



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

Fast Thyristor Type TFI353-1000-28

Maximum allowable mean on-state current			I_{TAV}	1000 A		
Repetitive peak off-state voltage			V_{DRM}	2000...2800 V		
Repetitive peak reverse voltage			V_{RRM}			
Turn-off time			t_q	50.0, 63.0 μs		
V_{DRM}, V_{RRM}, V	2000	2200	2400		2600	2800
Voltage code	20	22	24		26	28
$T_j, ^\circ C$	-60...+125					

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	906 1000 1347	$T_c=85\text{ }^{\circ}\text{C}$; Double side cooled; $T_c=79\text{ }^{\circ}\text{C}$; 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	1570	$T_c=79\text{ }^{\circ}\text{C}$; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	21.0 24.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
			22.0 25.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
I^2t	Safety factor	$A^2s\cdot 10^3$	2200 2800	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
			2000 2500	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=I_{FGM}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	2000...2800	$T_{j\text{ min}}<T_j<T_{j\text{ max}}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2100...2900	$T_{j\text{ min}}<T_j<T_{j\text{ max}}$; 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	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	2200	T _j =T _{j max} ; V _D =0.67·V _{DRM} ; I _{TM} = 7700 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	24.0...28.0	
a	Acceleration	m/s ²	50	Device clamped

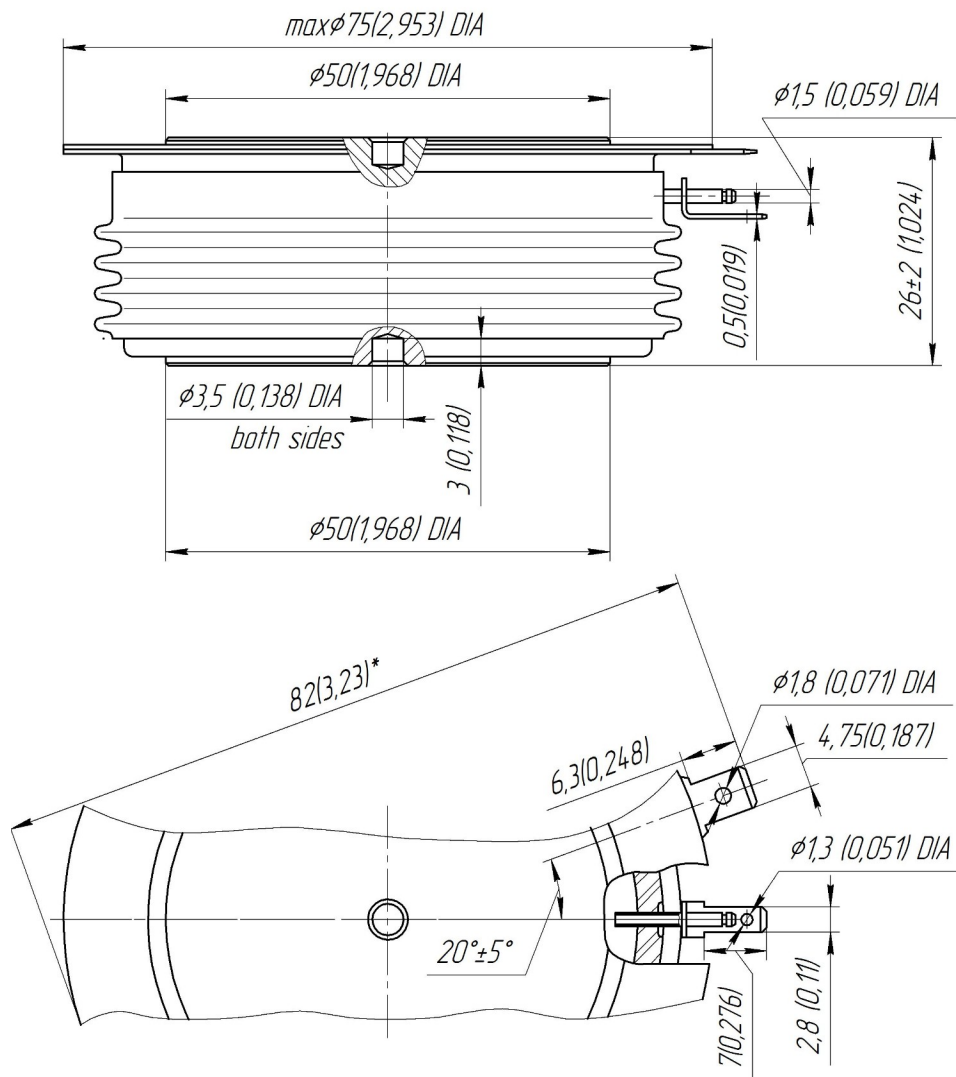
CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V _{TM}	Peak on-state voltage, max	V	2.40	T _j =25 °C; I _{TM} =3140 A	
V _{T(TO)}	On-state threshold voltage, max	V	1.408	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.360	0.5 π I _{TAV} < I _T < 1.5 π I _{TAV}	
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	150	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 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	0.45	T _j =T _{j max} ; V _D =0.67·V _{DRM} ;	
I _{GD}	Gate non-trigger direct current, min	mA	70.00	Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	0.85	T _j =25 °C; V _D =1500 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time ²⁾ , max	μs	2.00, 2.50, 3.20, 4.00	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	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·V _{DRM}
			63.0, 80.0	dv _D /dt=200 V/μs;	
Q _{rr}	Recovered charge, max	μC	1000	T _j =T _{j max} ; I _{TM} =I _{TAV} ;	
t _{rr}	Reverse recovery time, max	μs	8.7	di _R /dt=-50 A/μs;	
I _{rr}	Reverse recovery current, max	A	230	V _R =100 V	

THERMAL					
R _{thjc}	Thermal resistance, junction to case, max	°C/W	0.0200	Direct current	Double side cooled
R _{thjc-A}			0.0440		Anode side cooled
R _{thjc-K}			0.0360		Cathode side cooled
R _{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0040	Direct current	
MECHANICAL					
m	Weight, max	g	490		
D _s	Surface creepage distance	mm (inch)	31.60 (1.244)		
D _a	Air strike distance	mm (inch)	16.50 (0.649)		

PART NUMBERING GUIDE							
TFI	353	1000	28	A2	C3	H4	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 ₀ /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 ₀ /dt) _{crit} , V/μs	200	320	500	1000	1600	2000	2500
2) Turn-on time							
Symbol of group	P4	M4	K4	H4			
t _{gt} , μs	2.00	2.50	3.20	4.00			
3) Turn-off time (dv ₀ /dt=50 V/μs)							
Symbol of group	E3	C3					
t _q , μs	50.0	63.0					



All dimensions in millimeters (inches)

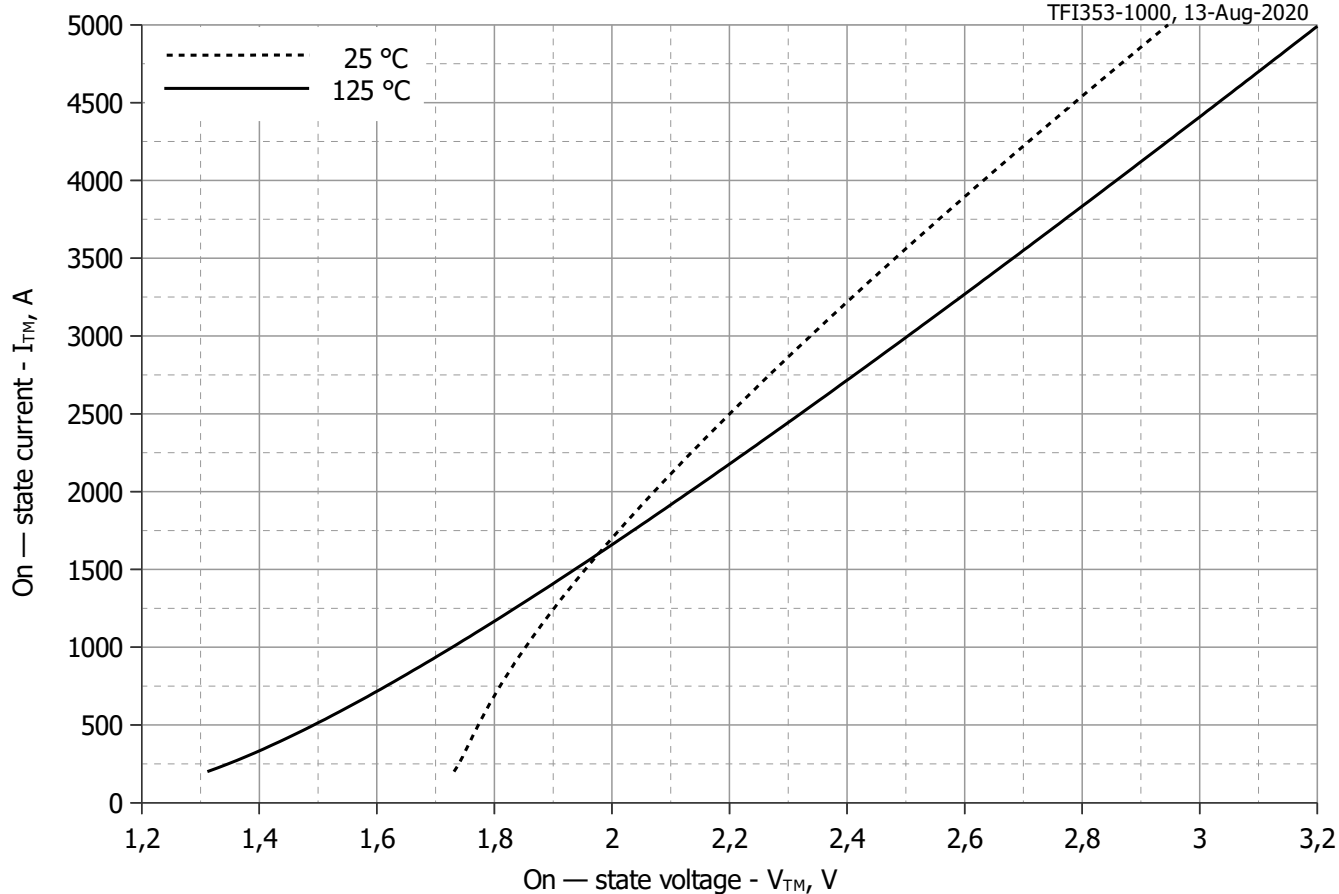


Fig 1 – On-state characteristics of Limit device

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 for max curves	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\max}$
A	1.30025504	0.93299045
B	0.00049547	0.00028330
C	0.13840335	0.04204247
D	-0.02843032	0.00700778

On-state characteristic model (see Fig. 1)

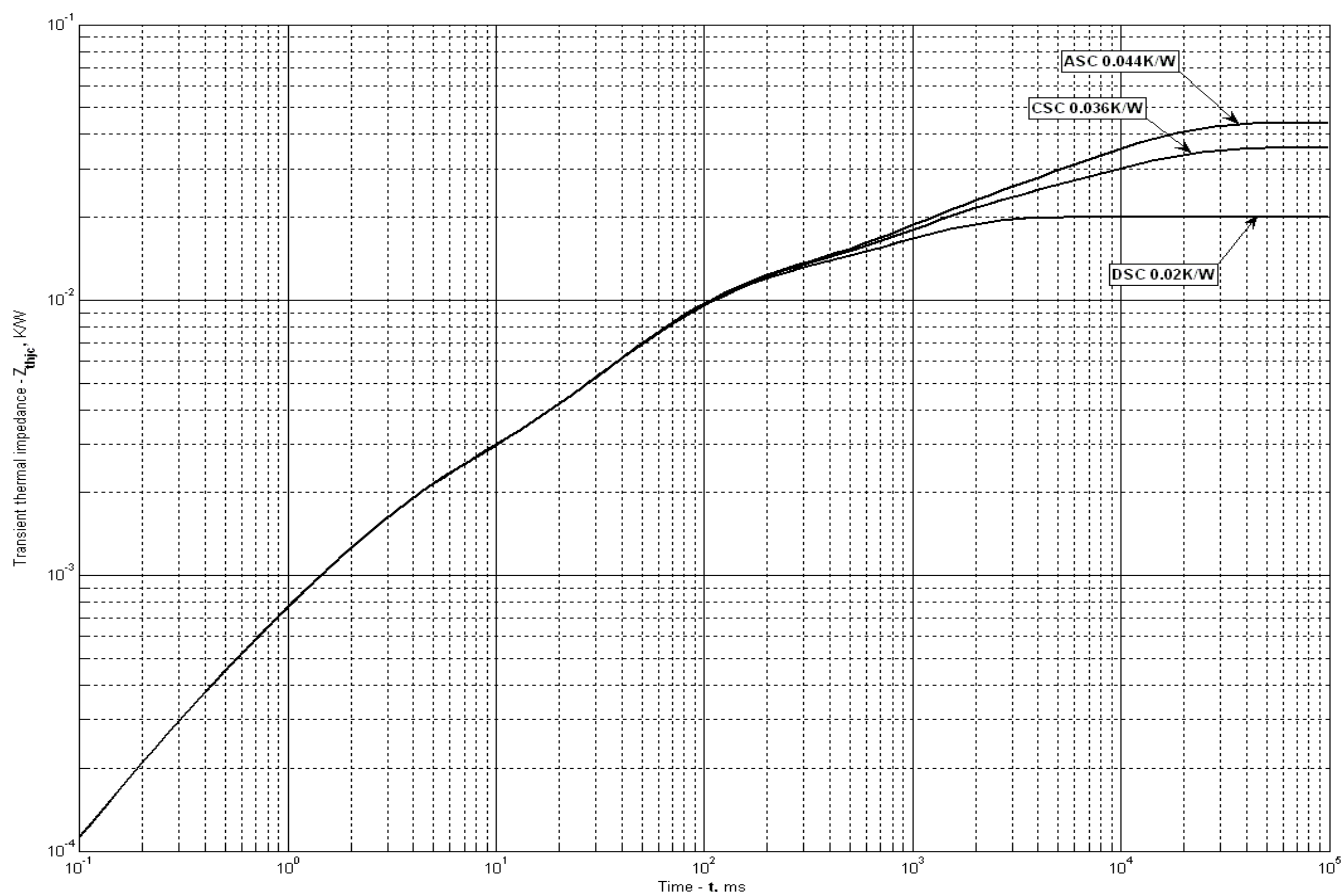


Fig 2 – Transient thermal impedance

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
$R_i, K/W$	0.009168	0.002899	0.001522	0.006297	0.00003033	0.00008163
τ_i, s	0.9681	0.05144	0.002417	0.07706	0.0004122	0.0002166

DC Cathode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.01568	0.00922	0.009098	0.00006319	0.001526	0.000116
τ_i, s	9.755	1.039	0.06857	0.01397	0.002449	0.0002632

DC Anode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.02398	0.009274	0.009094	-0.00003741	0.00155	0.0001282
τ_i, s	9.752	1.065	0.06762	0.01374	0.002533	0.0002841

