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

Fast Thyristor
Type TFI473-1600-40

Mean on-state current		I_{TAV}	1600 A
Repetitive peak off-state voltage		V_{DRM}	3800...4000 V
Repetitive peak reverse voltage		V_{RRM}	
Turn-off time		t_q	125 µs
V_{DRM}, V_{RRM}, V	3800		4000
Voltage code	38		40
T_j, °C	–60...+125		

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Mean on-state current	A	1569 1600 2303	T_c=85 °C; Double side cooled; T_c=83 °C; Double side cooled; T_c=55 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	2512	T_c=83 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	34.0 39.0	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=2 A/µs
			36.0 41.0	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=2 A/µs
I^2t	Safety factor	$A^2s{\cdot}10^3$	5700 7600	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=2 A/µs
			5300 6900	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=2 A/µs
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	3800...4000	$T_{j\,min}$< 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	3900...4100	$T_{j\,min}$< 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·V_{DRM} 0.6·V_{RRM}	T_j=$T_{j\,max}$; 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	2000	$T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; I_{TM}=3200 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	2.70	T_j=25 °C; I_{TM}=5024 A	
$V_{T(TO)}$	On-state threshold voltage, max	V	1.503	$T_j=T_{j\,max}$;	
r_T	On-state slope resistance, max	mΩ	0.272	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	$T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; 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	$T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; Direct gate current	
I_{GD}	Gate non-trigger direct current, min	mA	60.00		
SWITCHING					
t_{gd}	Delay time, max	µs	1.40	T_j=25 °C; V_D=1500 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	4.00, 6.30, 8.00, 10.0		
t_q	Turn-off time[3)], max	µs	125	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}
			160	dv_D/dt=200 V/µs;	
Q_{rr}	Total recovered charge, max	µC	3000	$T_j=T_{j\,max}$; I_{TM}=2000 A; di_R/dt=-50 A/µs; V_R=100 V	
t_{rr}	Reverse recovery time, max	µs	14		
I_{rrM}	Peak reverse recovery current, max	A	430		

THERMAL					
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0100	Direct current	Double side cooled
R_{thjc-A}			0.0220		Anode side cooled
R_{thjc-K}			0.0180		Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0020	Direct current	
MECHANICAL					
w	Weight, max	g	1600		
D_s	Surface creepage distance	mm (inch)	55.13 (2.170)		
D_a	Air strike distance	mm (inch)	25.10 (0.988)		

PART NUMBERING GUIDE

TFI	473	1600	40	A2	X2	A4	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

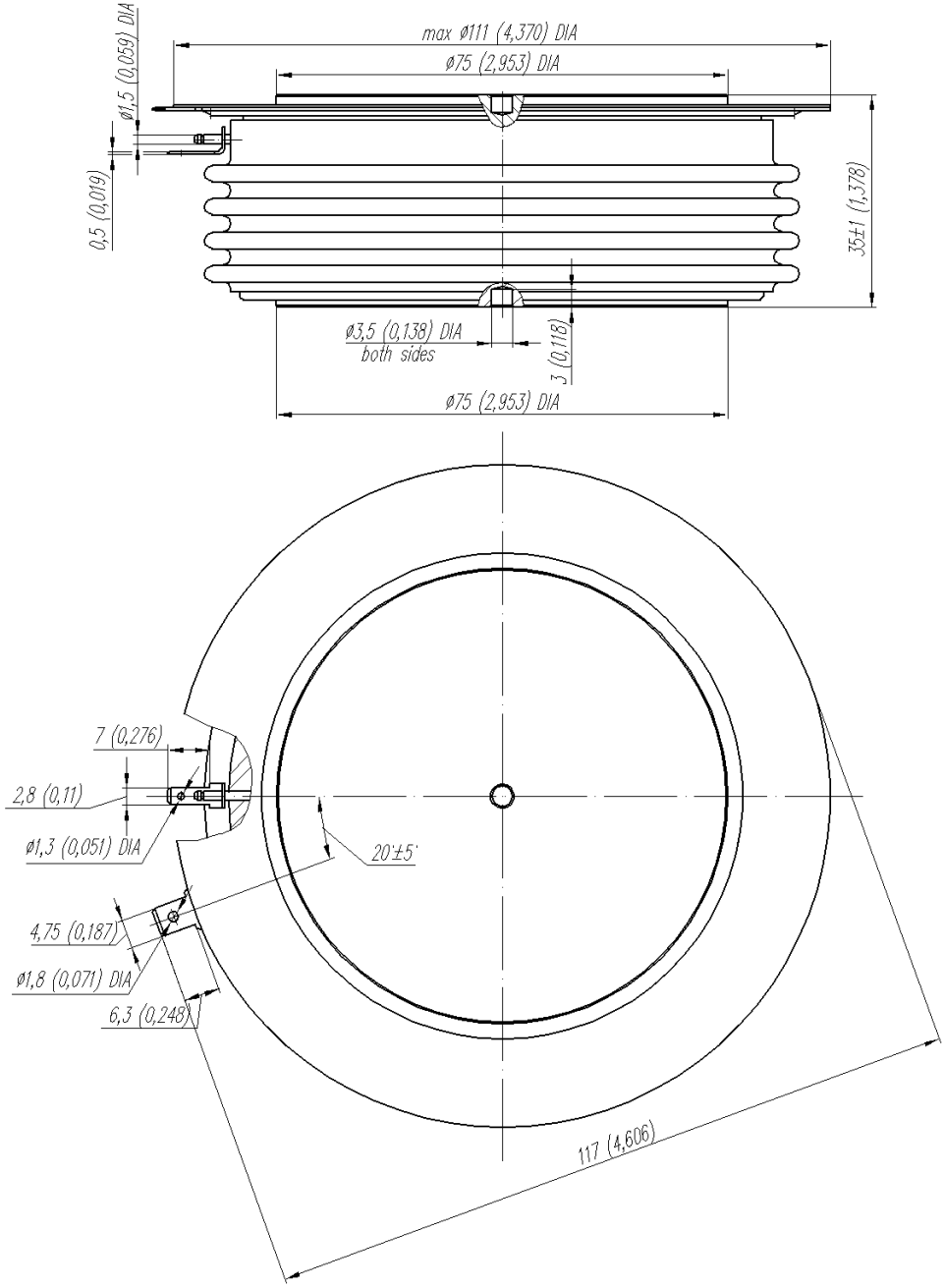
Symbol of group	H4	C4	B4	A4
t_{gt}, μs	4.00	6.30	8.00	10.0

[3] Turn-off time (dv_D/dt=50 V/μs)

Symbol of group	X2
t_q, μs	125

OVERALL DIMENSIONS

Package type: T.F5



All dimensions in millimeters (inches)

