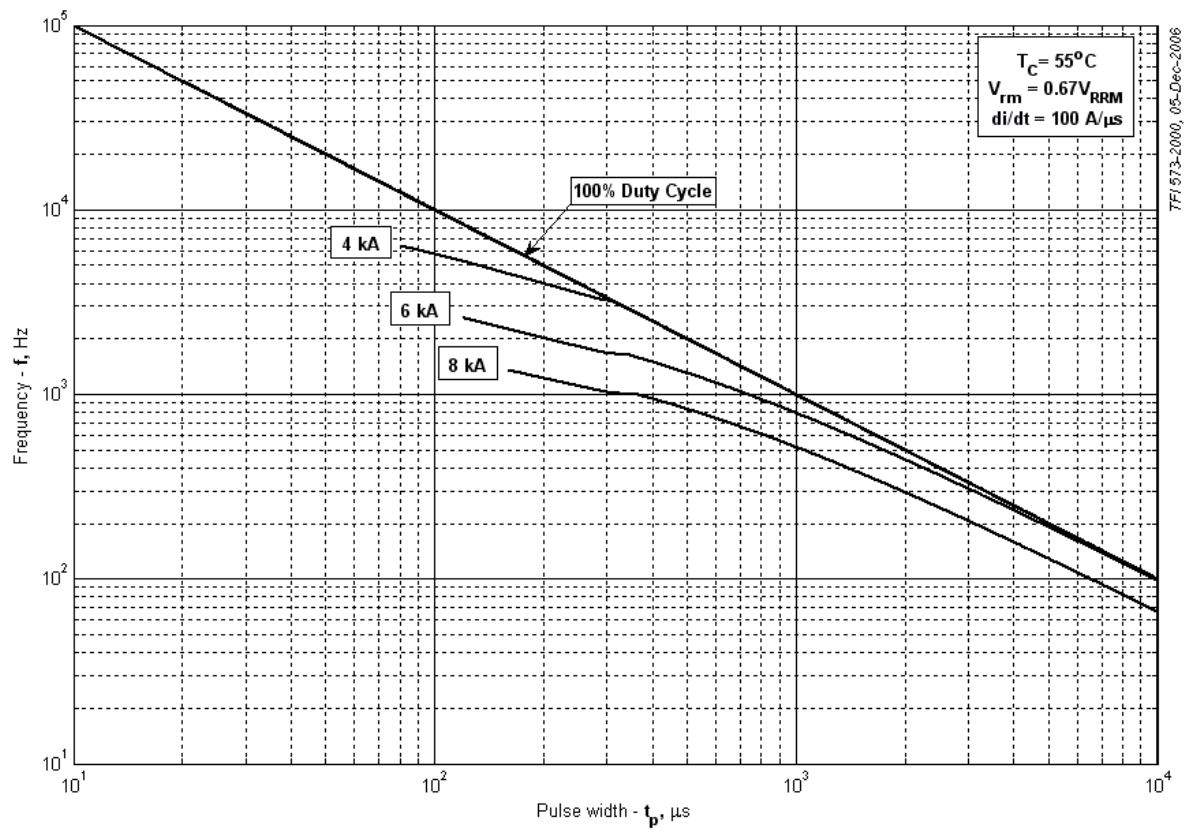


Fig 20 – Square wave frequency ratings

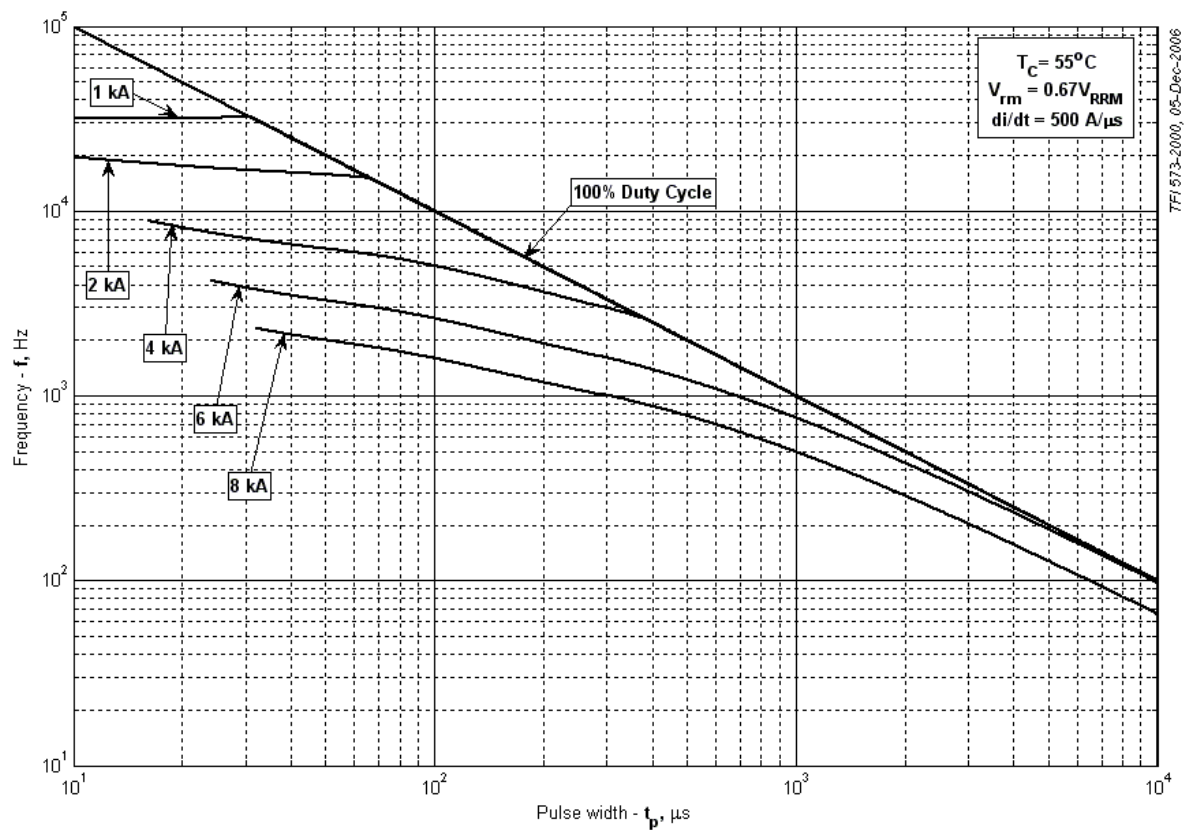