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

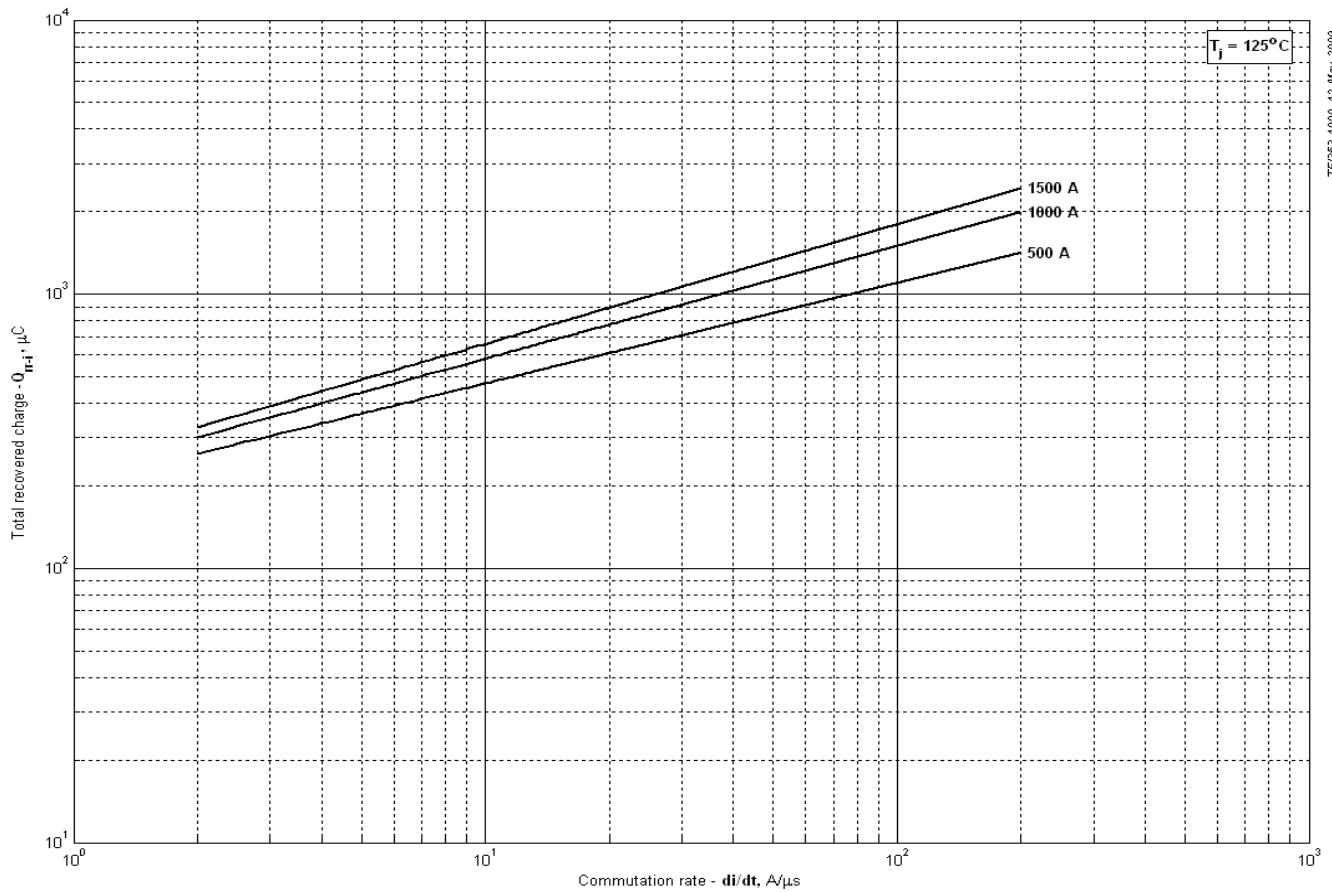


Fig 3 - Total recovered charge, Q_{rr-i} (integral)

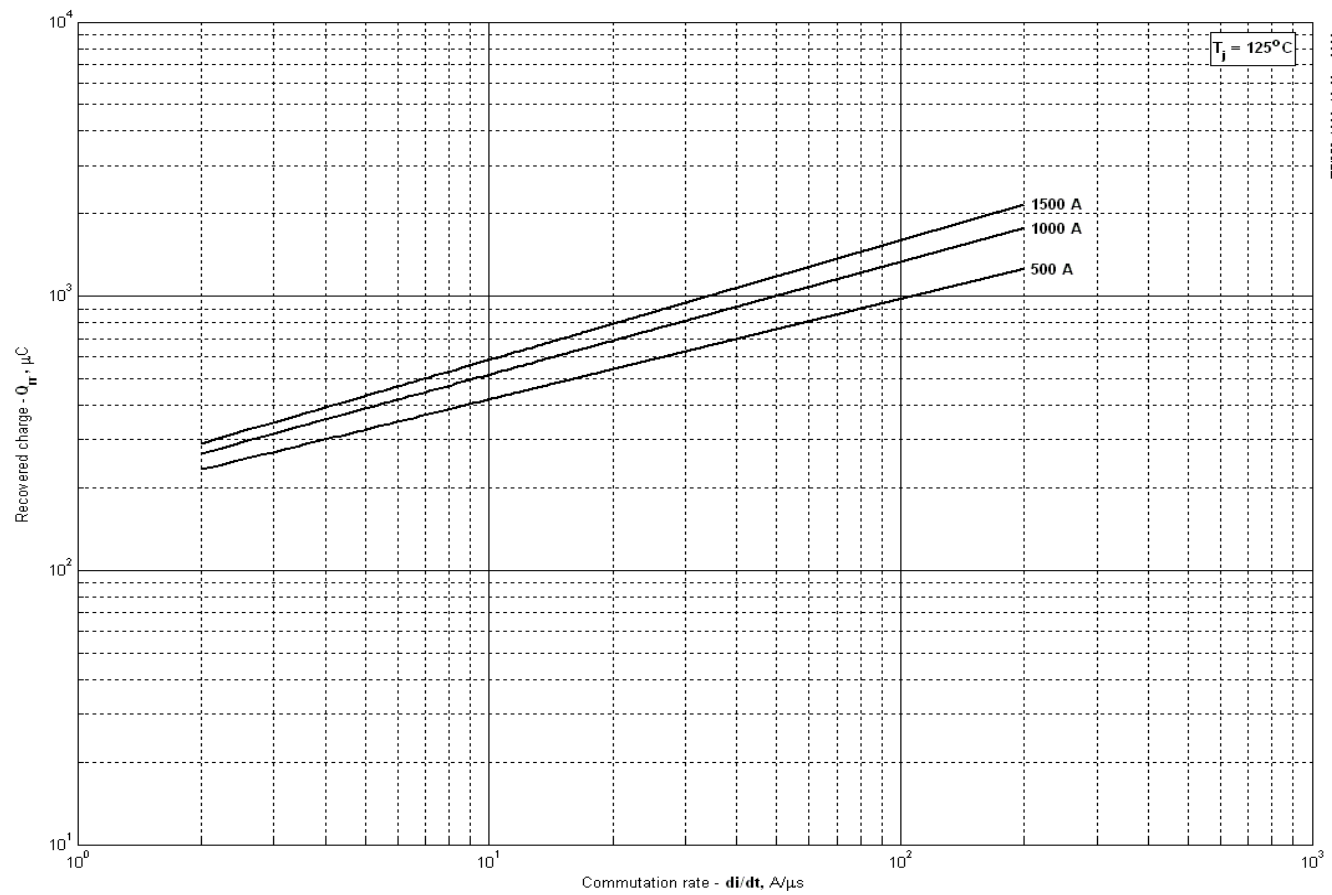


Fig 4 - Recovered charge, Q_{rr} (linear)

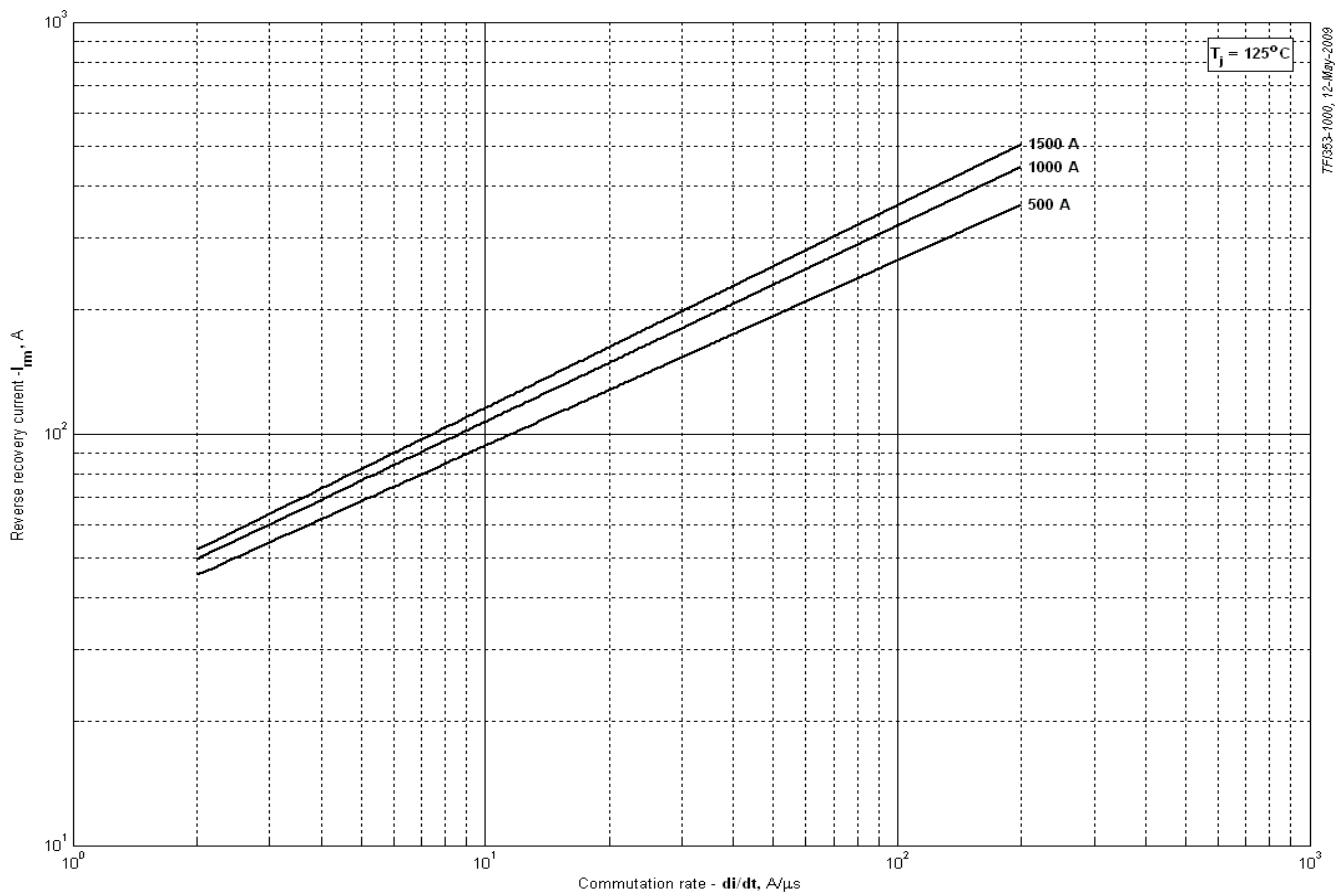


Fig 5 - Peak reverse recovery current, I_{rr}

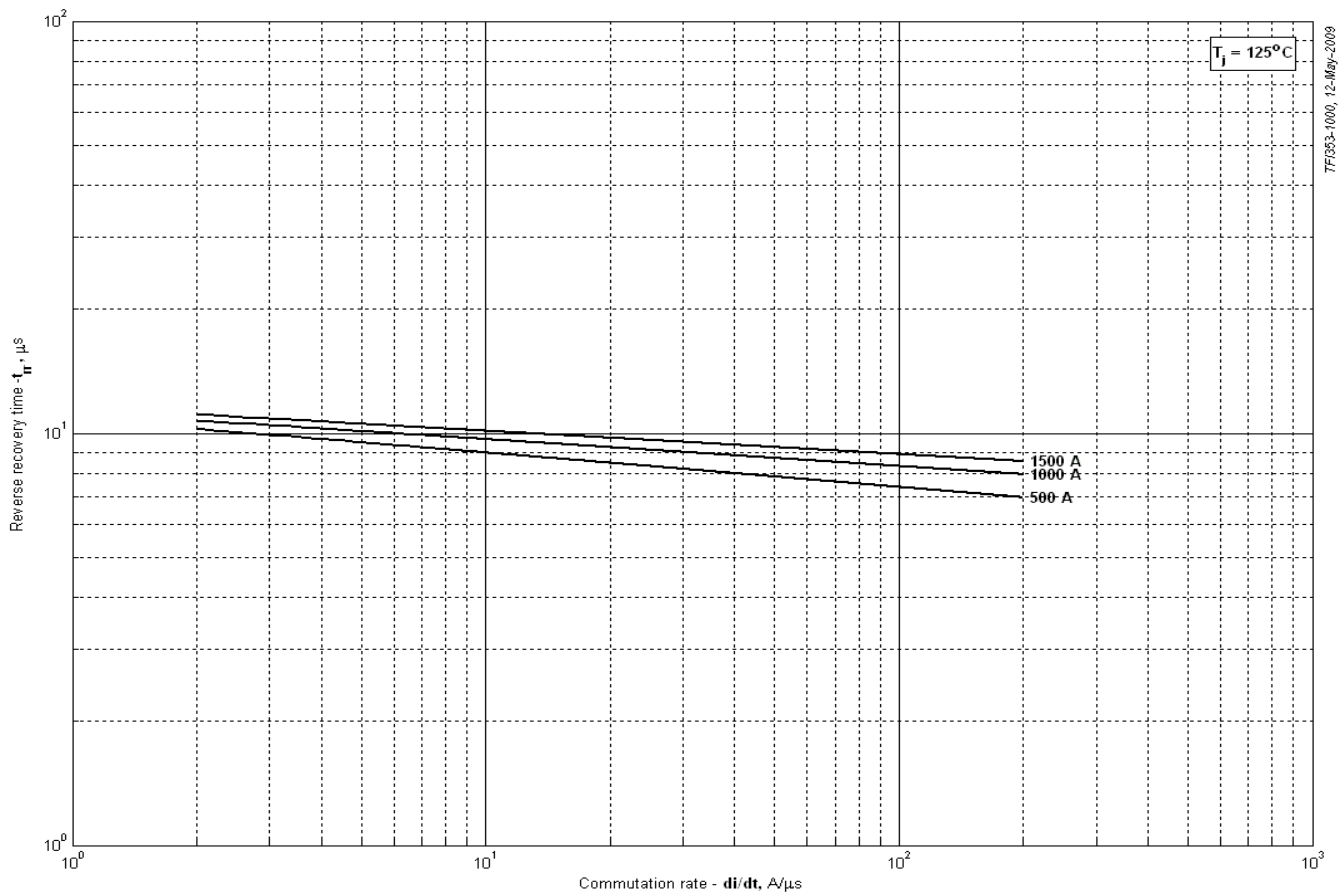


Fig 6 - Maximum recovery time, t_{rr} (50% chord)