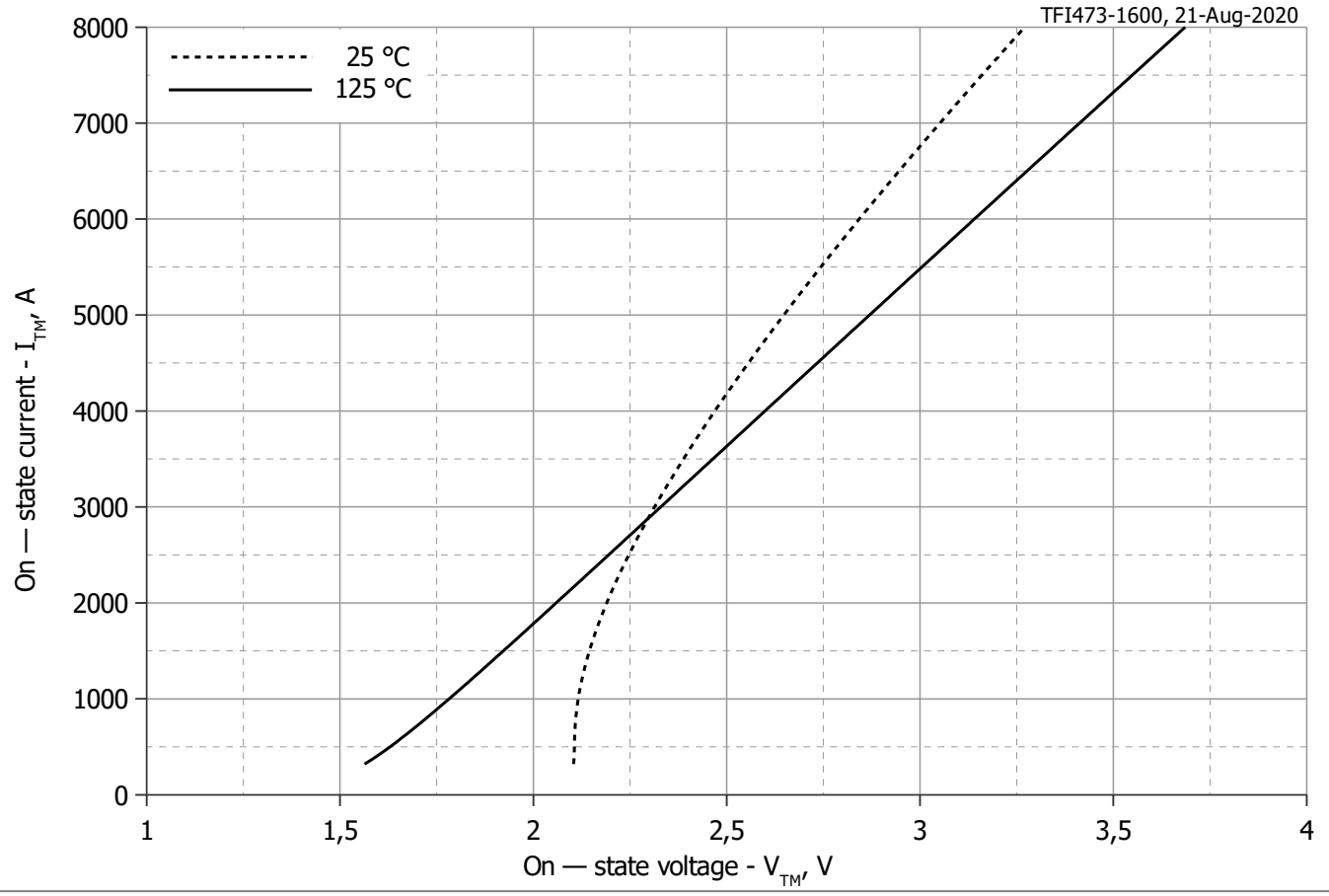


Fig 1 – On-state characteristics of Limit device

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°C	$T_j = T_{j\,max}$
A	1.47450812	1.05128932
B	0.00039464	0.00029823
C	0.19510255	0.09240769
D	-0.03481433	-0.00650641

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

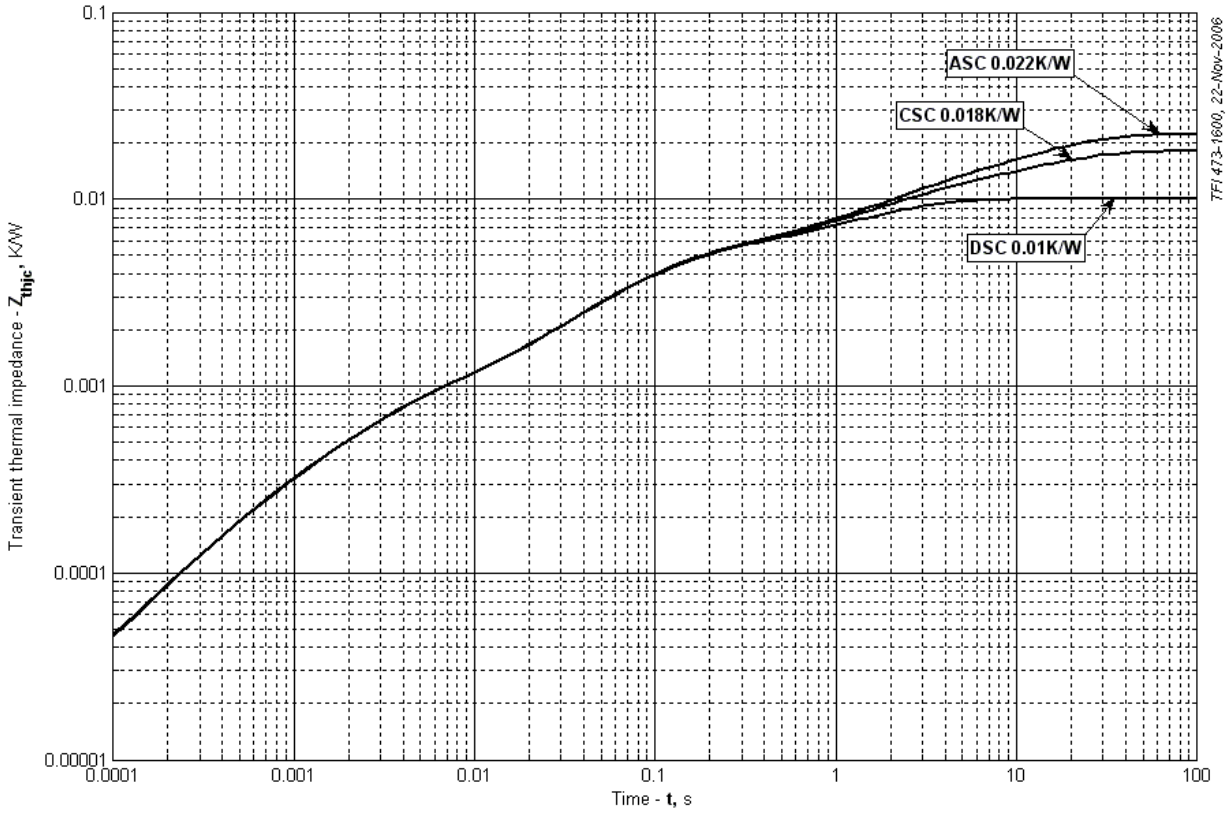


Fig 2 – Transient thermal impedance

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.