Fig 21 – Square wave frequency ratings

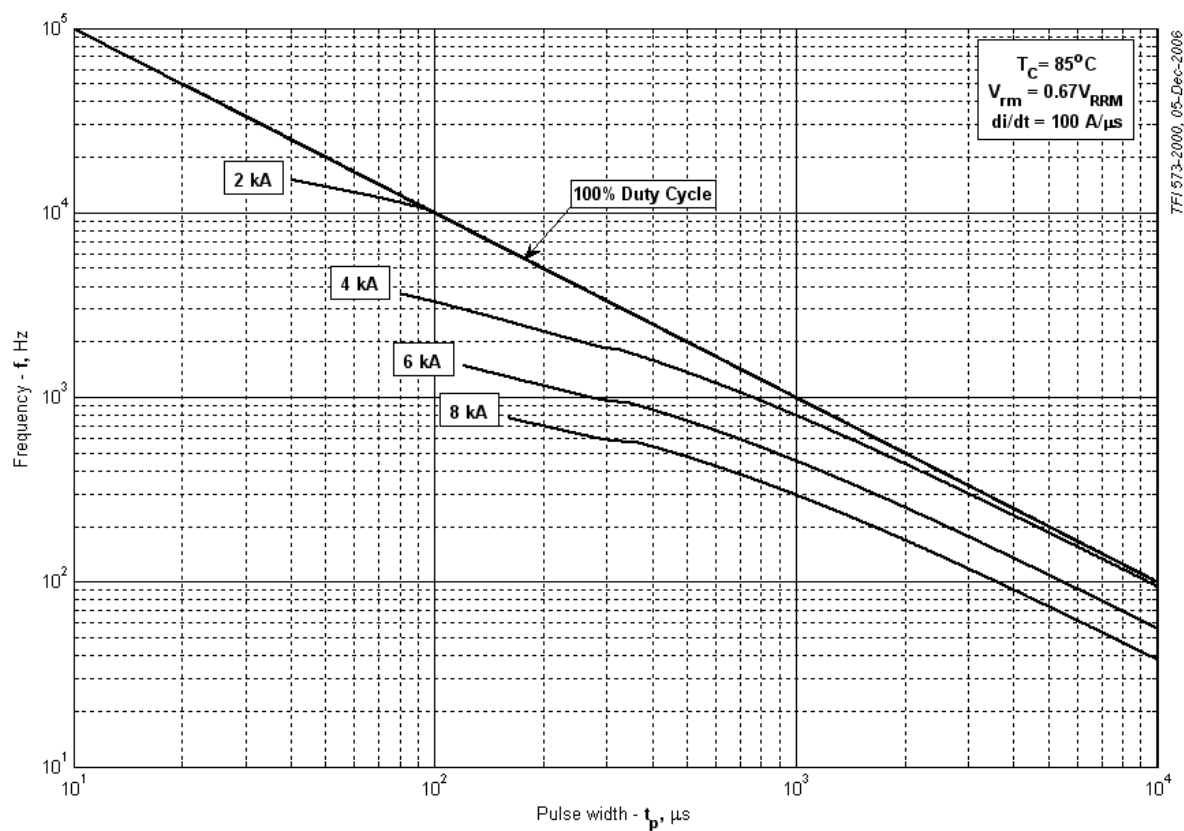