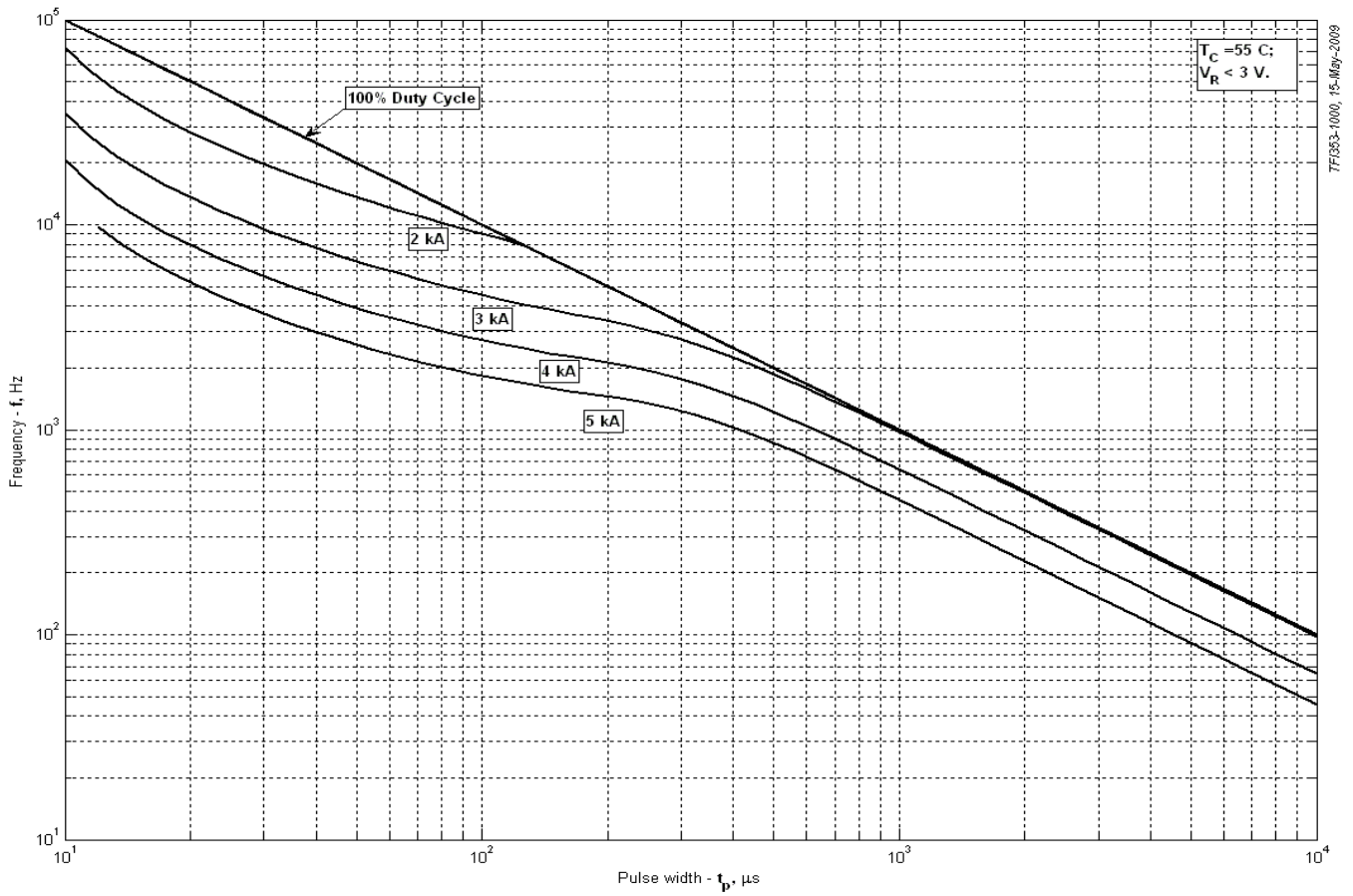


Fig 7 - Sine wave frequency ratings

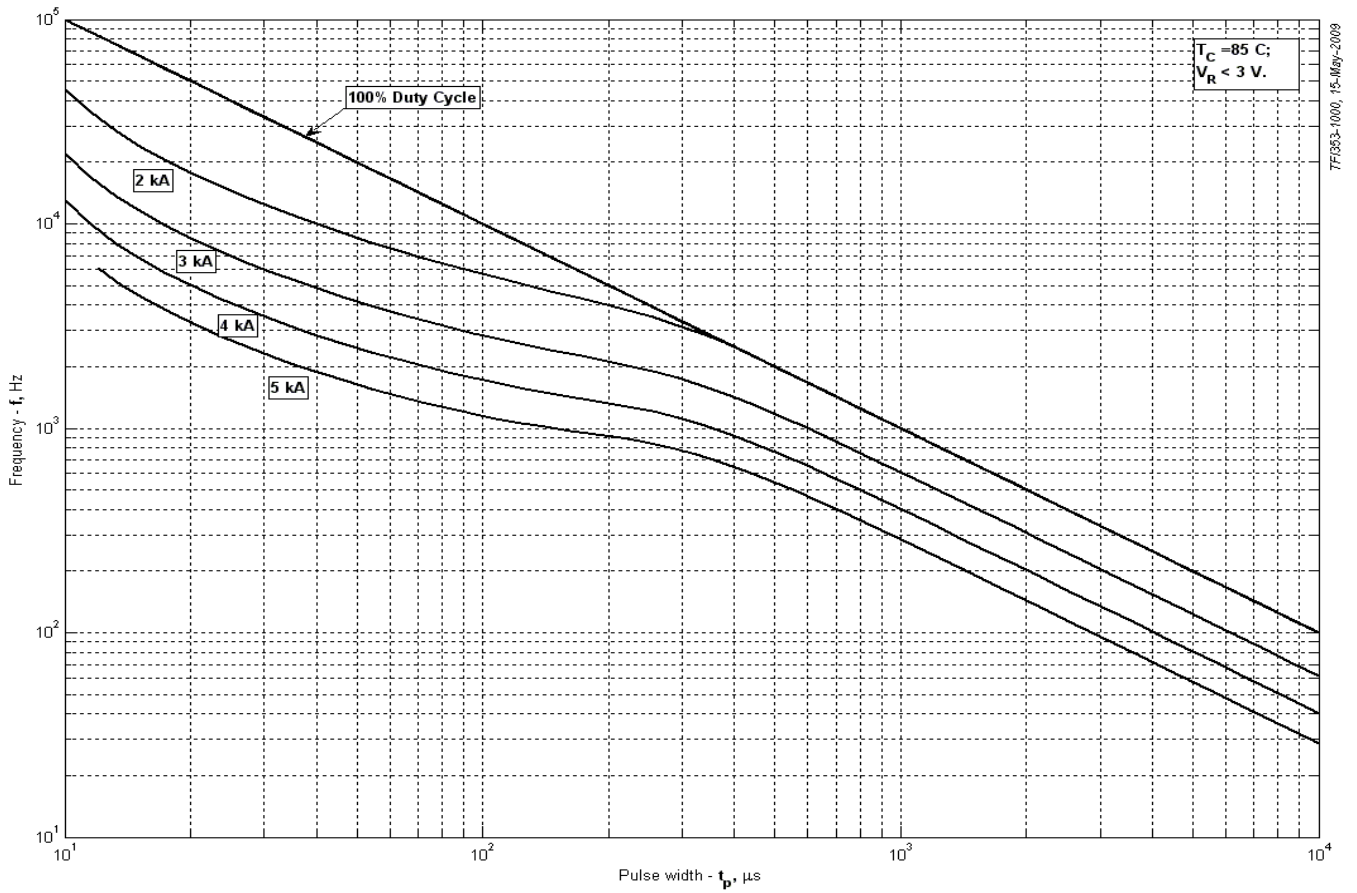


Fig 8 - Sine wave frequency ratings

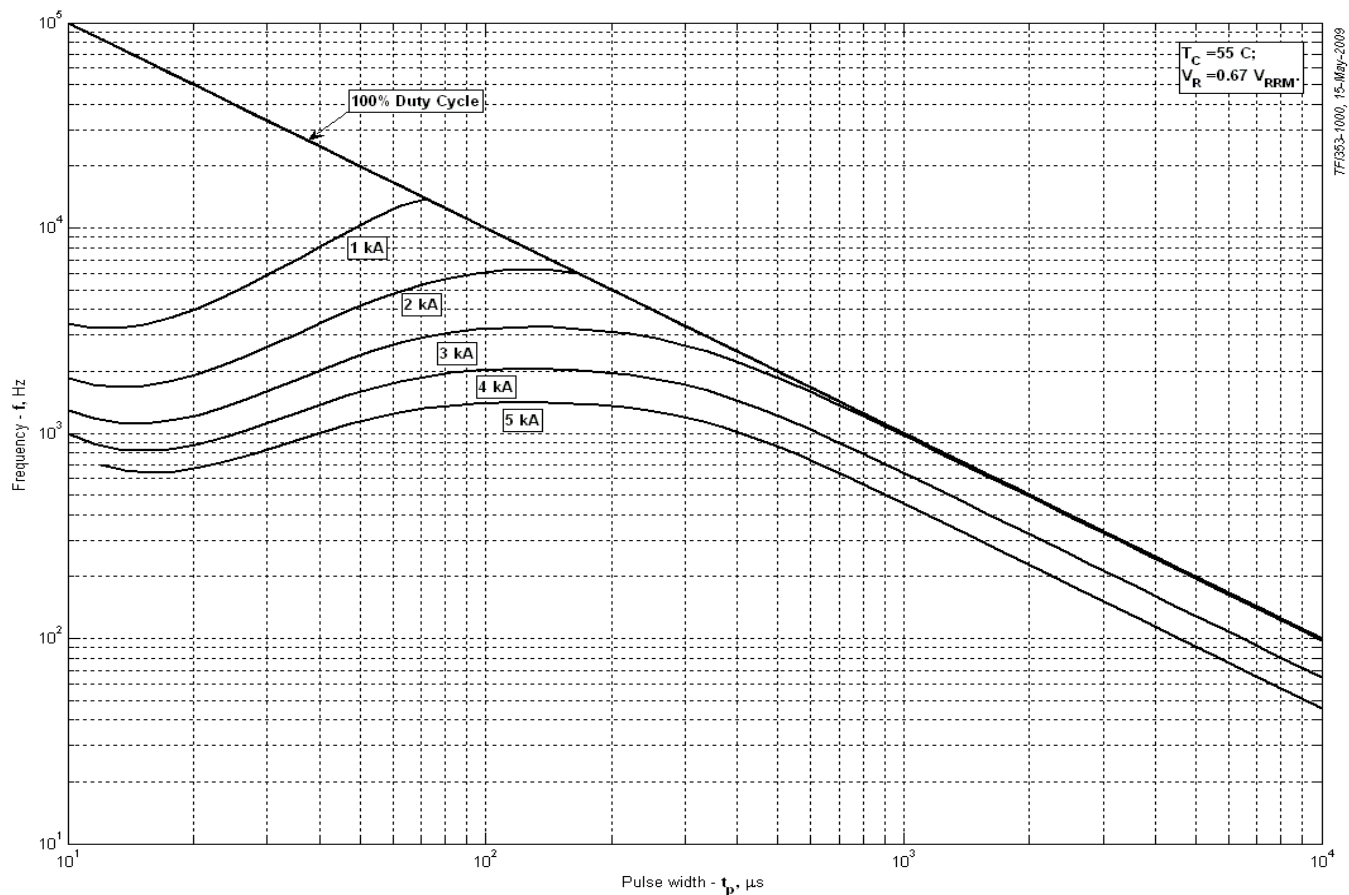


Fig 9 - Sine wave frequency ratings

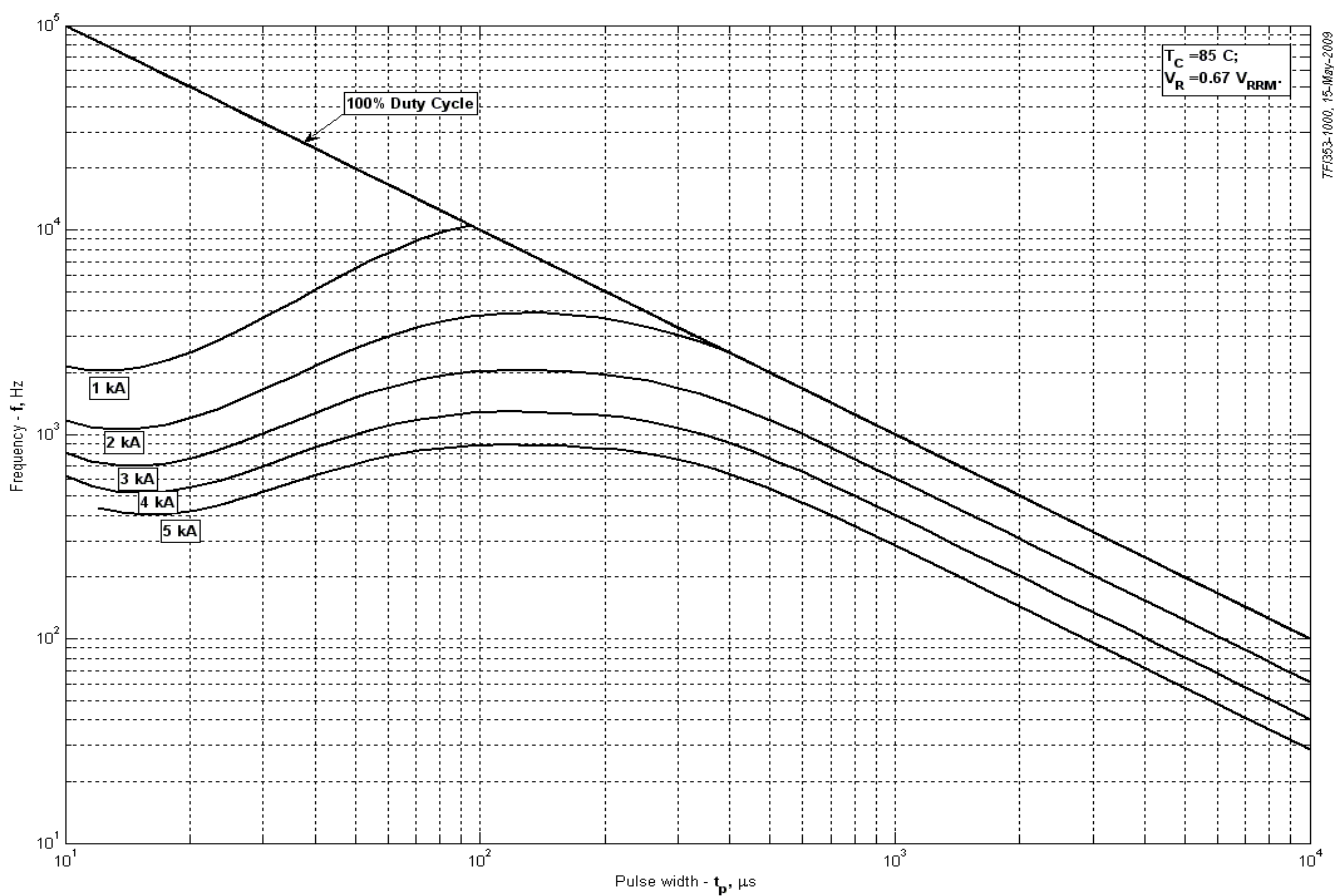


Fig 10 - Sine wave frequency ratings

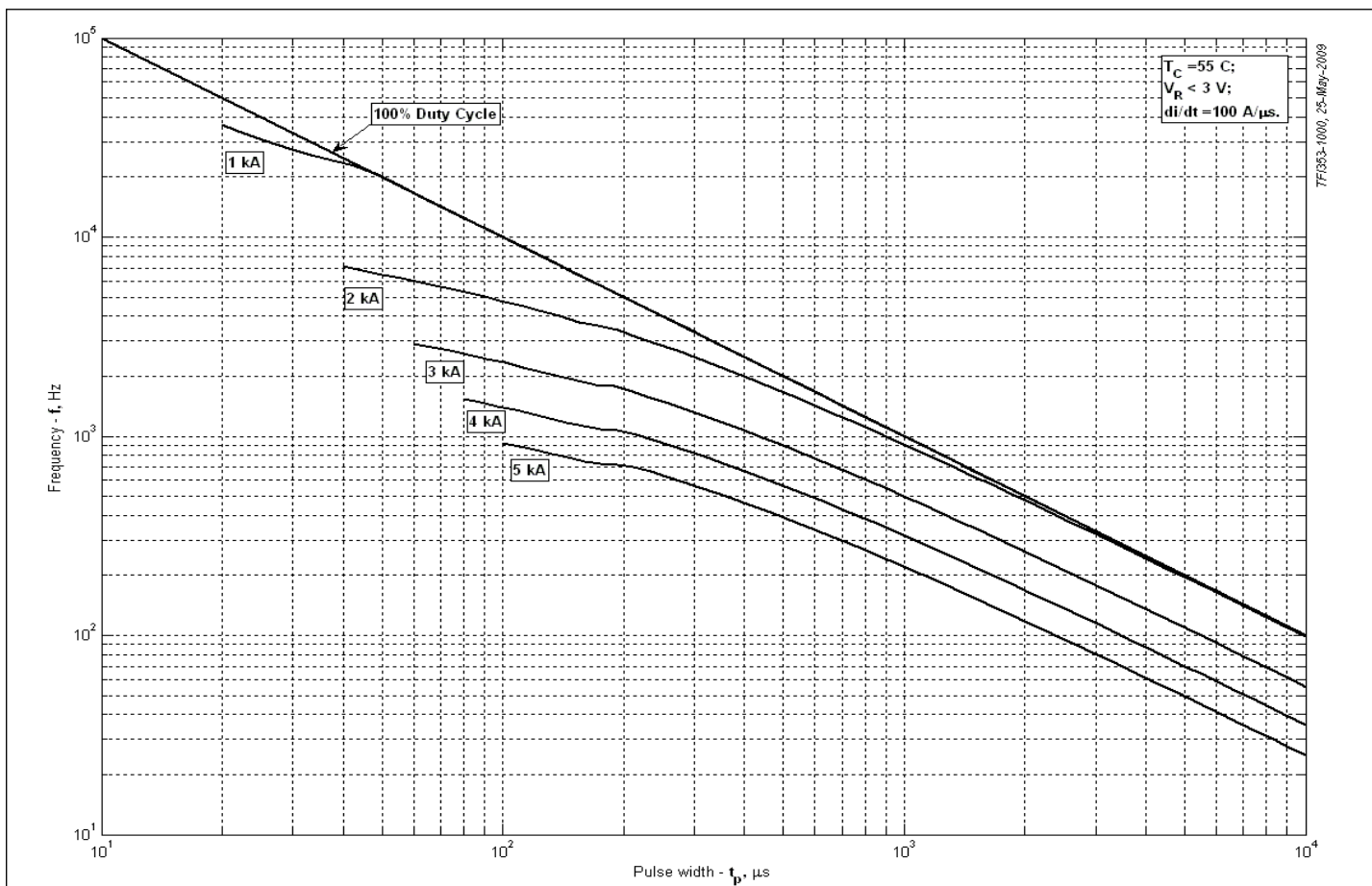