$\mathbf{Z_{thjc}}$ = Thermal resistance at time t.

$\mathbf{R_i}$ = Amplitude of p_{th} term.

$\boldsymbol{\tau_i}$ = Time constatnt of r_{th} term.

DC Double side cooled

i	1	2	3	4	5	6
$\mathbf{R_i}$, **K/W**	0.002785	0.003537	0.0005787	0.0006418	0.00009446	0.002362
$\boldsymbol{\tau_i}$, **s**	2.061	0.07354	0.002615	0.1375	0.0004601	1.210

DC Anode side cooled

i	1	2	3	4	5	6
$\mathbf{R_i}$, **K/W**	0.01246	0.00478	0.0006333	0.003716	0.0005969	0.00006119
$\boldsymbol{\tau_i}$, **s**	13.310	1.871	0.2261	0.07337	0.002363	0.0003248

DC Cathode side cooled

i	1	2	3	4	5	6
$\mathbf{R_i}$, **K/W**	0.008256	0.004771	0.0006239	0.003744	0.0005969	0.00006164
$\boldsymbol{\tau_i}$, **s**	13.250	1.783	0.2371	0.07347	0.002367	0.000327

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

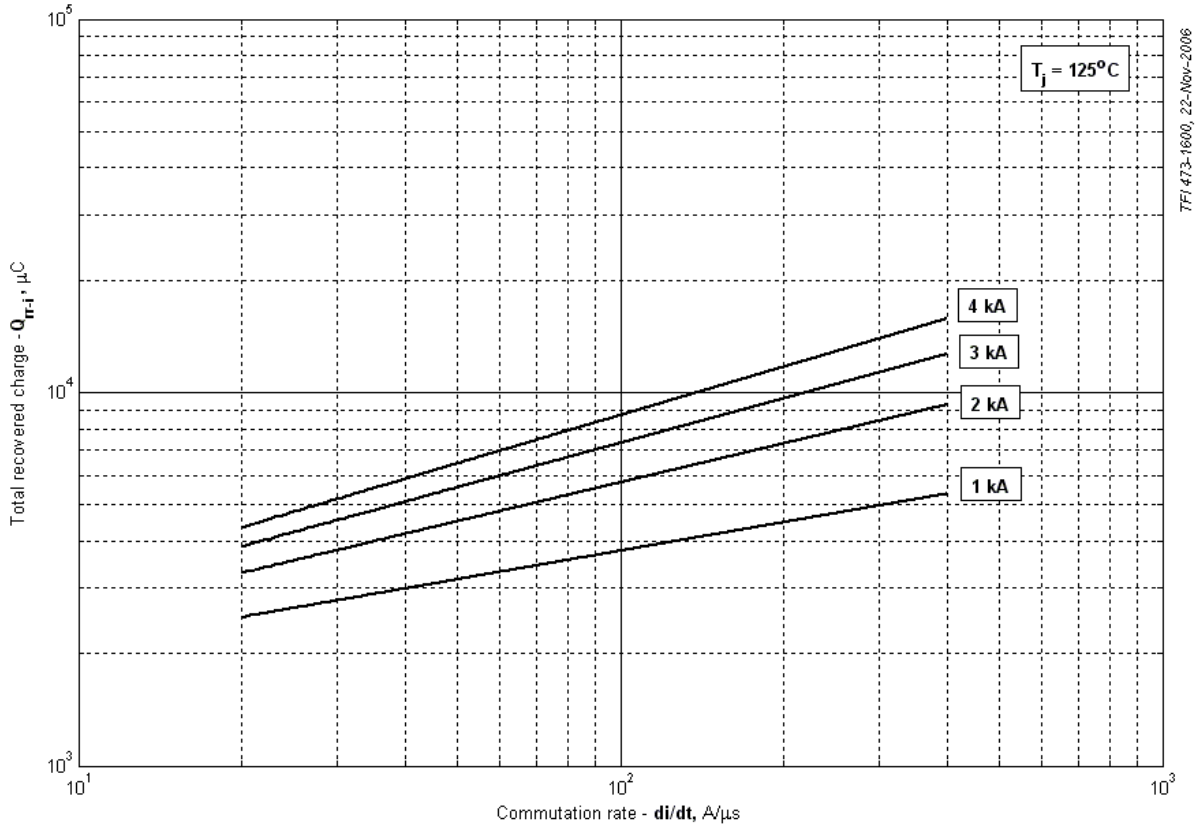


Fig 3 – Total recovered charge, Q_{rr-i} (integral)