Fig 22 – Square wave frequency ratings

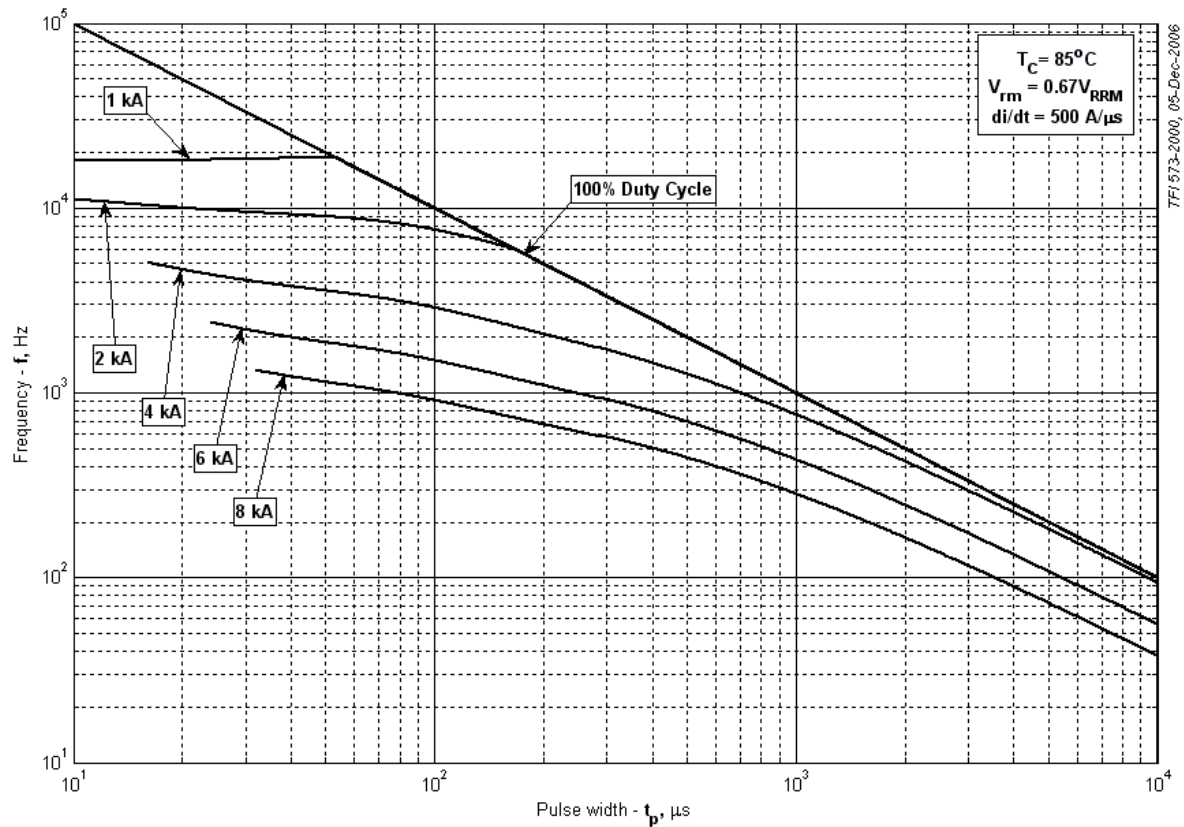


Fig 23 – Square wave frequency ratings