Fig 11 - Square wave frequency ratings

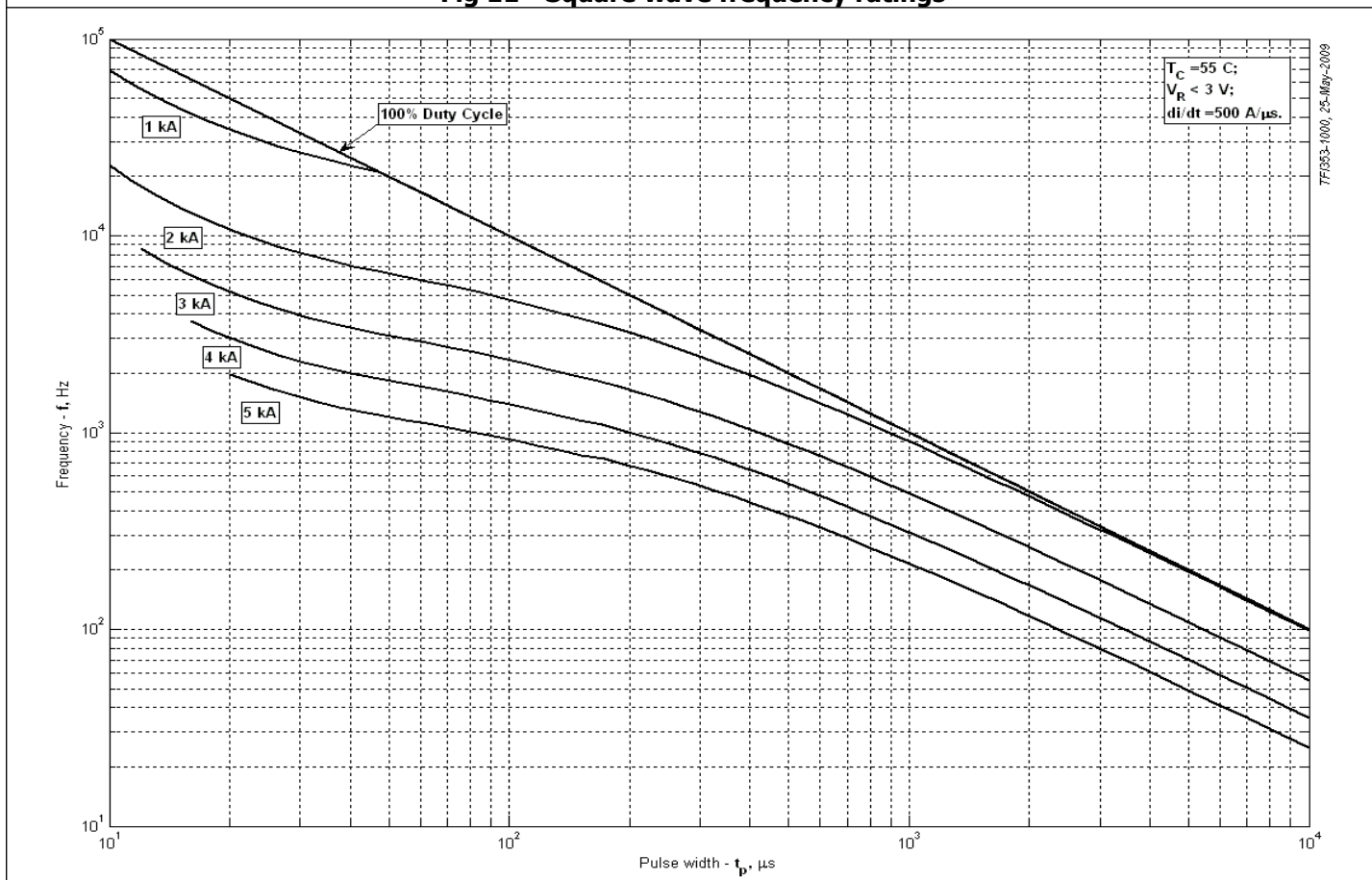


Fig 12 - Square wave frequency ratings

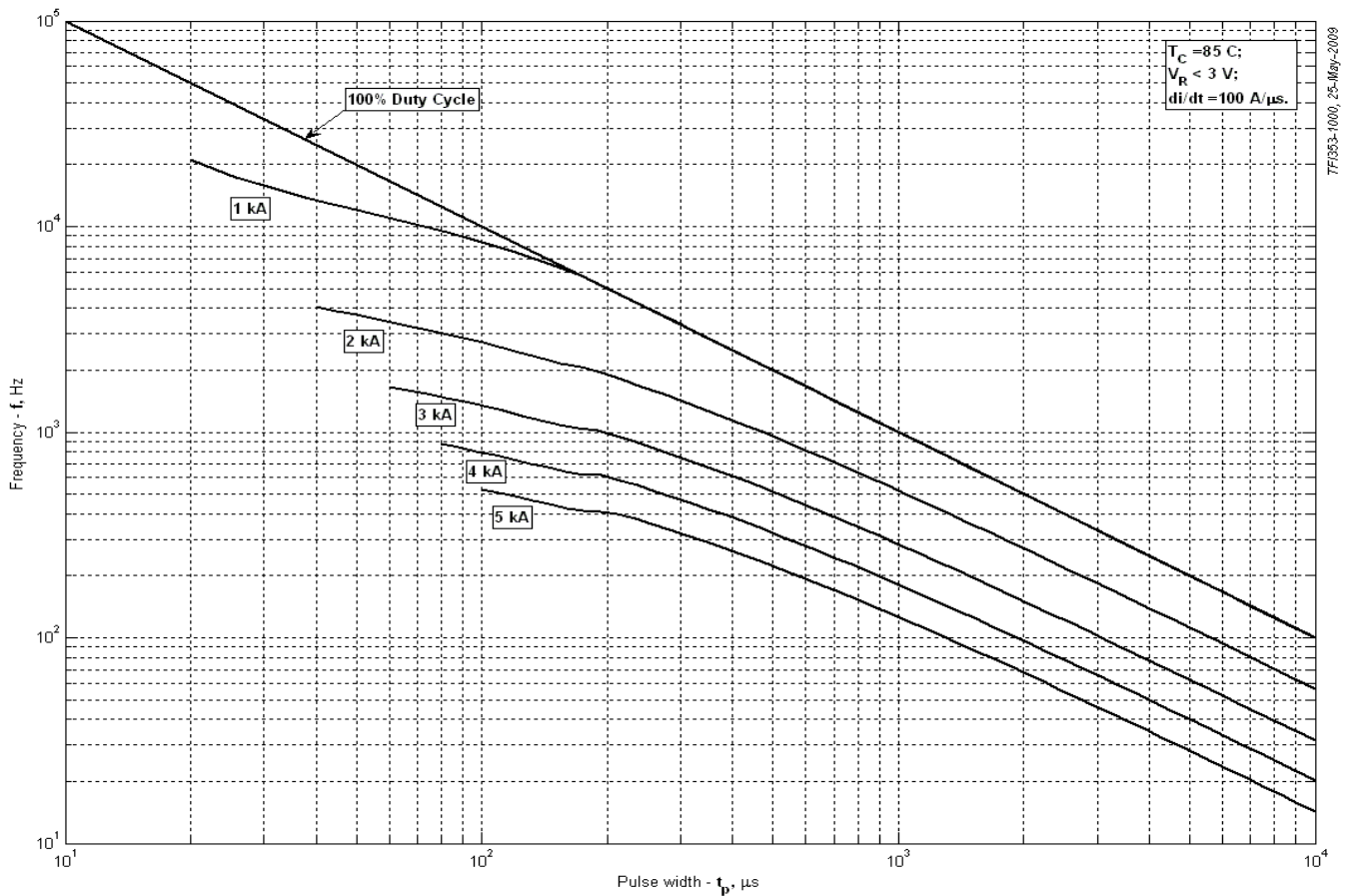


Fig 13 - Square wave frequency ratings

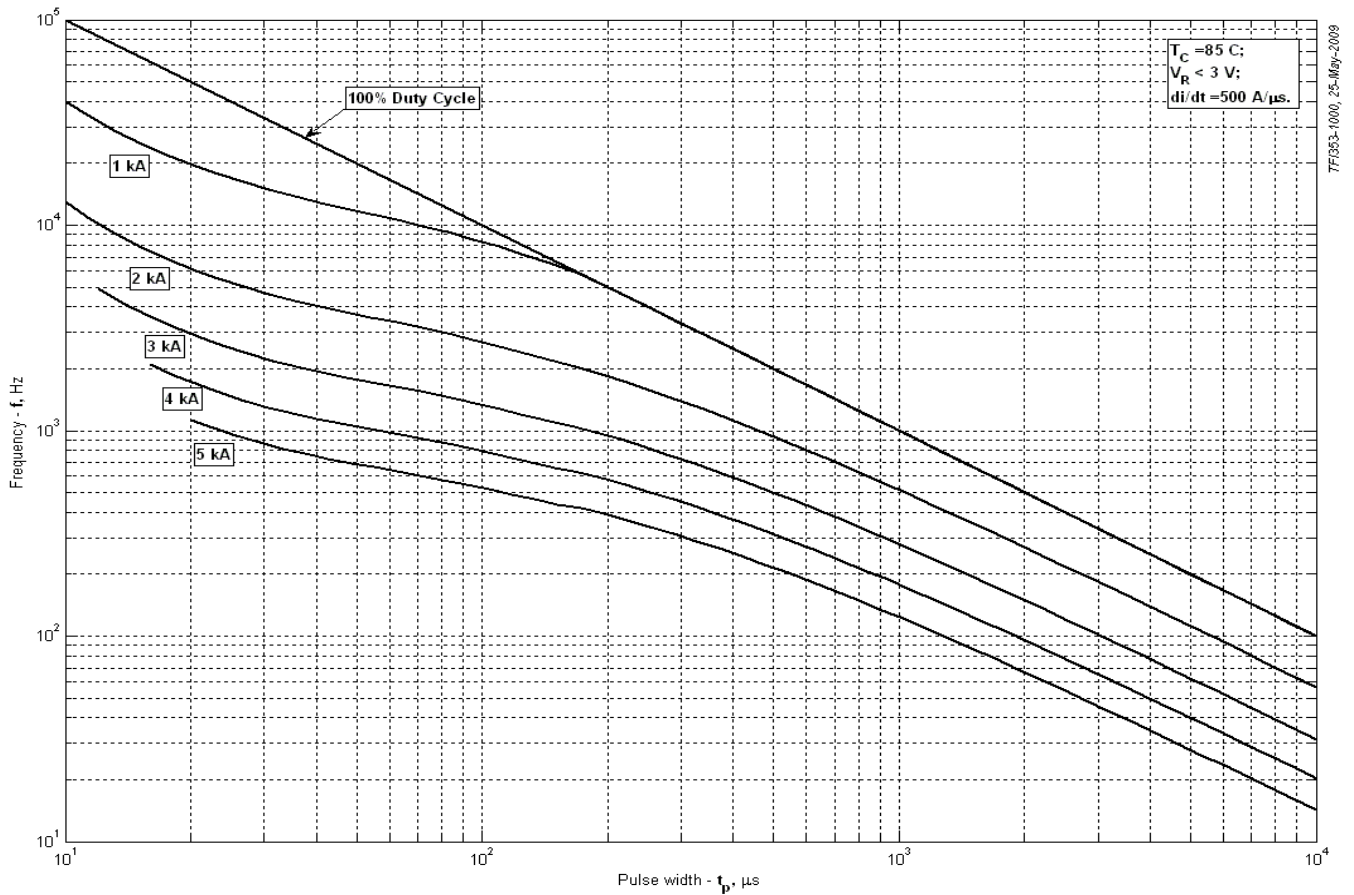


Fig 14 - Square wave frequency ratings

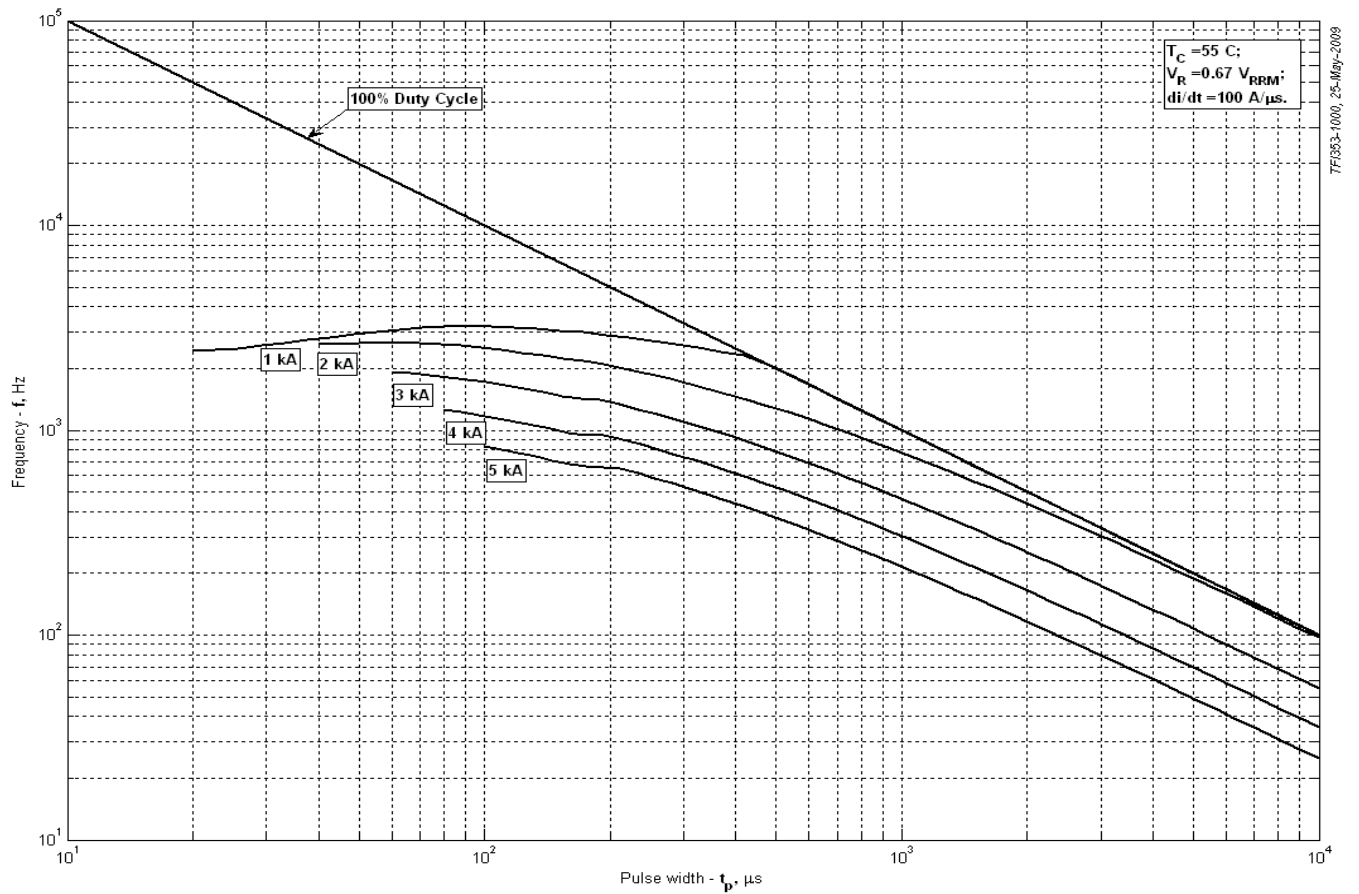


Fig 15 - Square wave frequency ratings