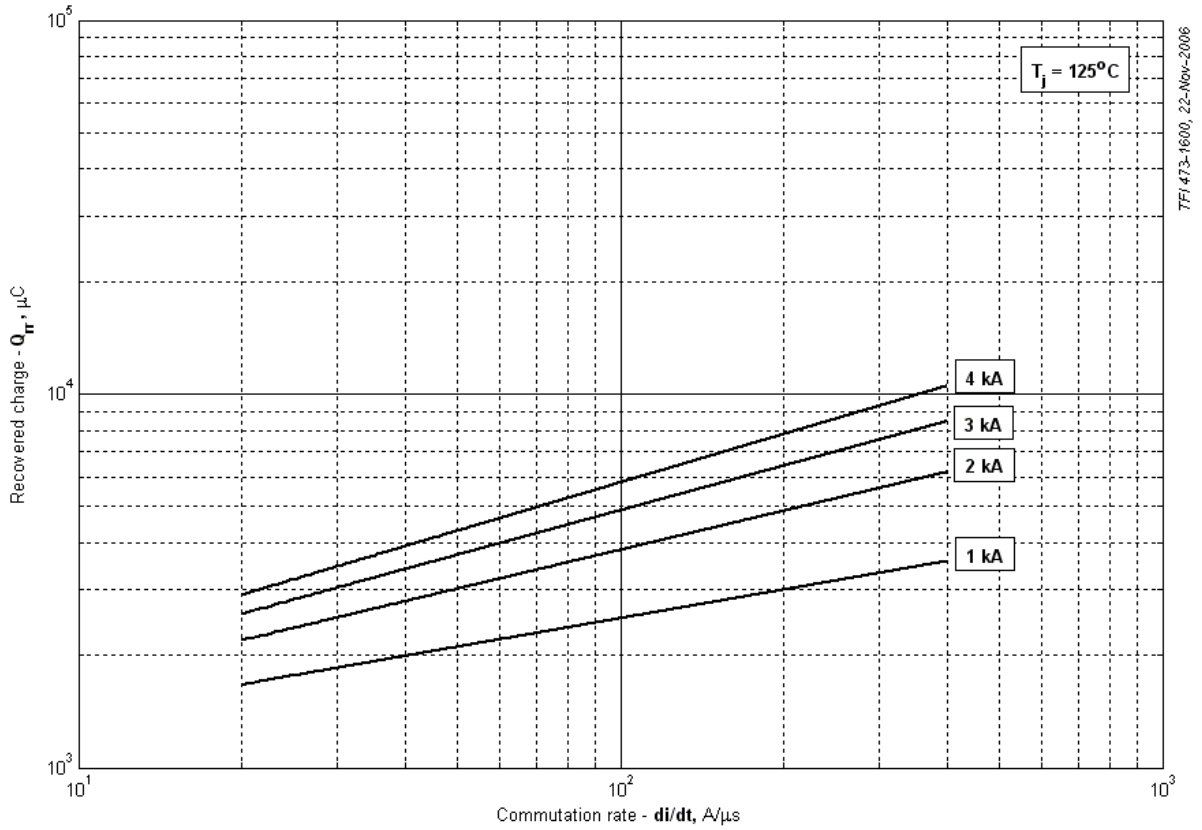


Fig 4 - Recovered charge, Q_{rr} (50% chord)