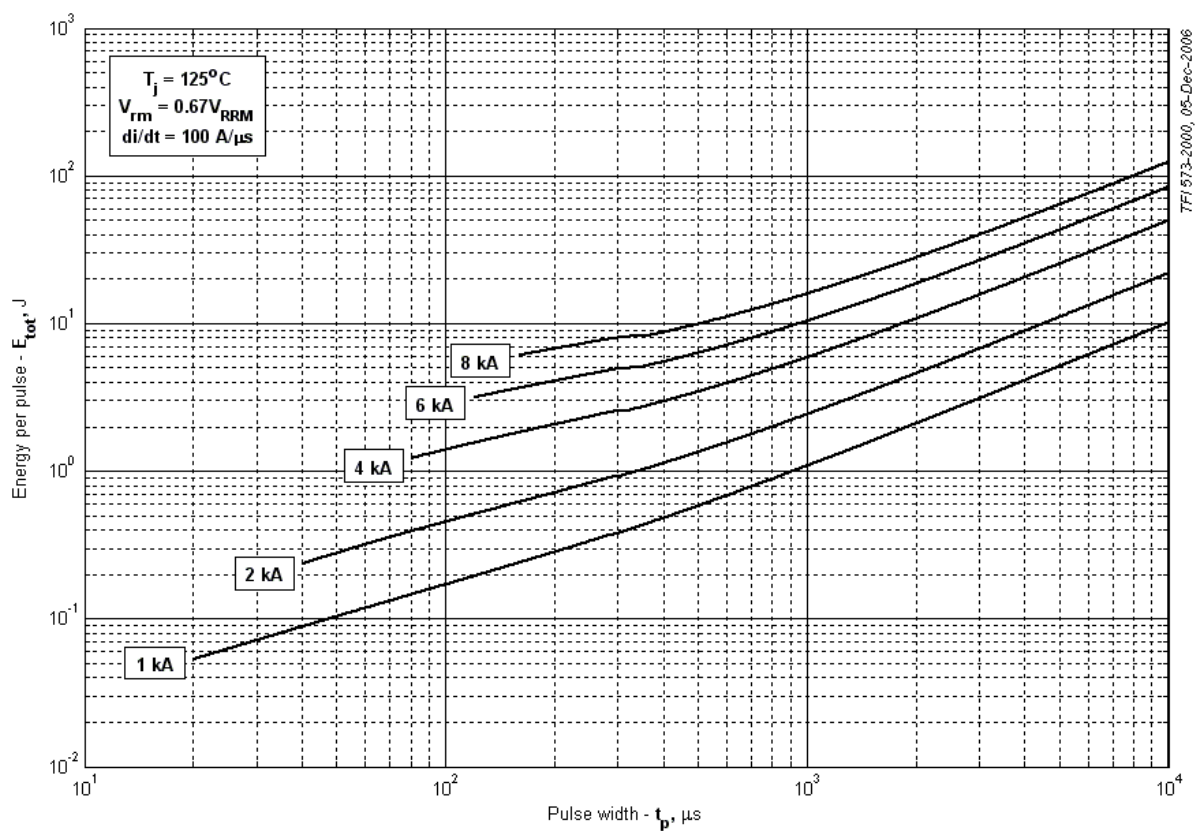


Fig 24 – Square wave energy per pulse

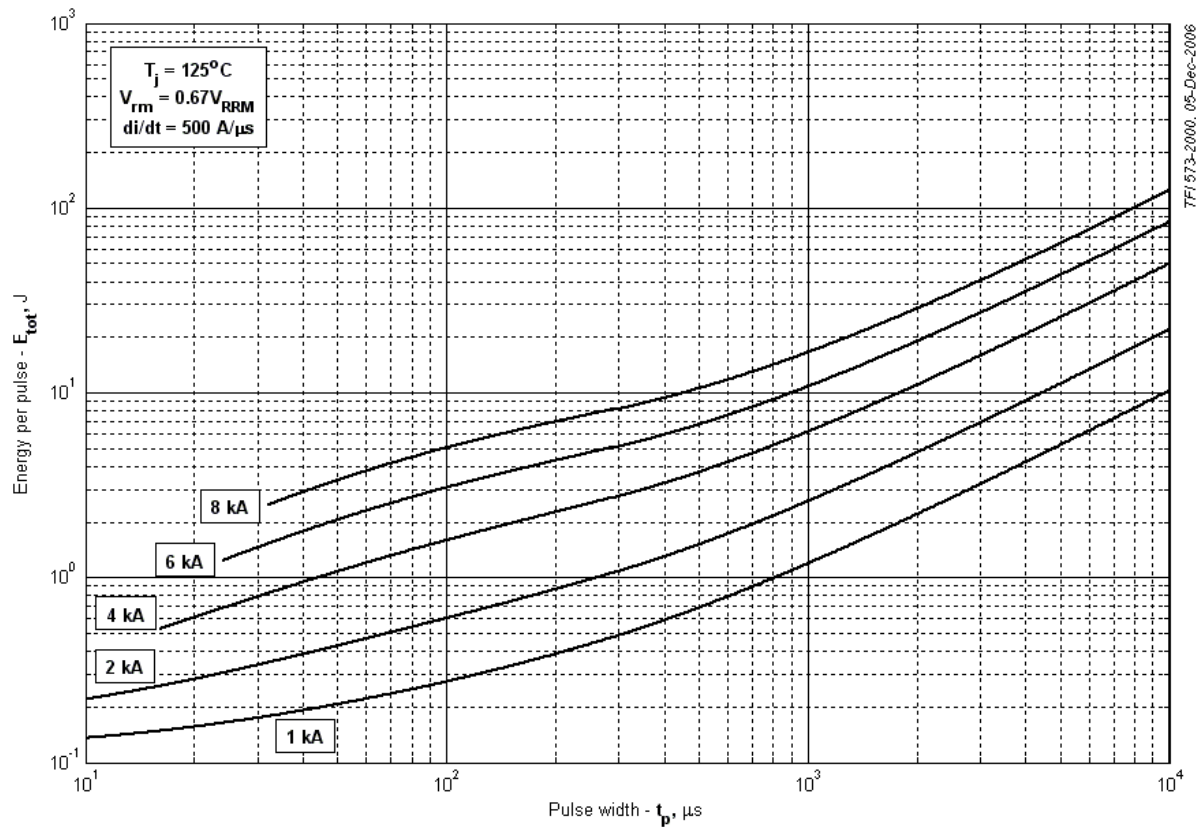