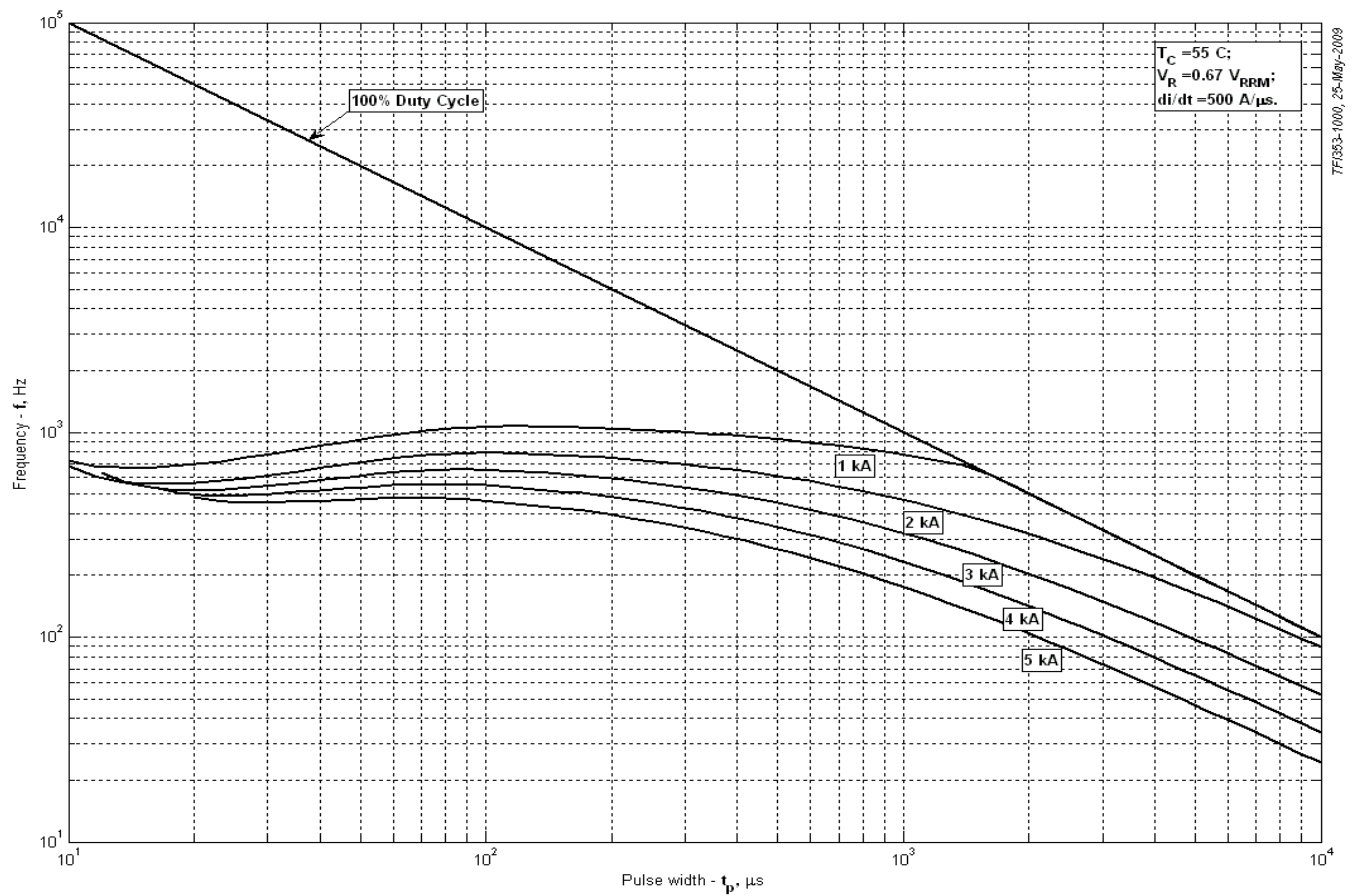


Fig 16 - Square wave frequency ratings

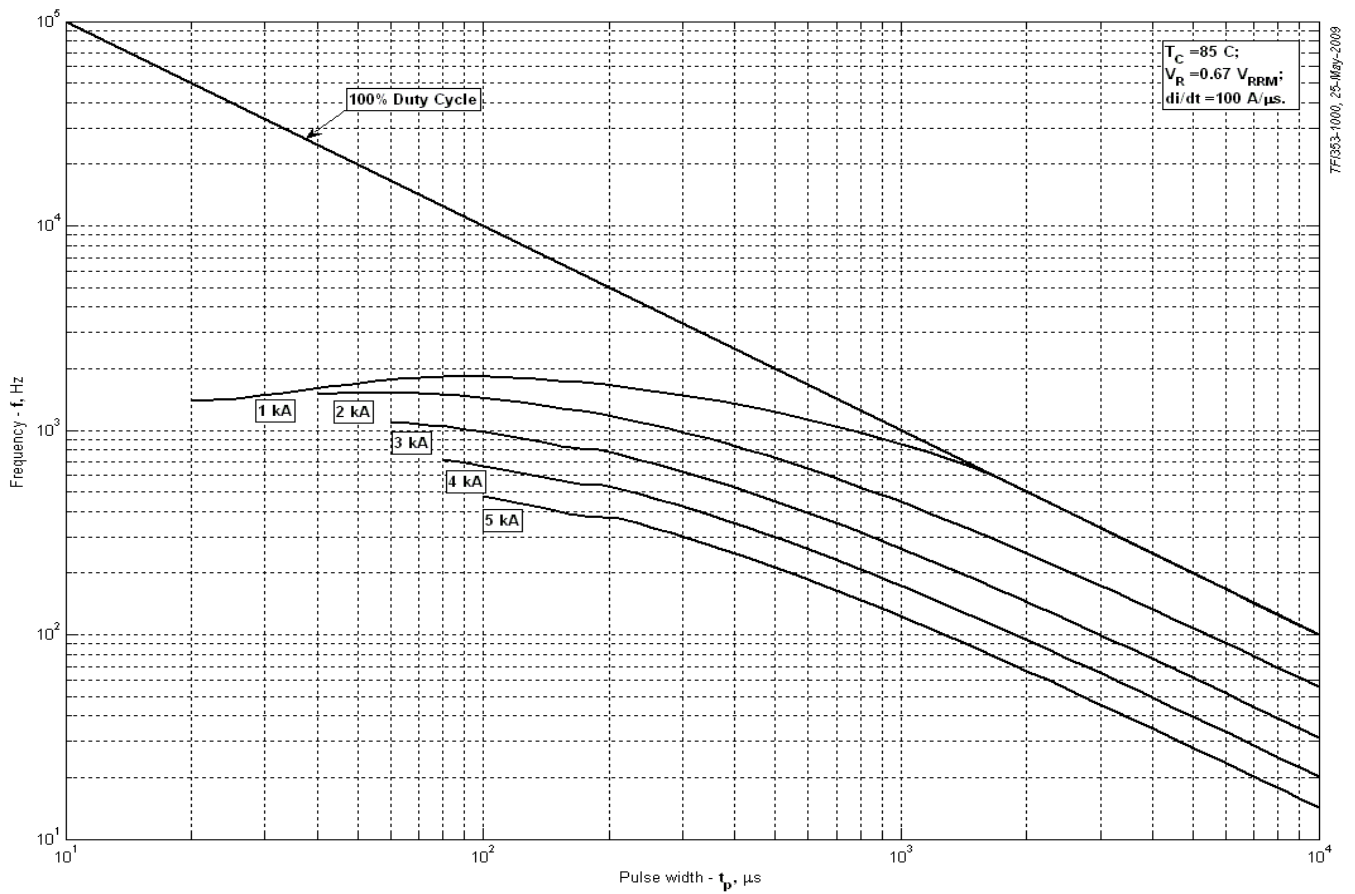


Fig 17 - Square wave frequency ratings

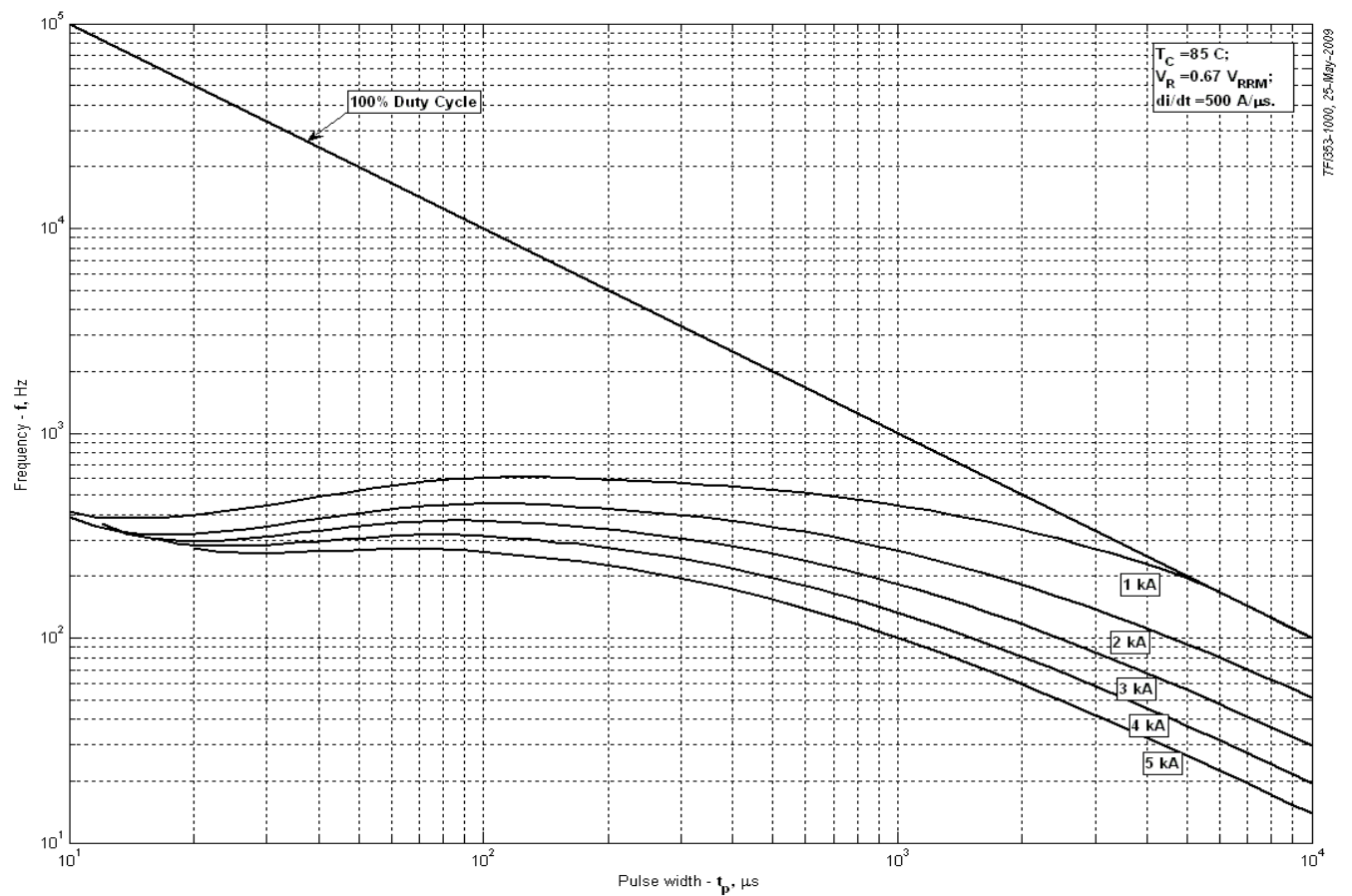


Fig 18 - Square wave frequency ratings

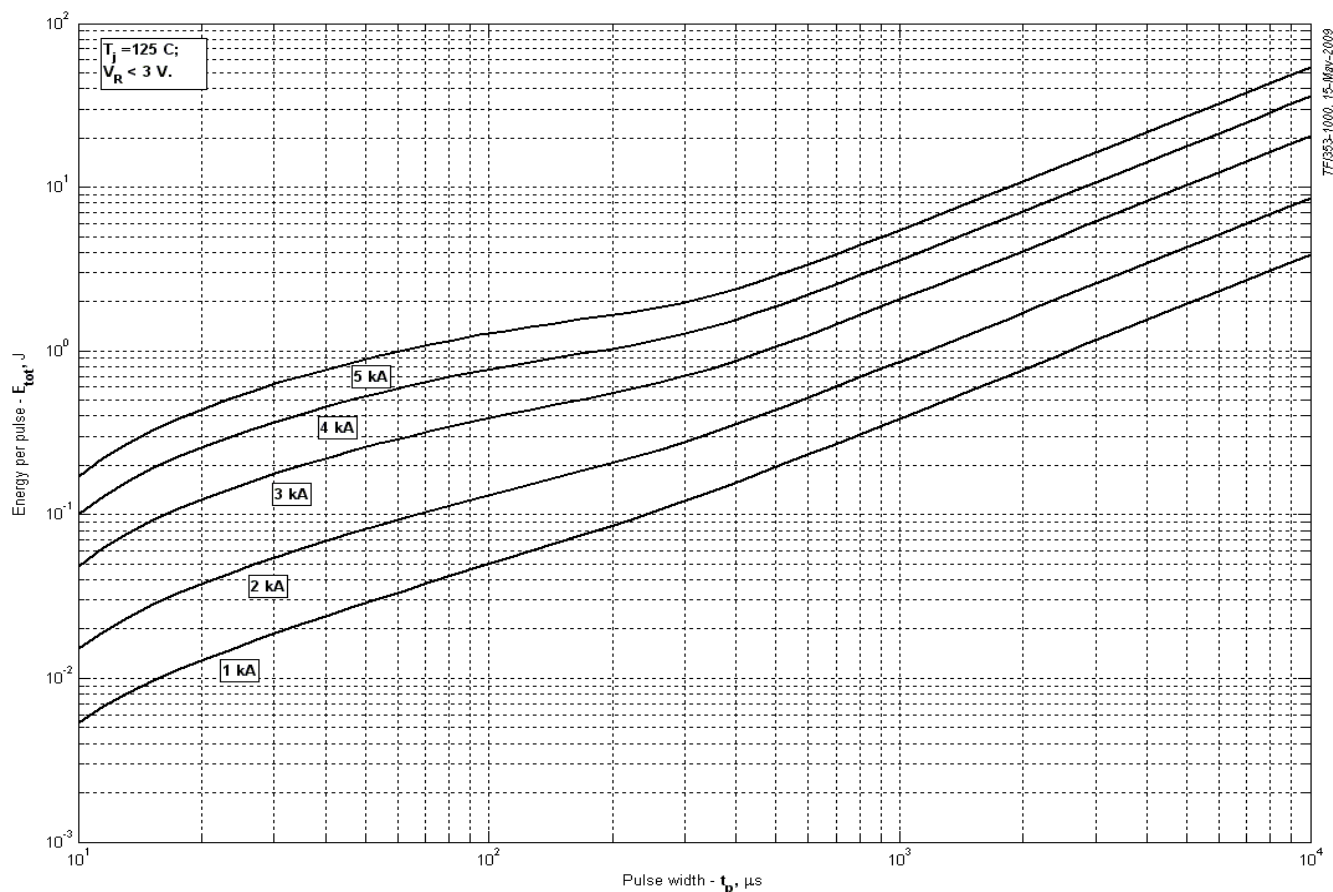


Fig 19 - Sine wave loss energy per pulse