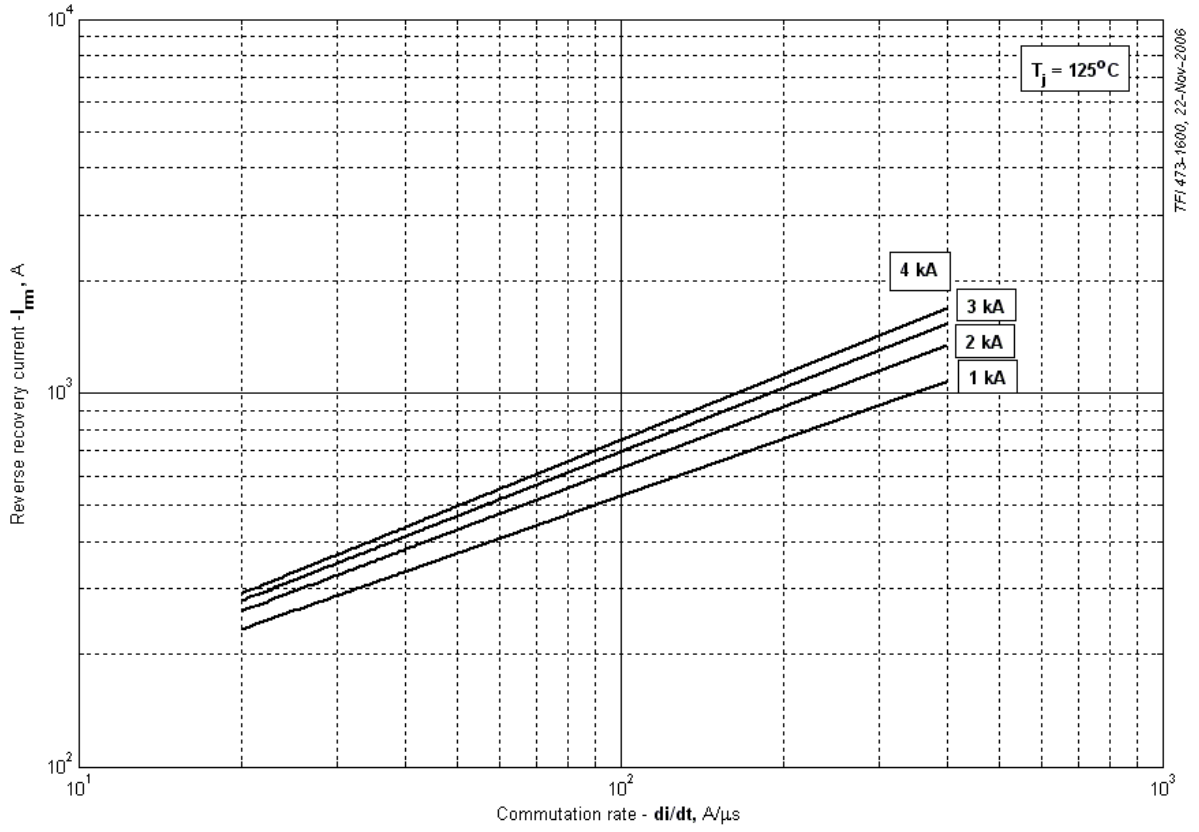


Fig 5 – Peak reverse recovery current, I_{rm}

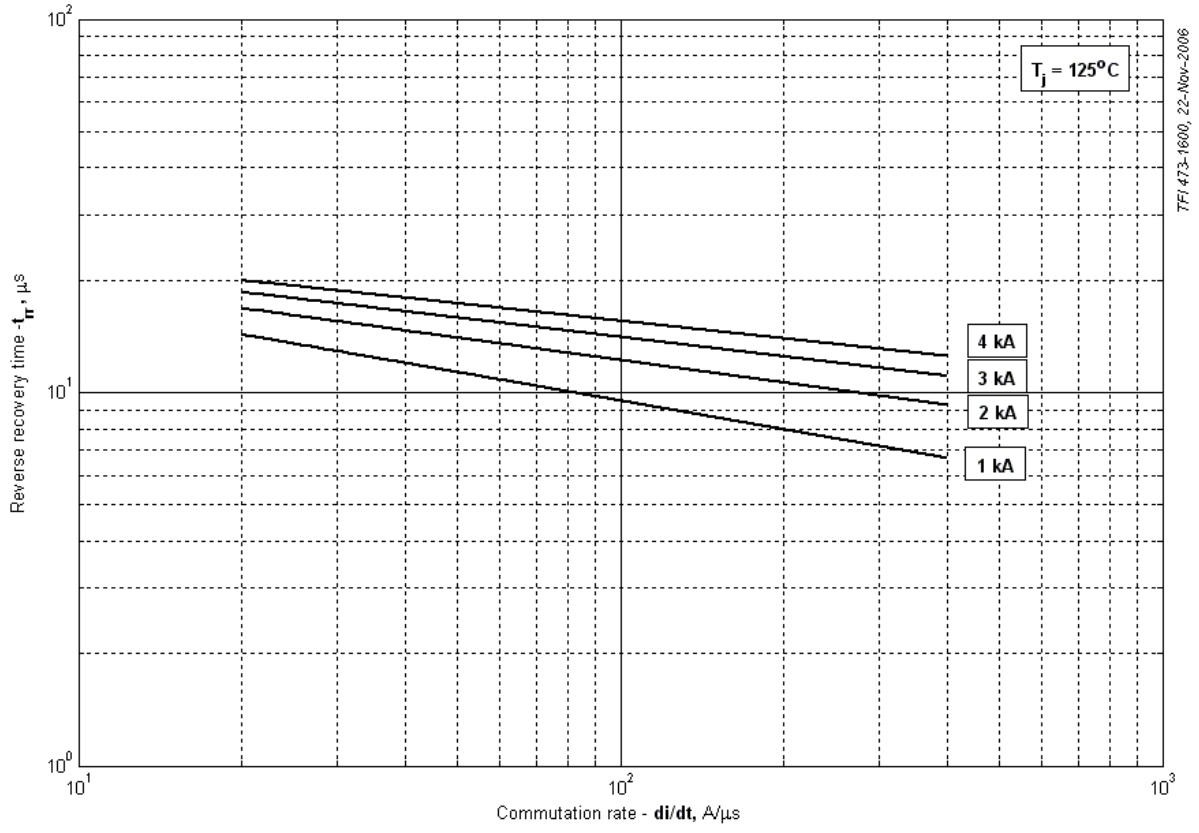


Fig 6 – Maximum recovery time, t_{rr} (50% chord)