Fig 25 – Square wave energy per pulse

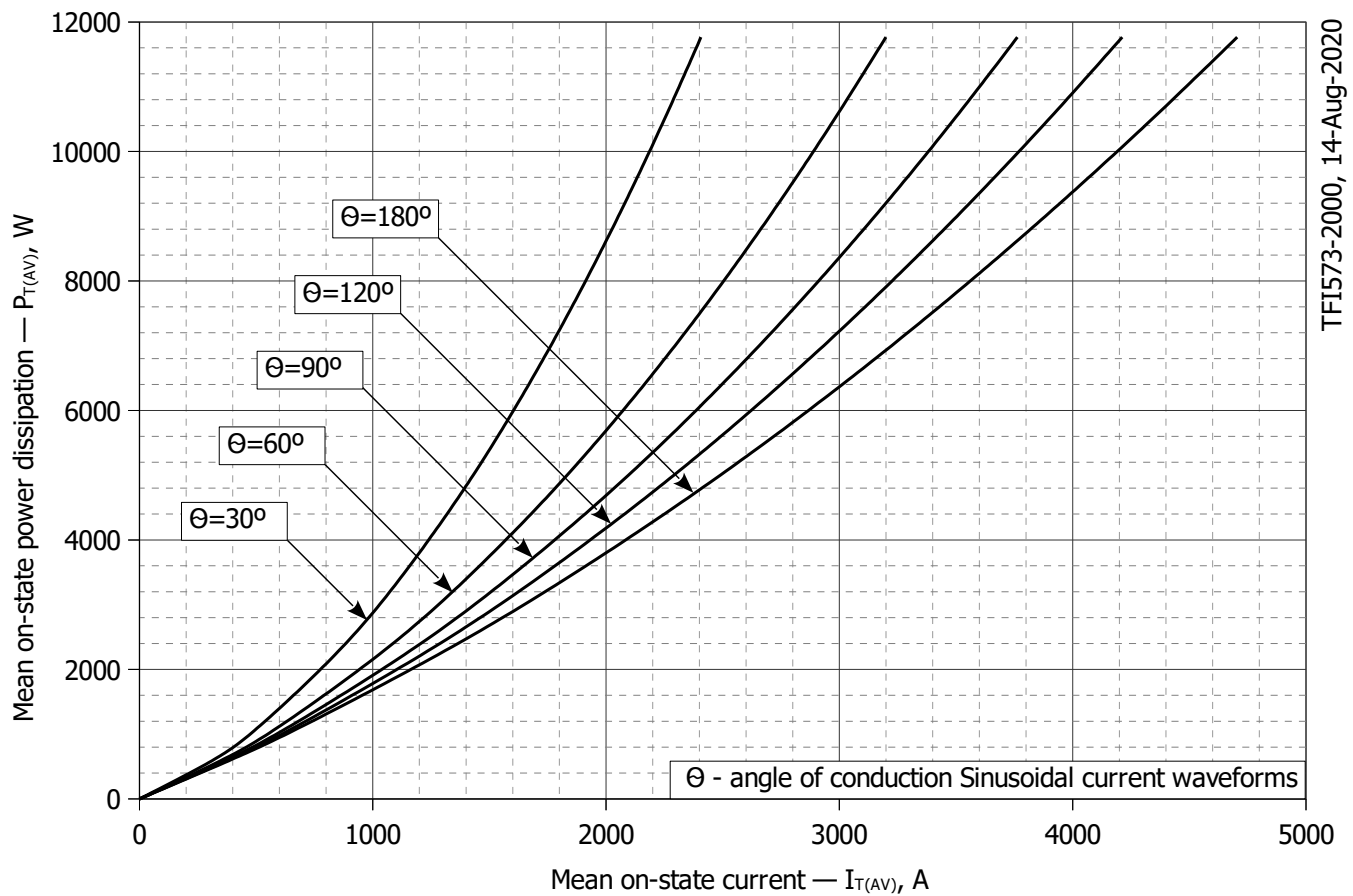


Fig 26 