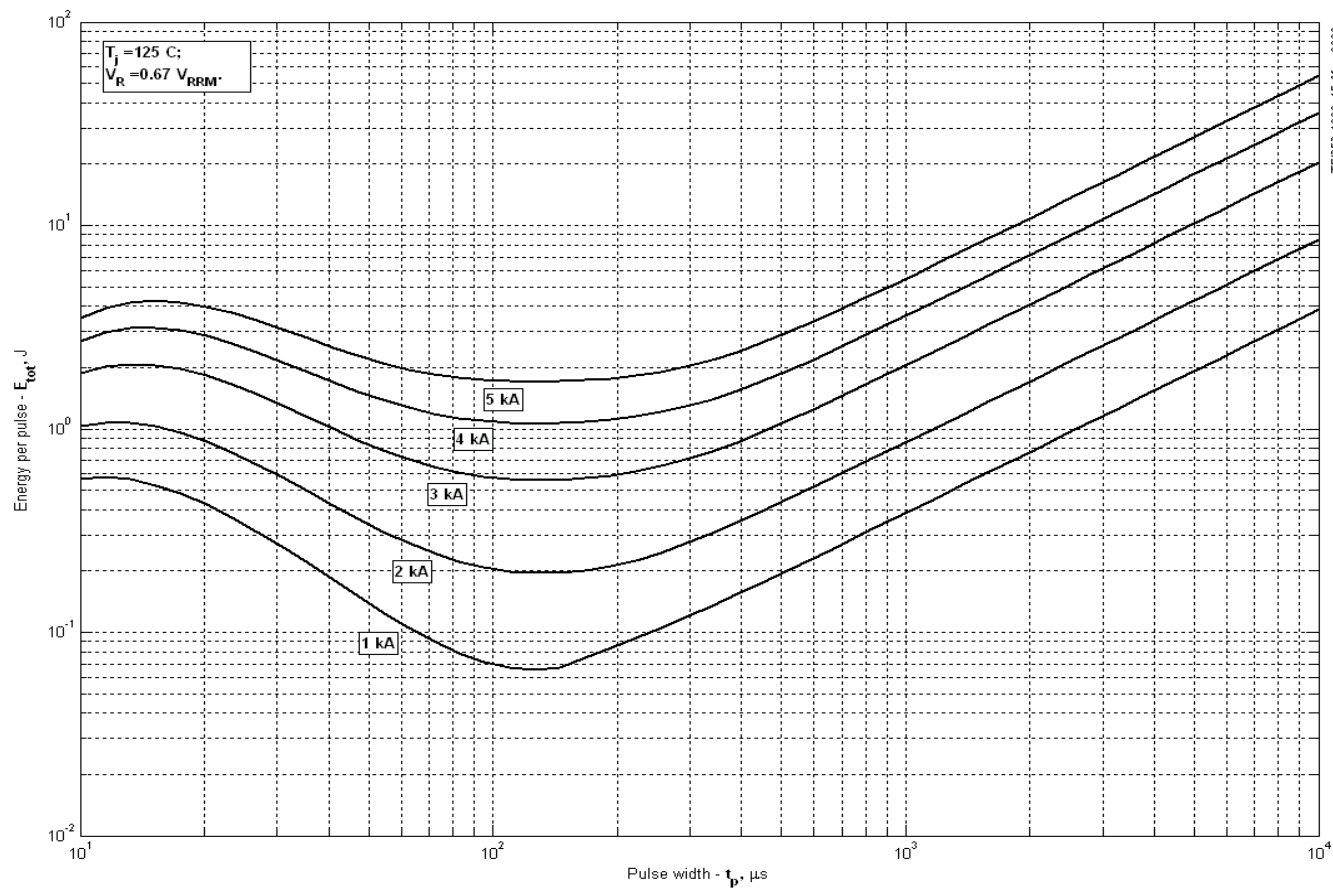


Fig 20 - Sine wave loss energy per pulse

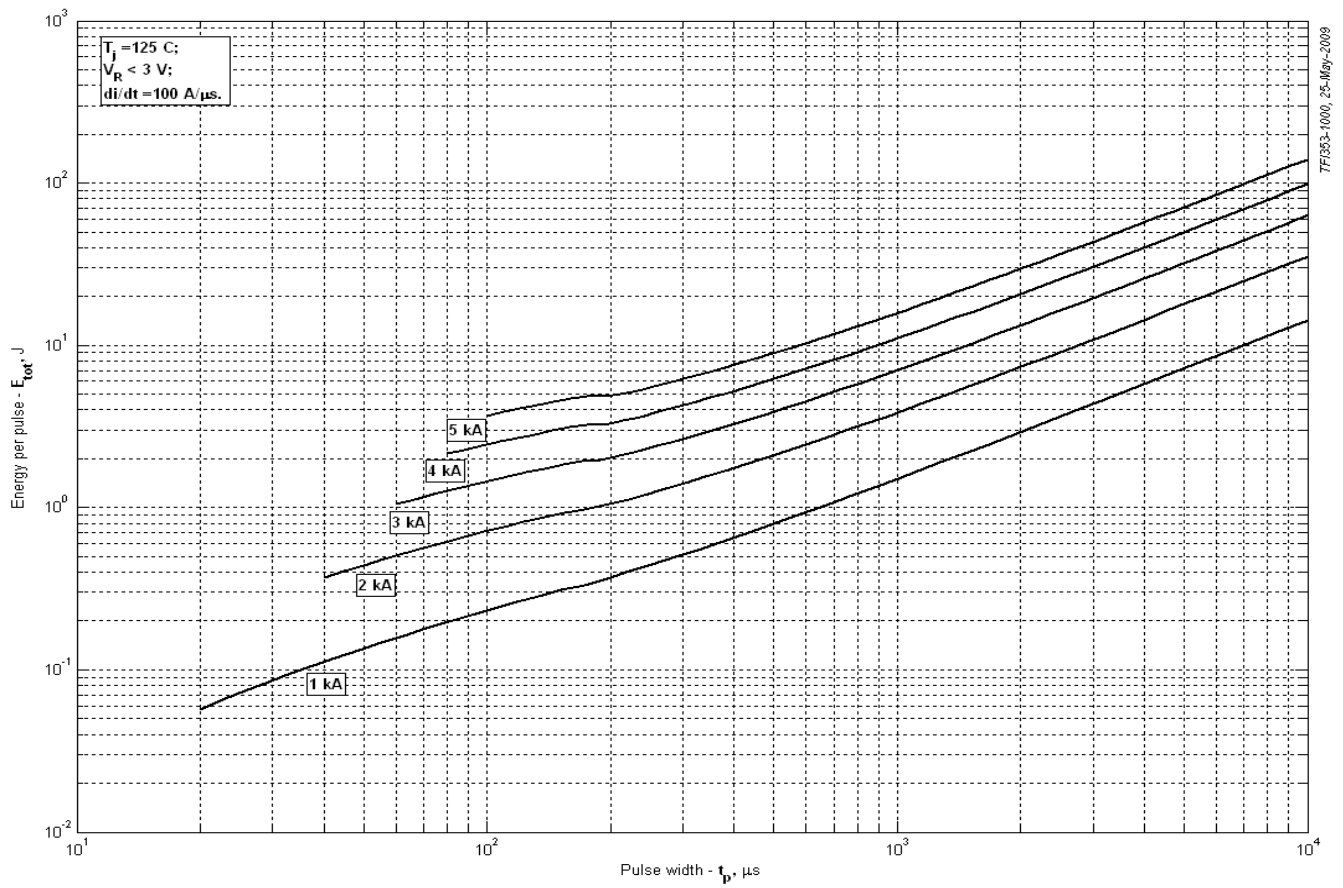


Fig 21 - Square wave loss energy per pulse

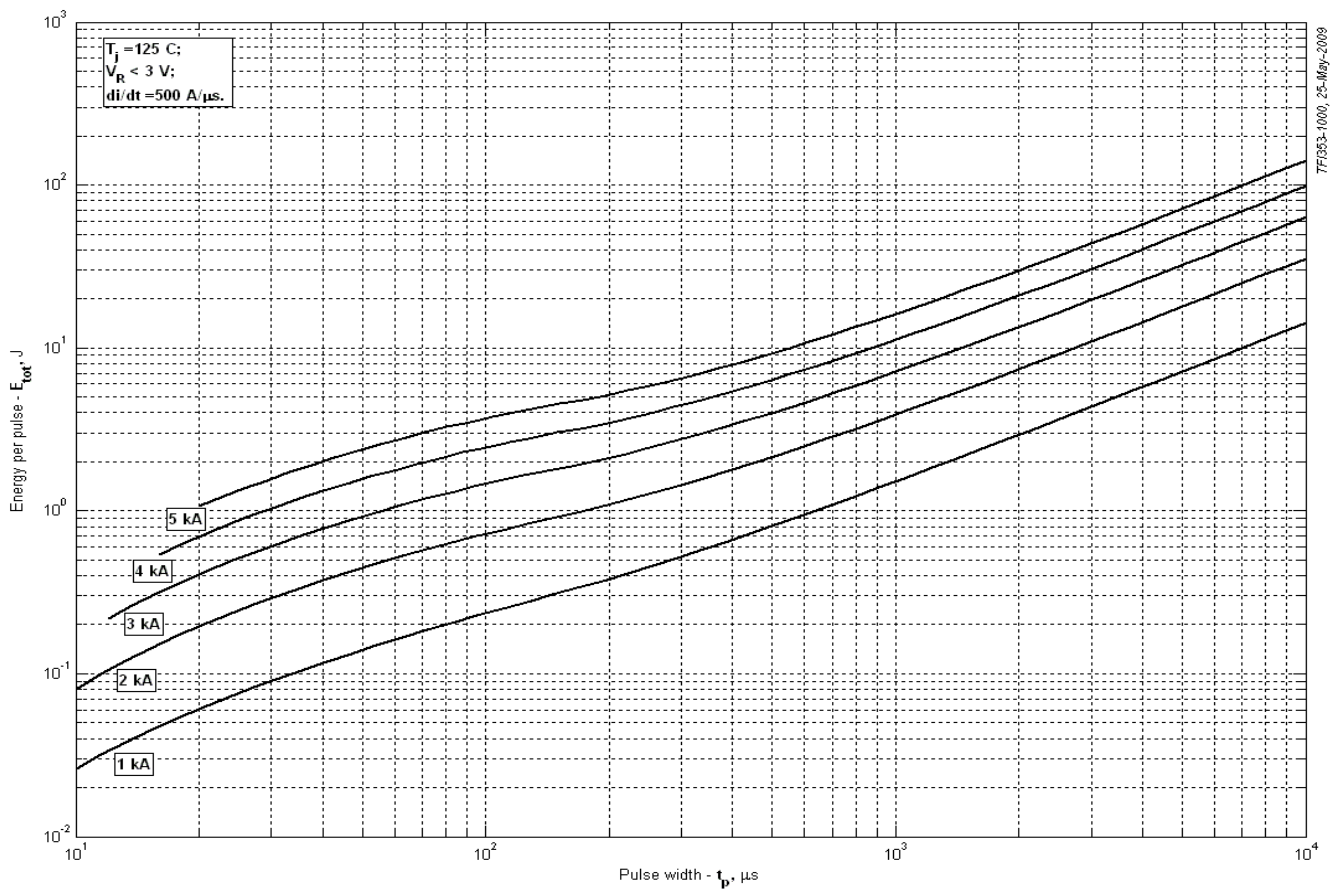


Fig 22 - Square wave loss energy per pulse

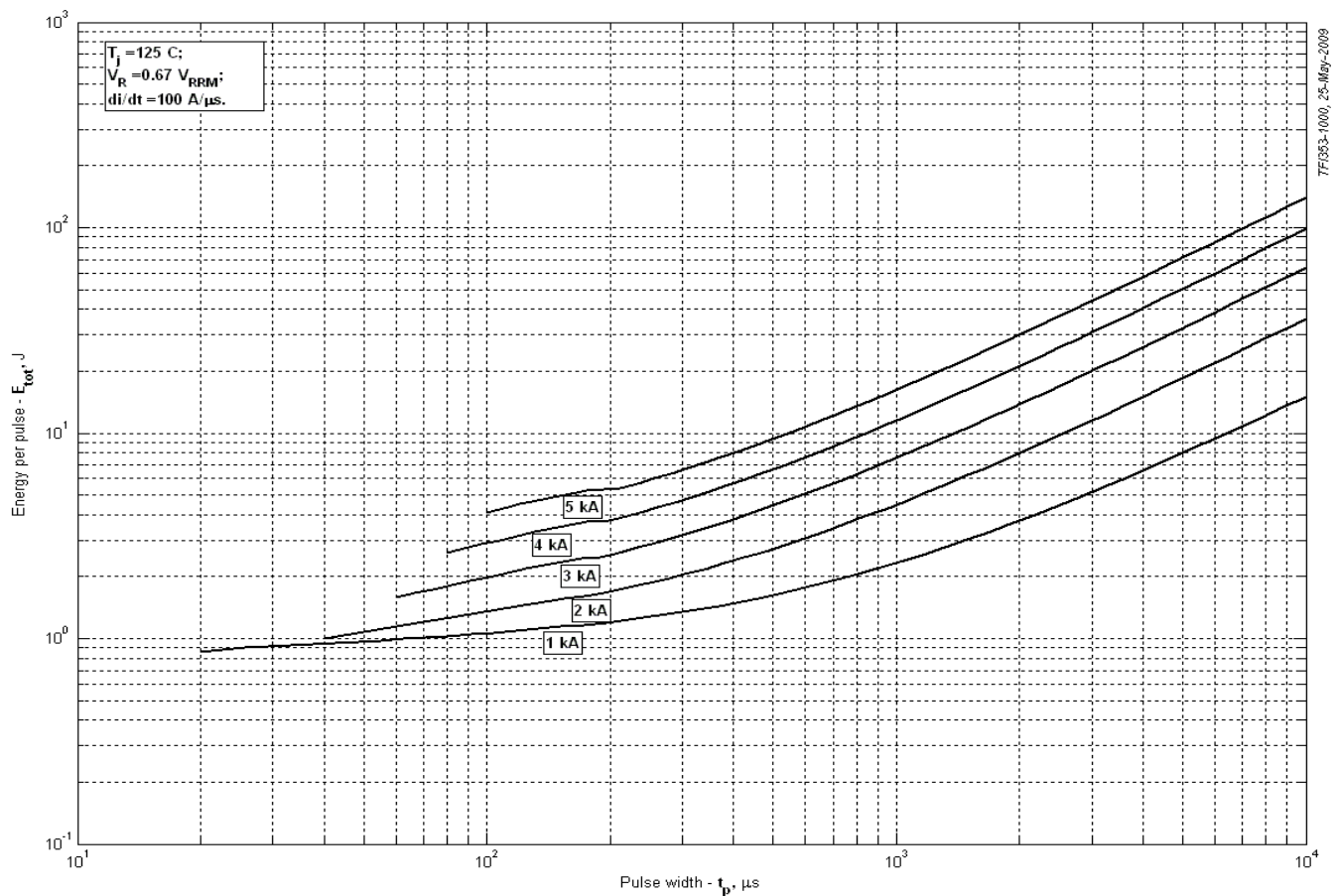


Fig 23 - Square wave loss energy per pulse

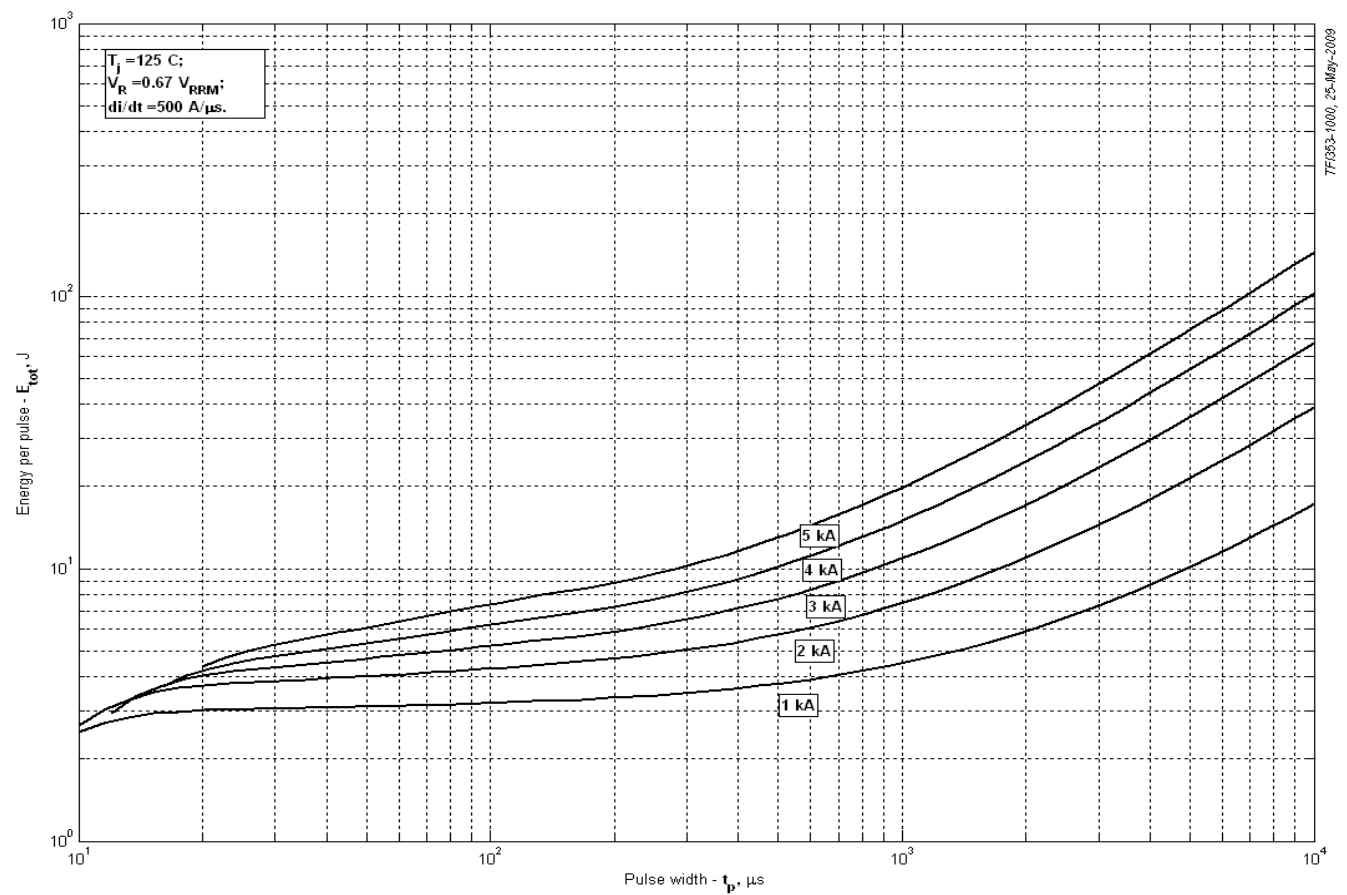