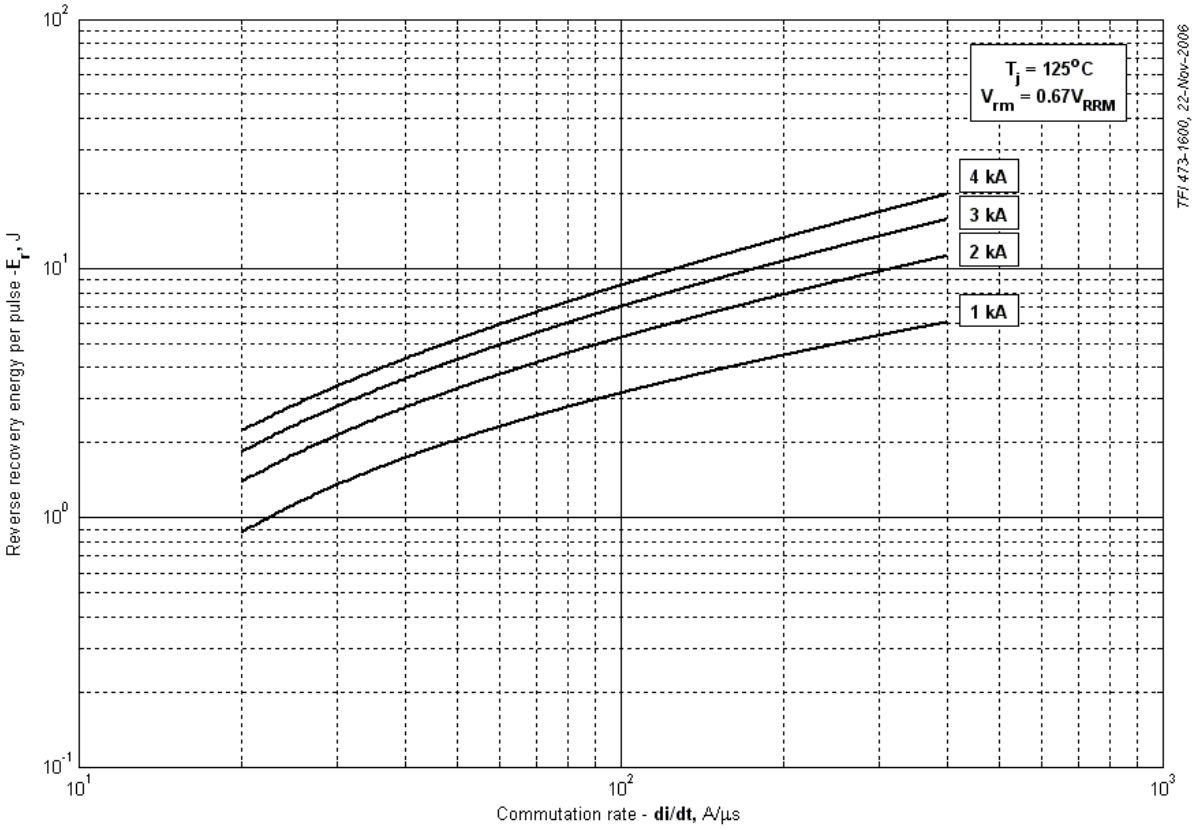


Fig 7 – Reverse recovery energy per pulse

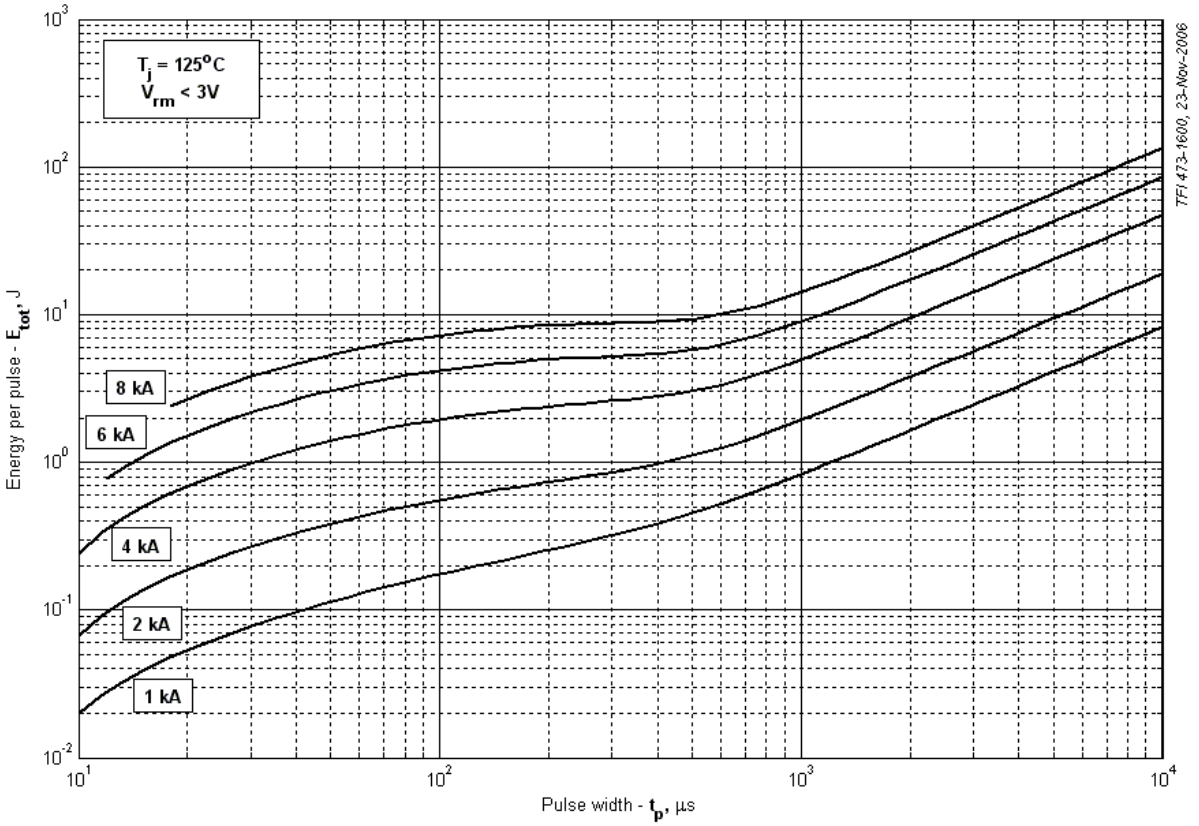


Fig 8 – Sine wave energy per pulse

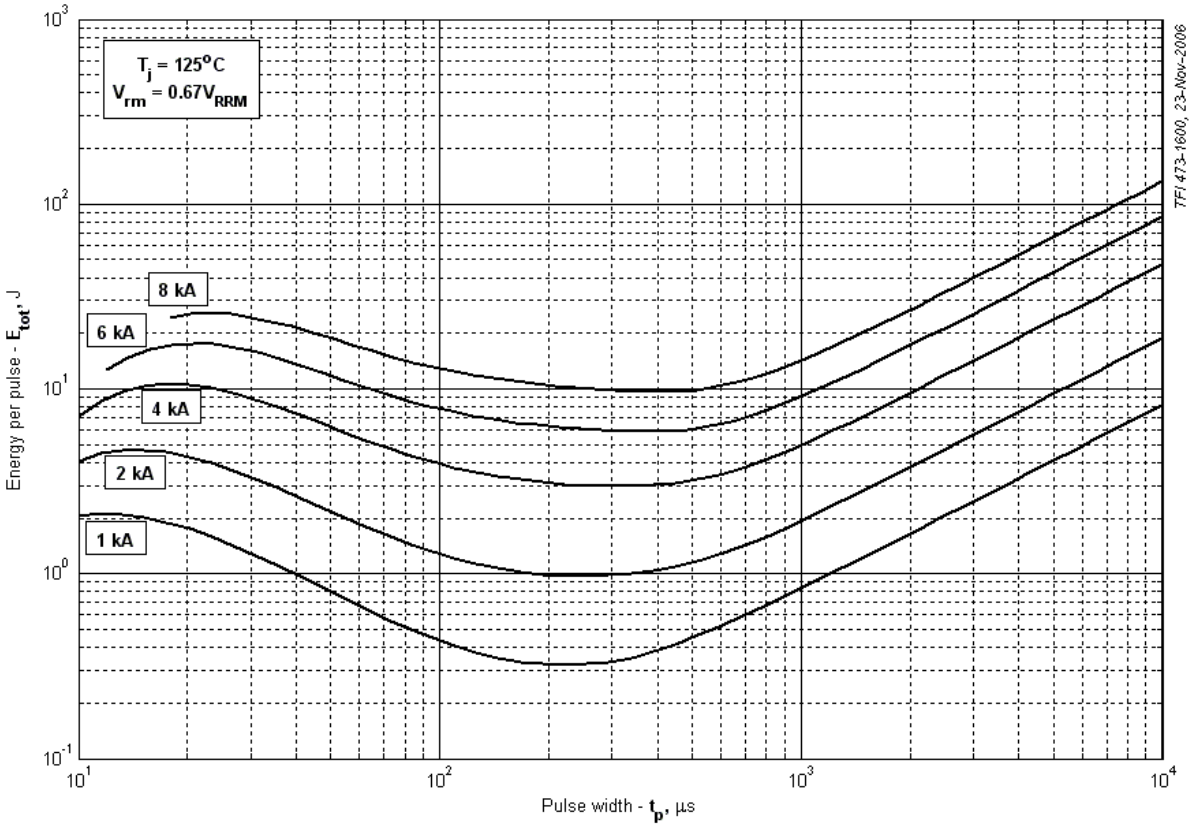