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

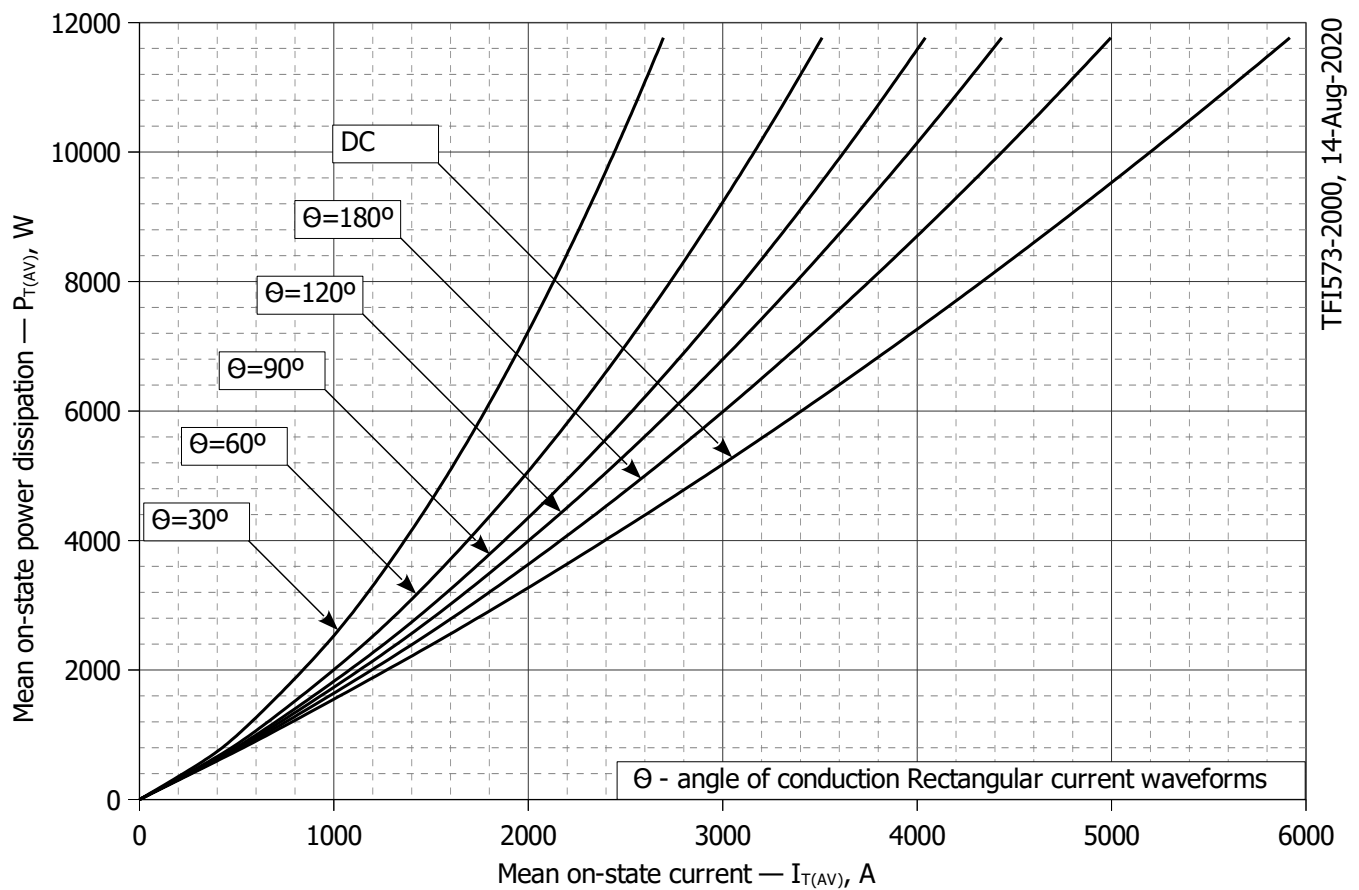


Fig 27 