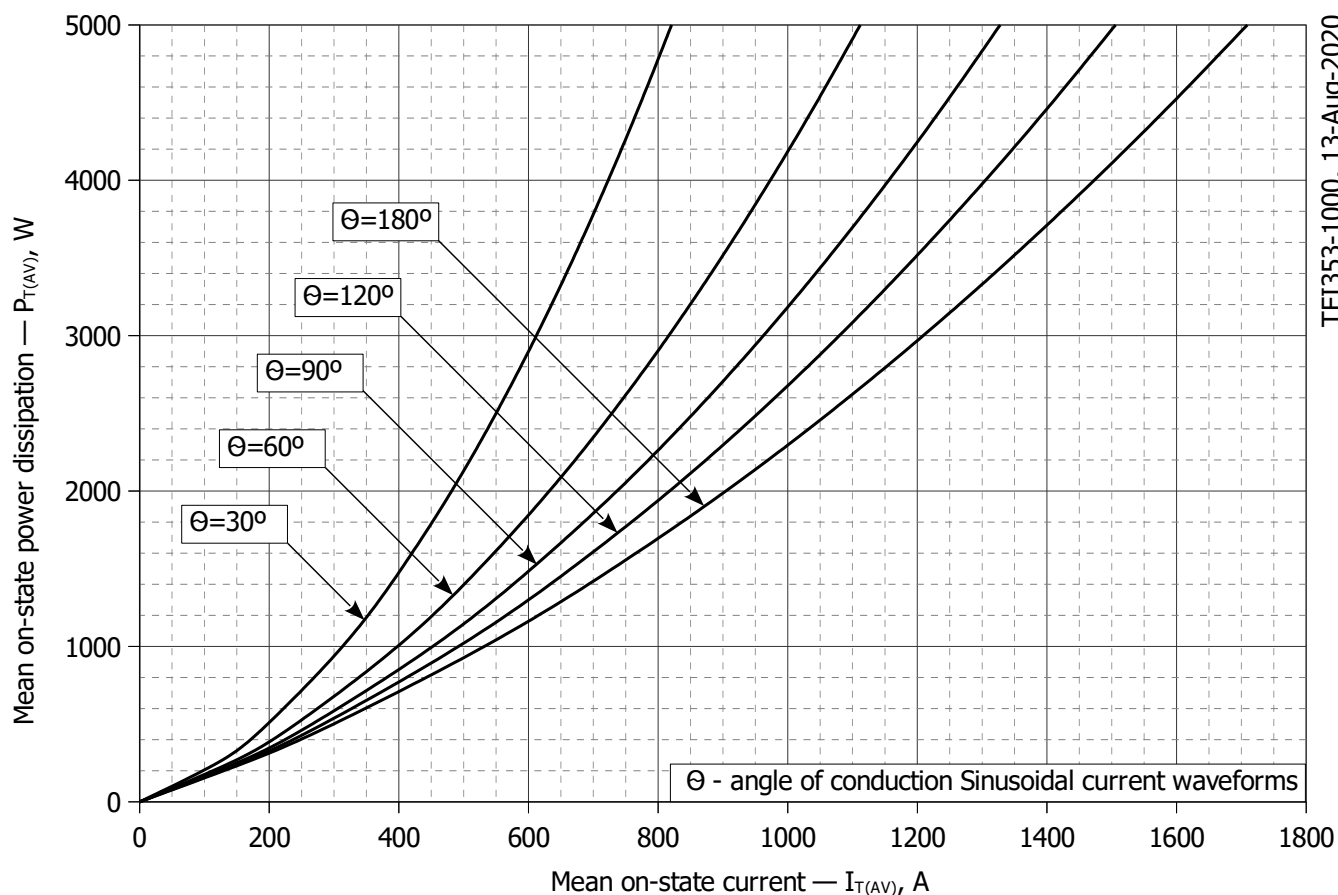
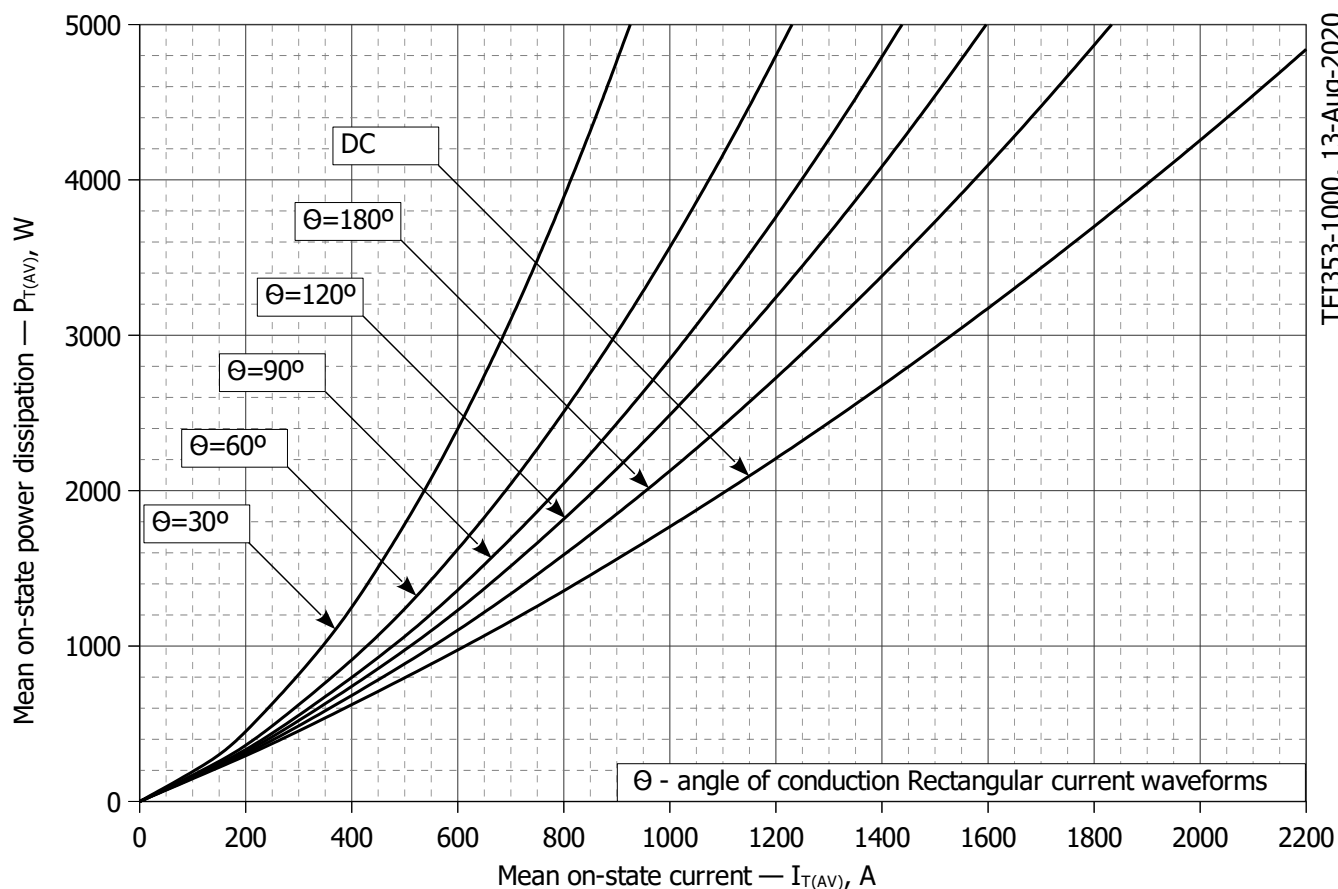


Fig 24 - Square wave loss energy per pulse



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Fig 25 – 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)



TFI353-1000, 13-Aug-2020

Fig 26 - 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)