Fig 9 – Sine wave energy per pulse

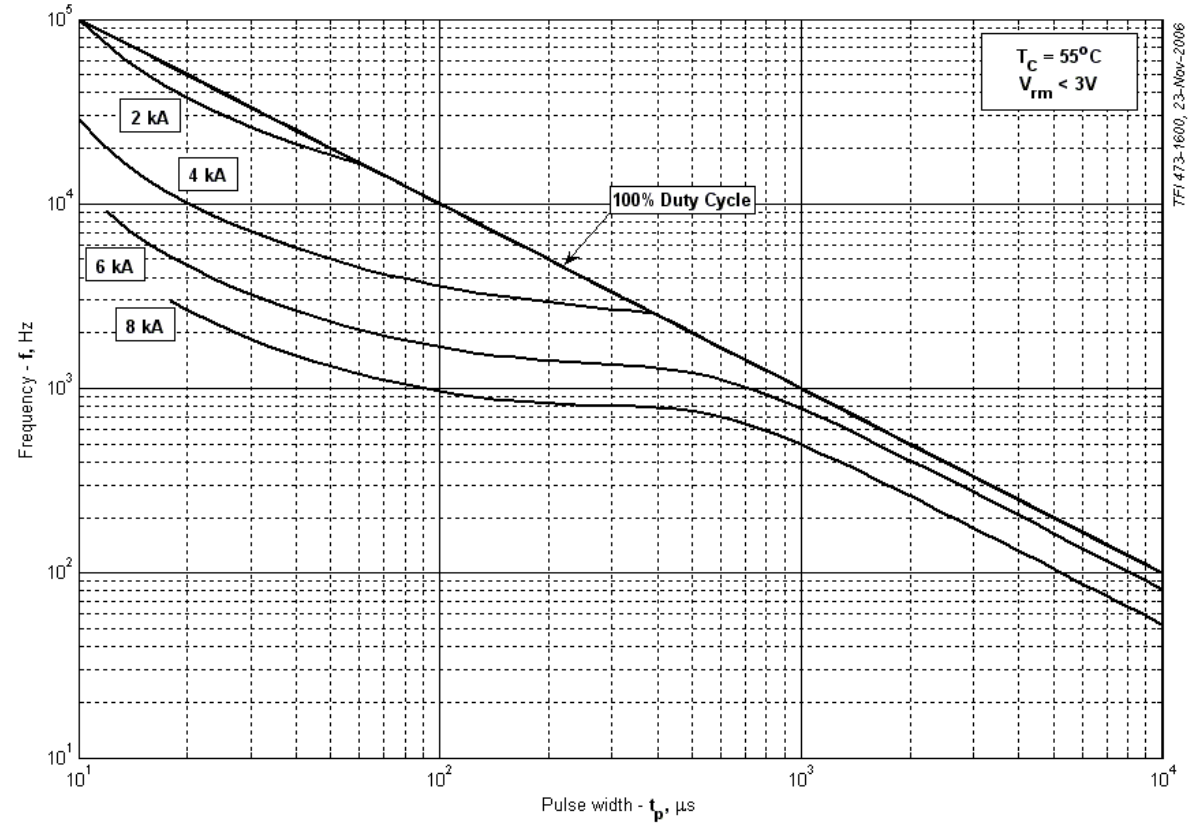


Fig 10 – Sine wave frequency ratings

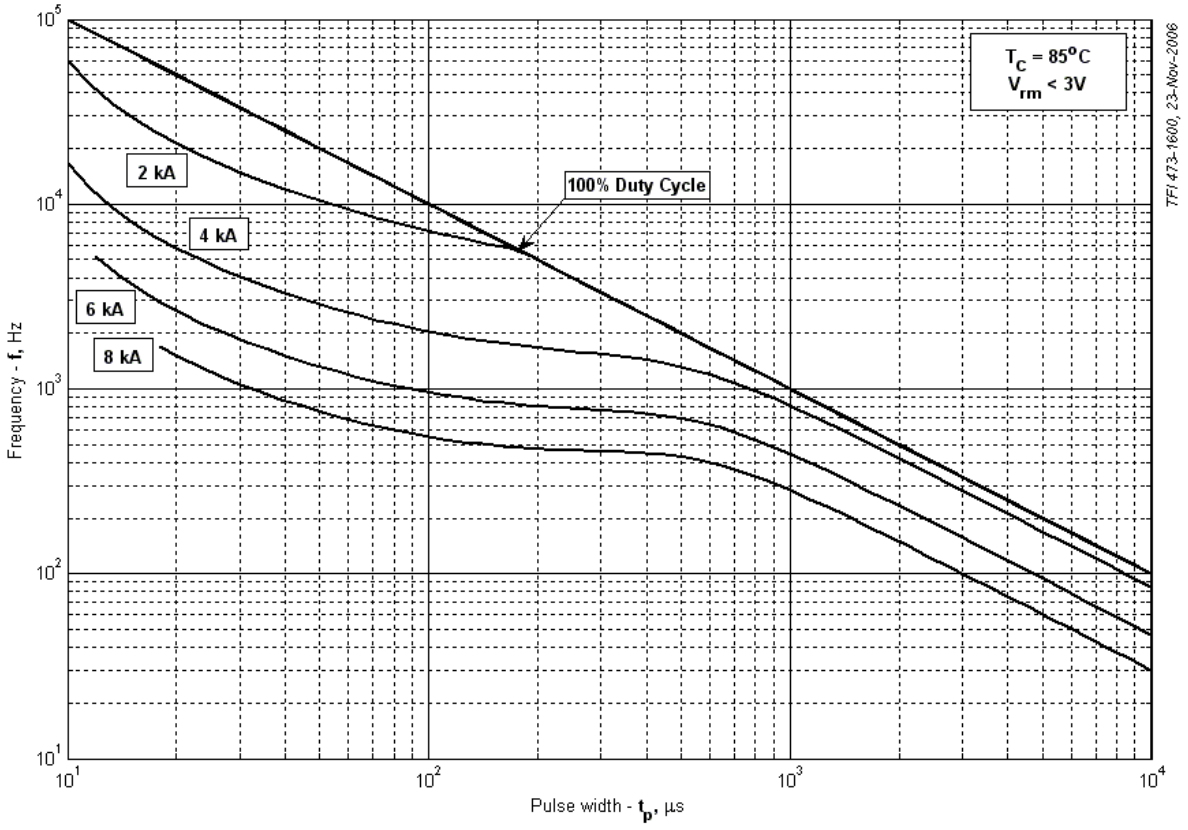


Fig 11 – Sine wave frequency ratings

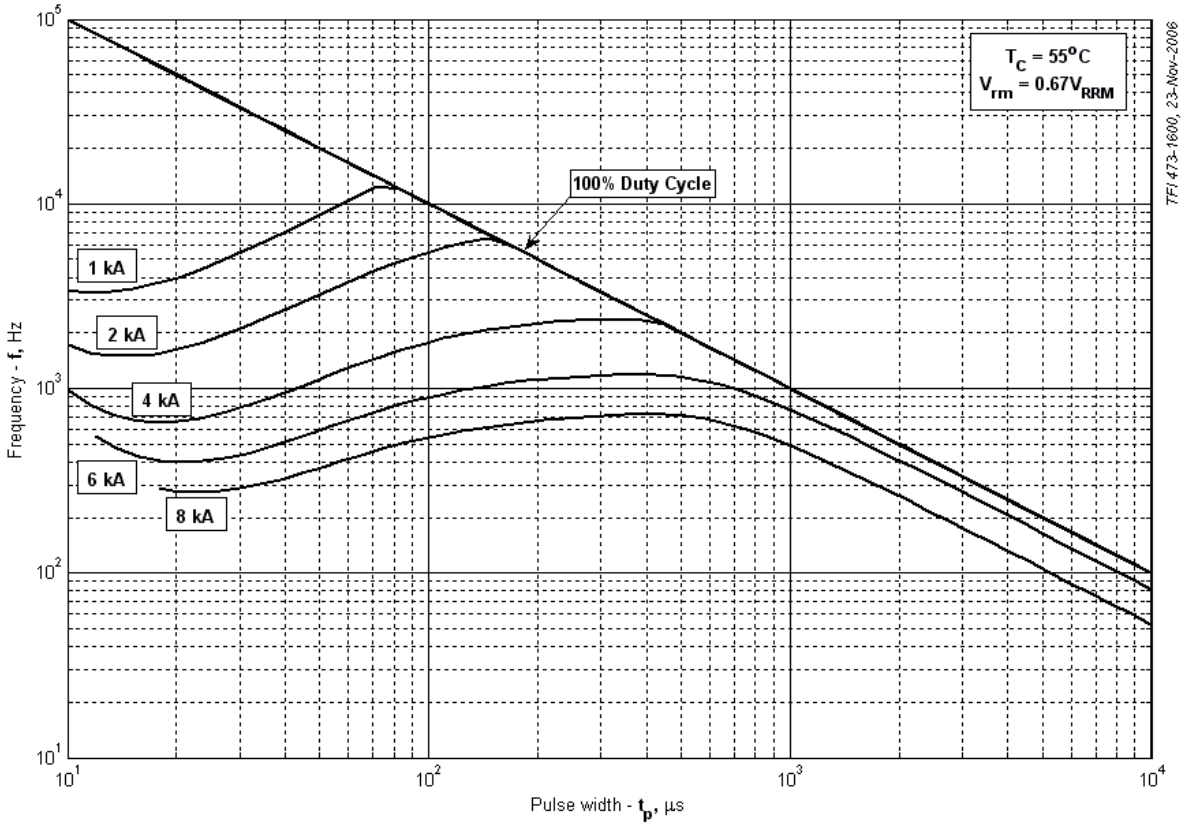