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

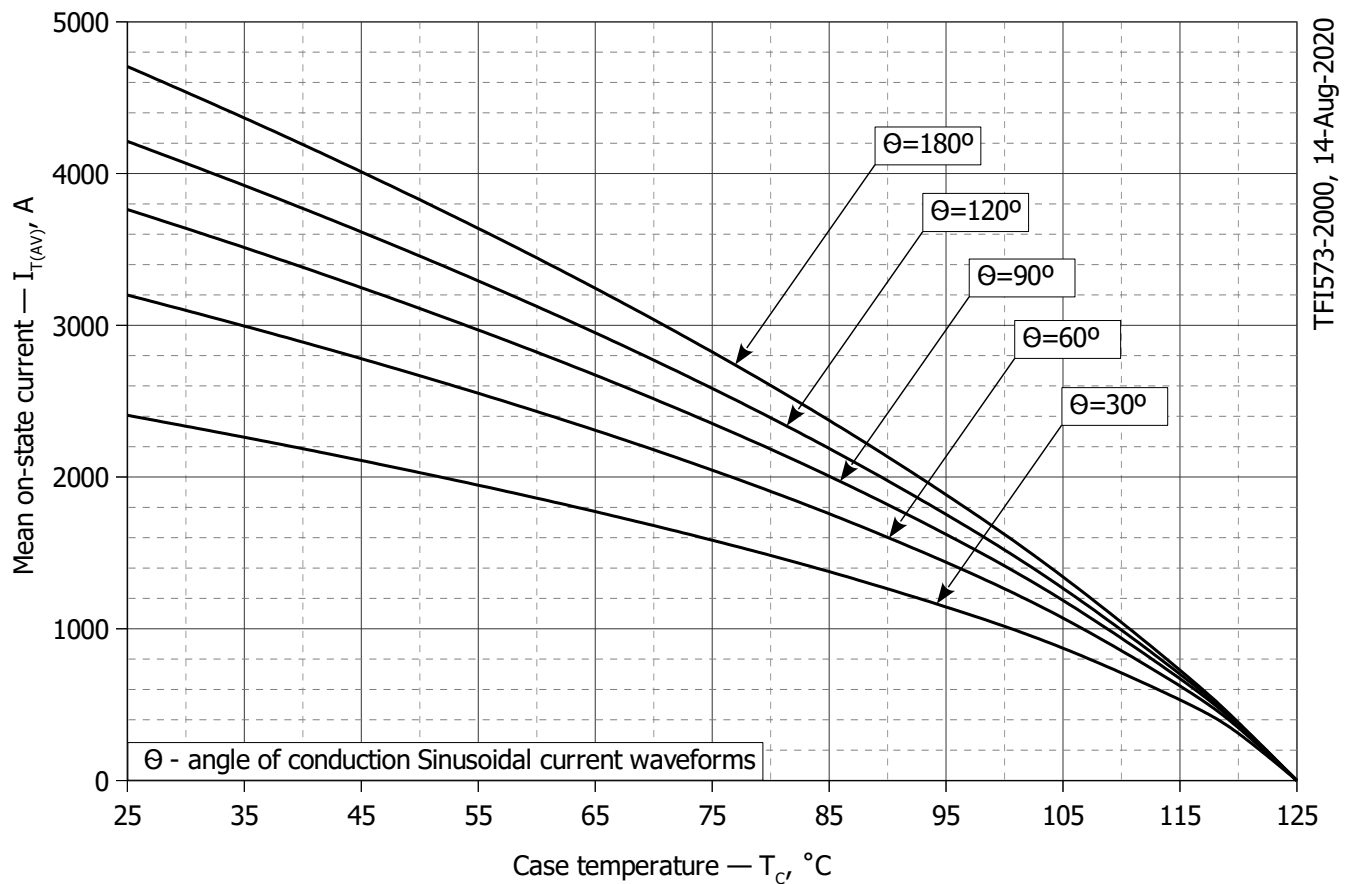
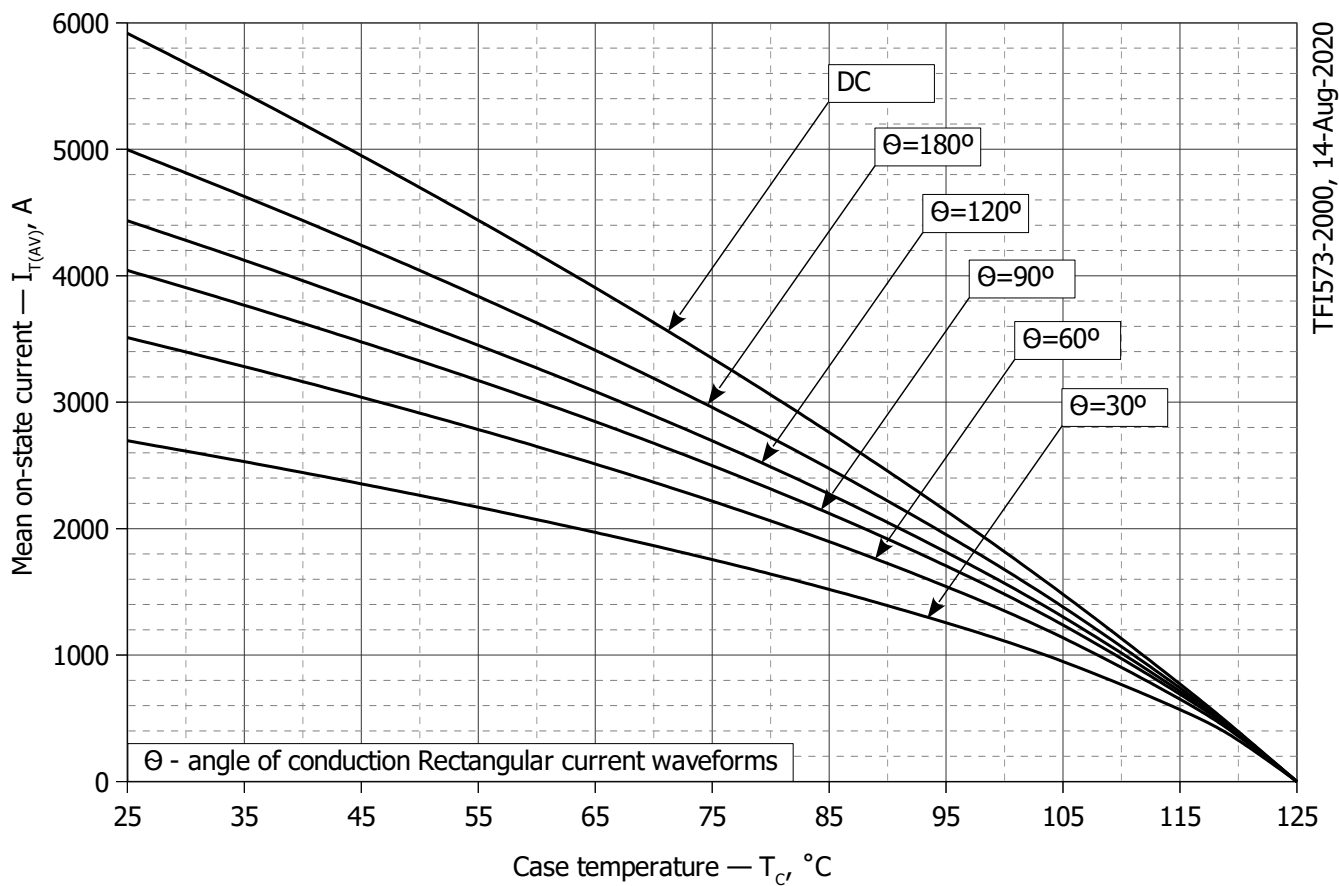