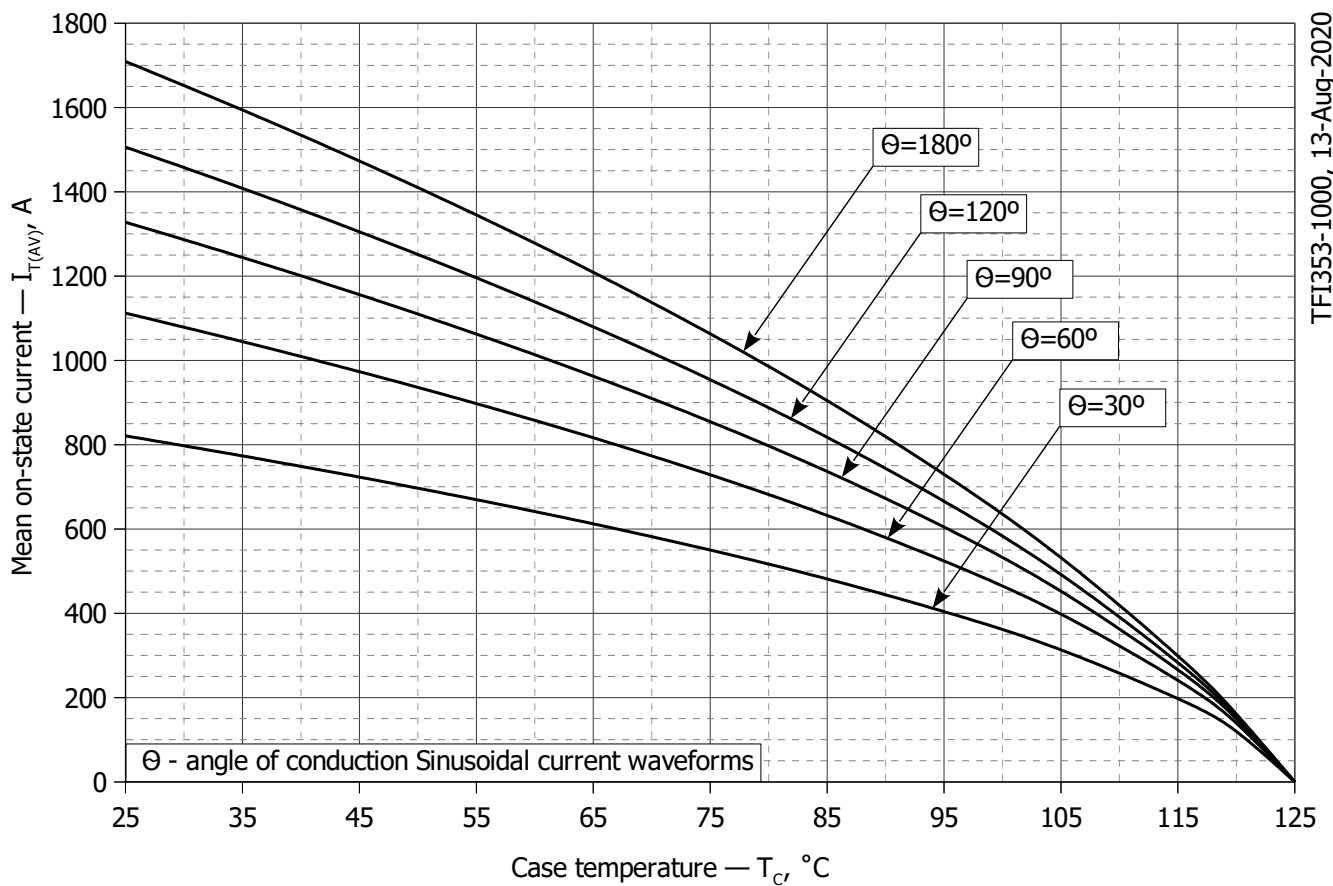


Fig 27 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

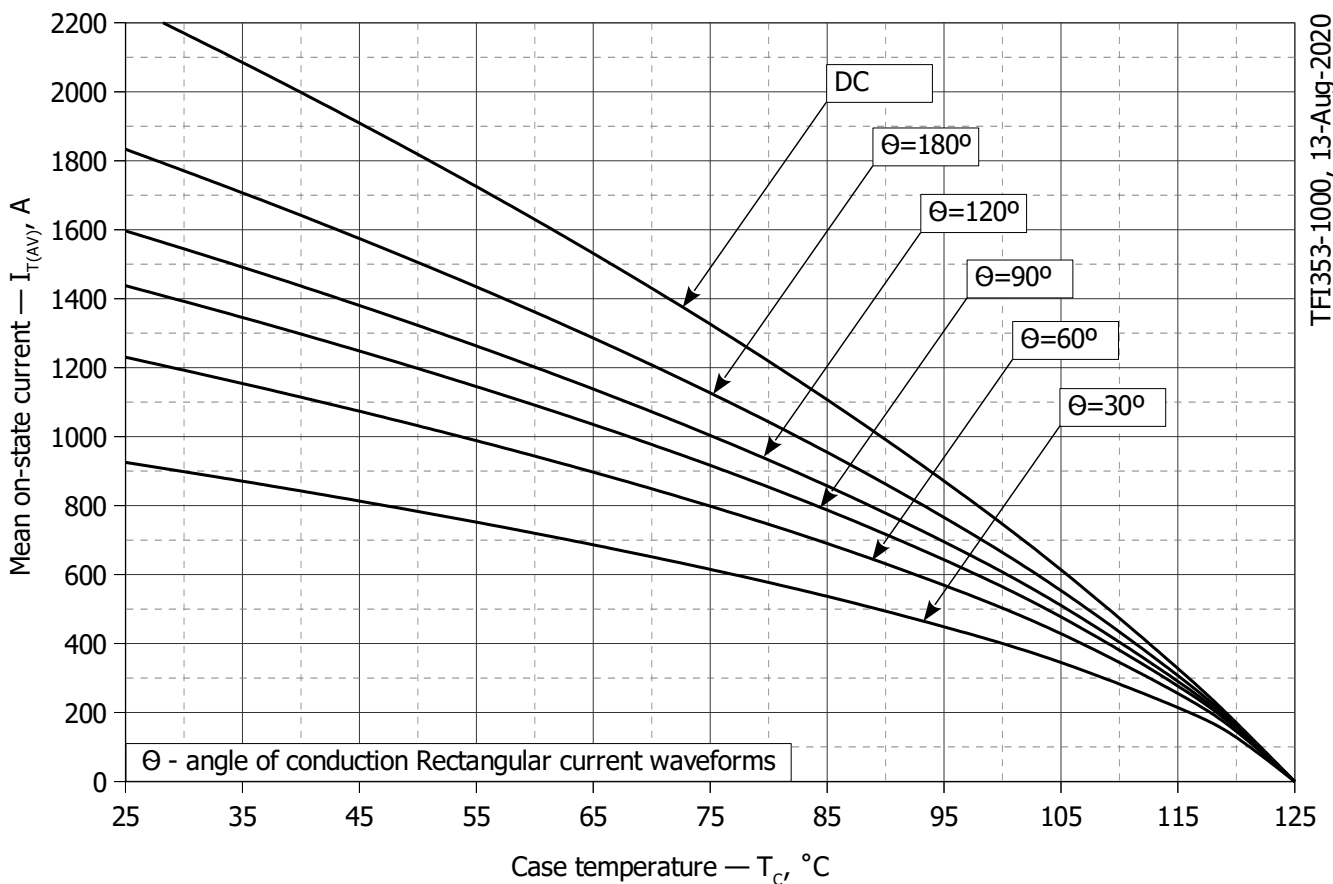


Fig 28 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

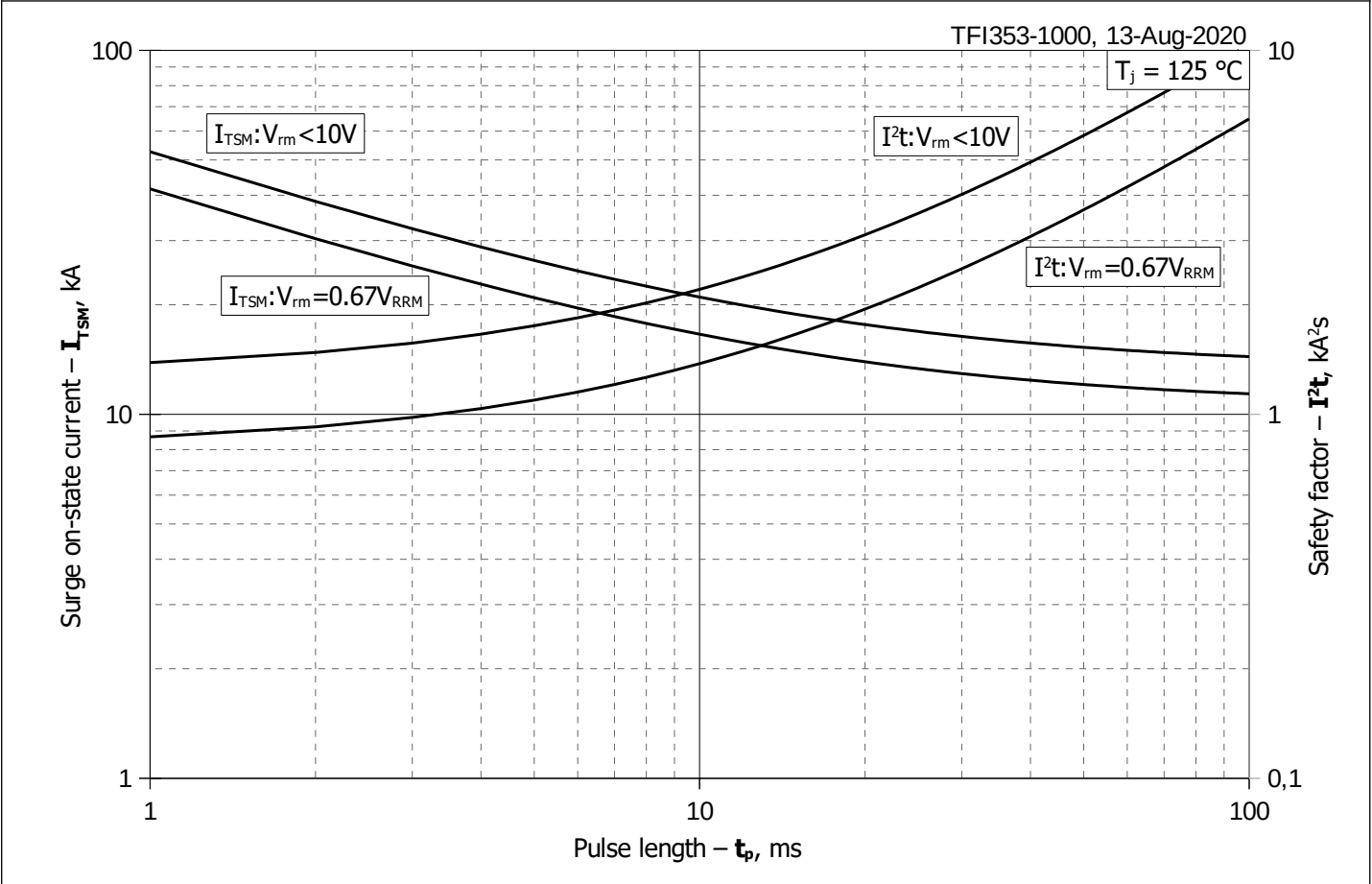


Fig 29 – Maximum surge and I^2t ratings

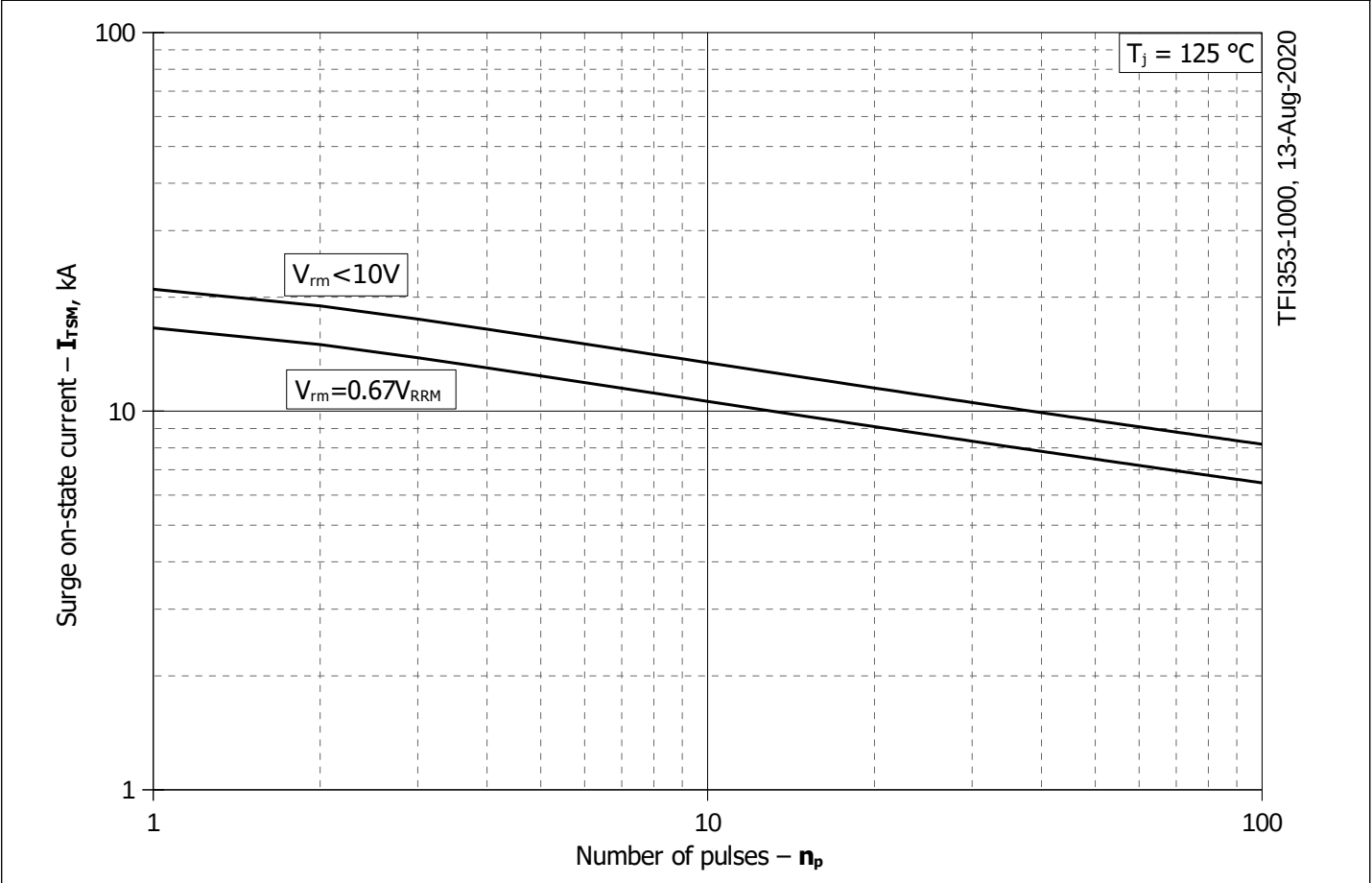


Fig 30 - Maximum surge ratings