Fig 28 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)



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Fig 29 - Mean on-state current I_{TAV} vs. case temperature T_C for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

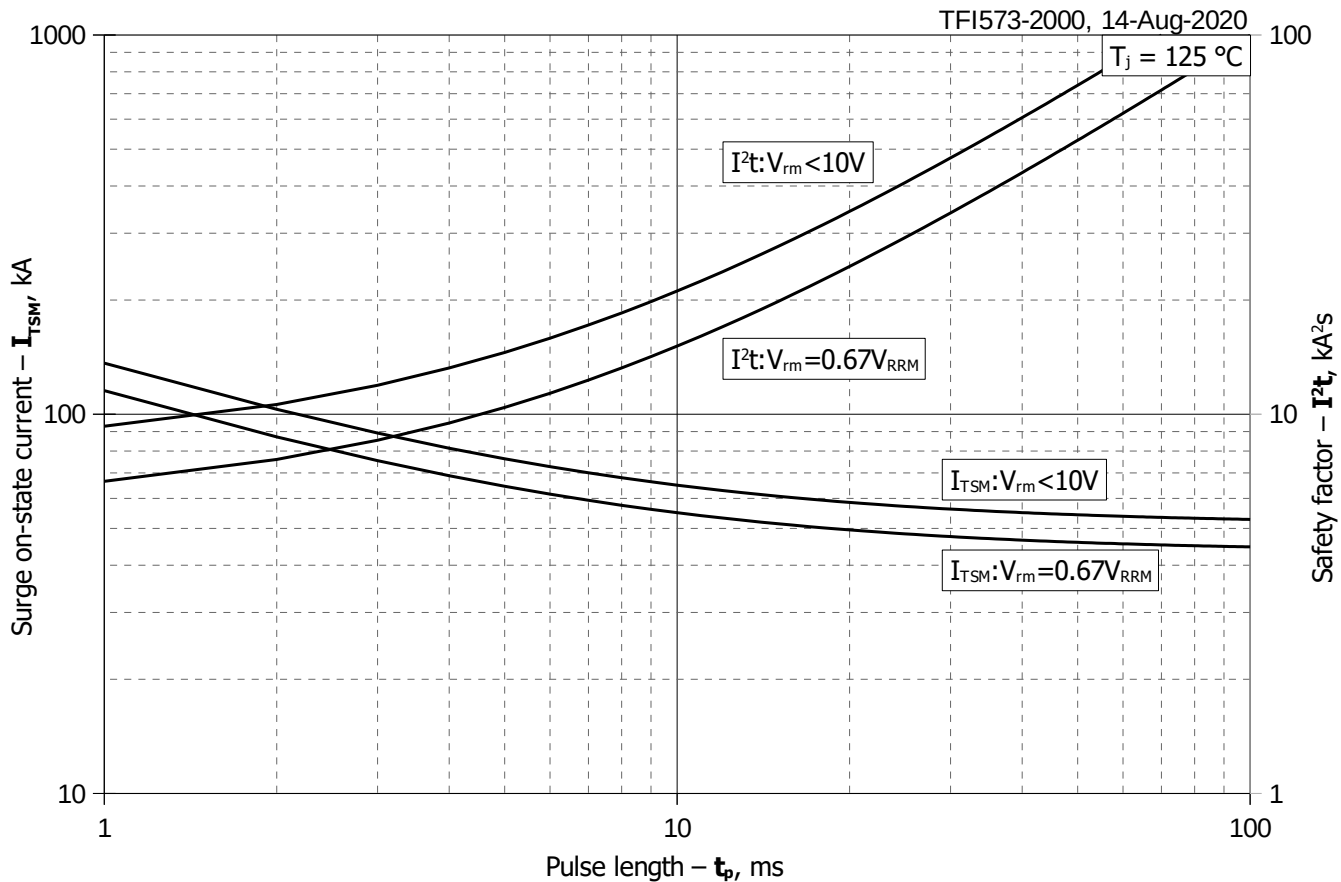


Fig 30 – Maximum surge and I^2t ratings

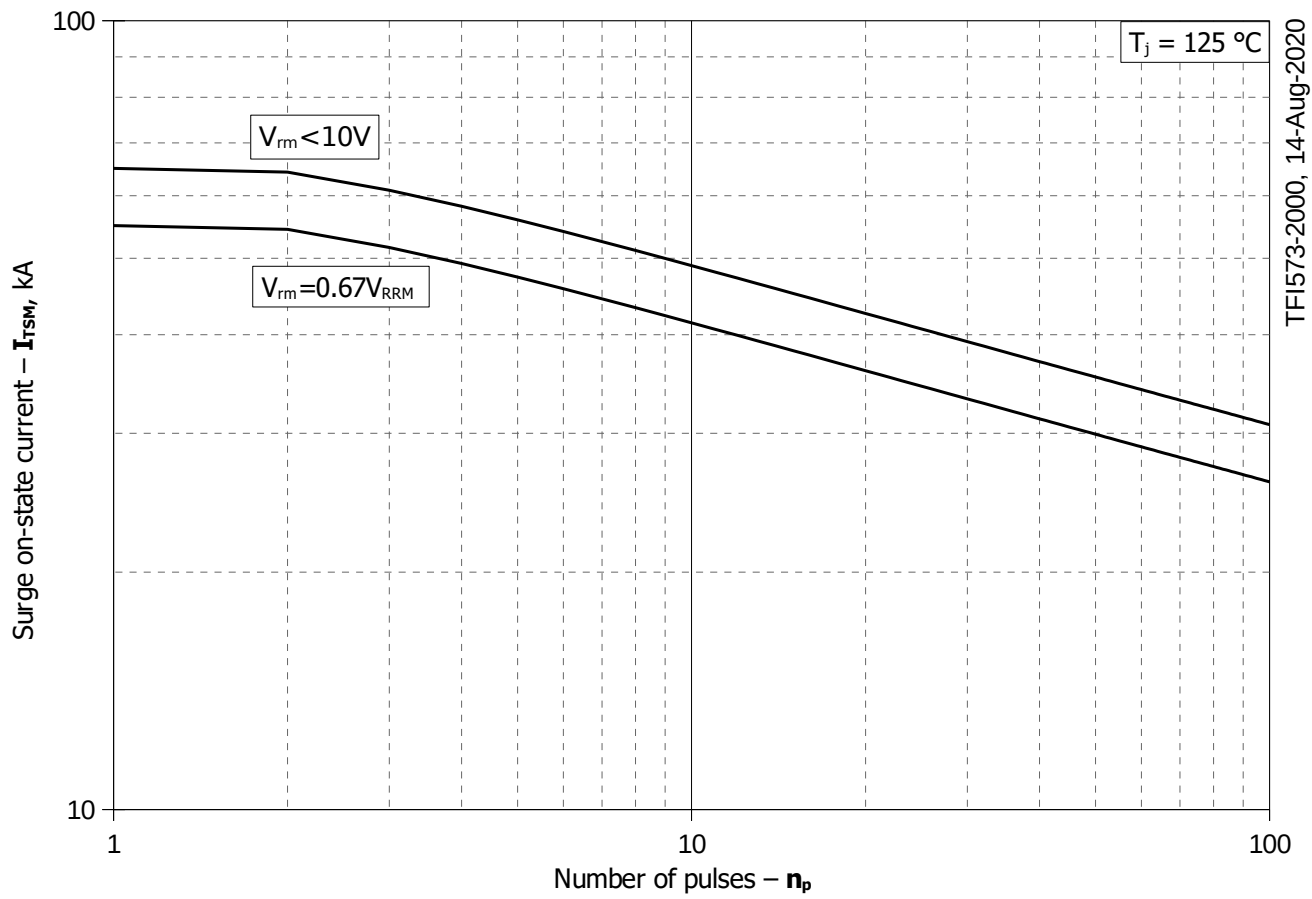


Fig 31 – Maximum surge ratings