Fig 12 – Sine wave frequency ratings

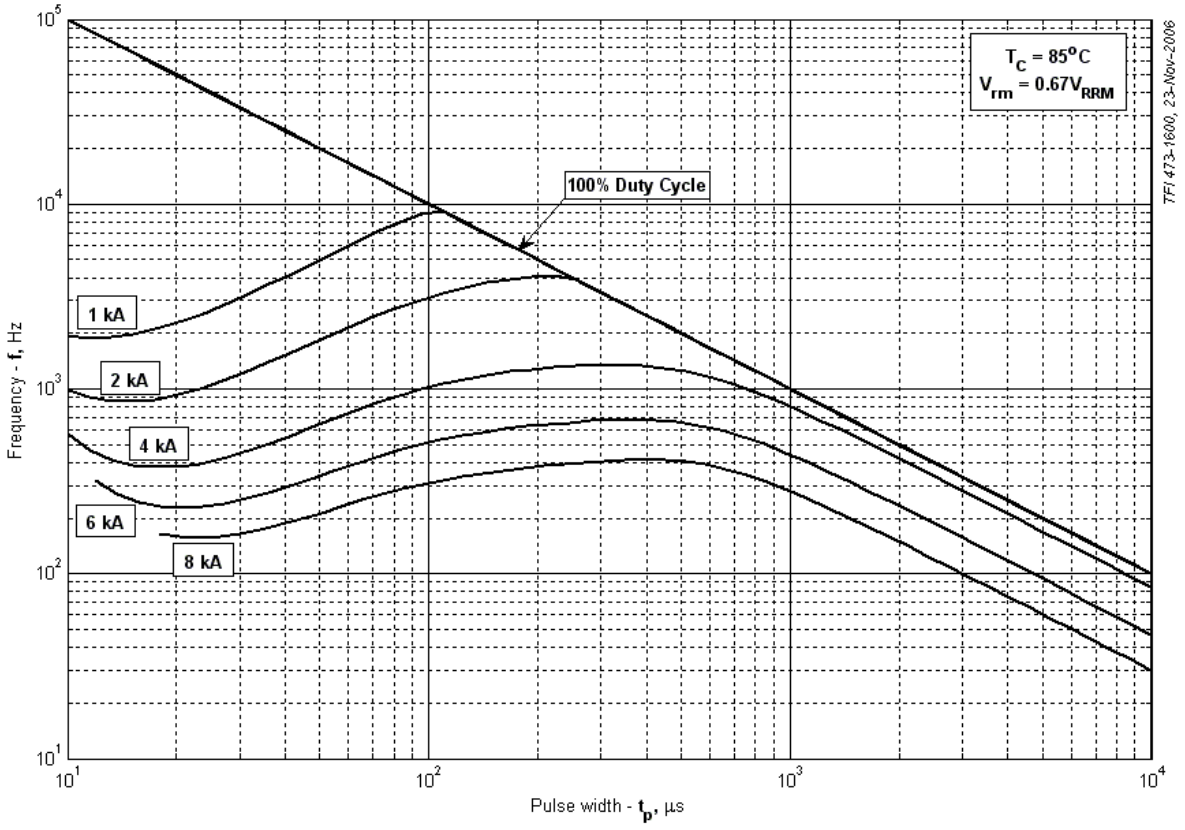


Fig 13 – Sine wave frequency ratings

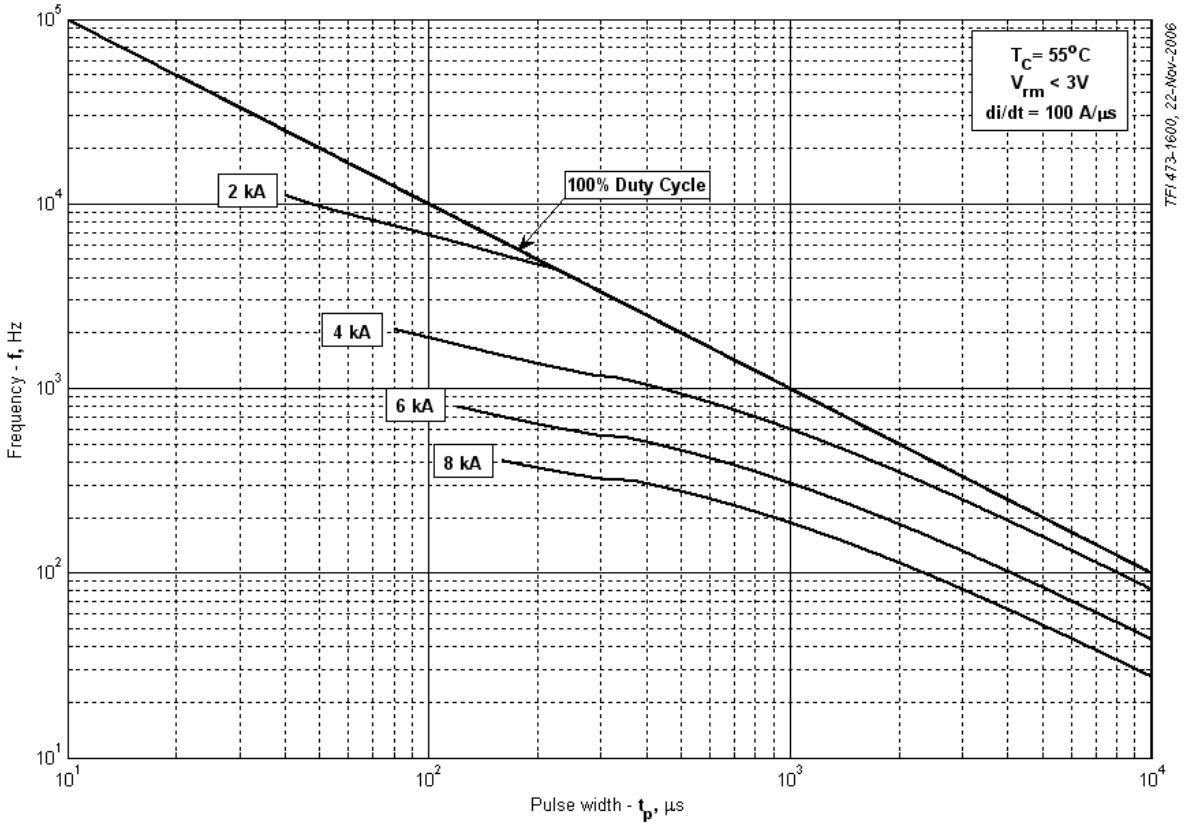


Fig 14 – Square wave frequency ratings

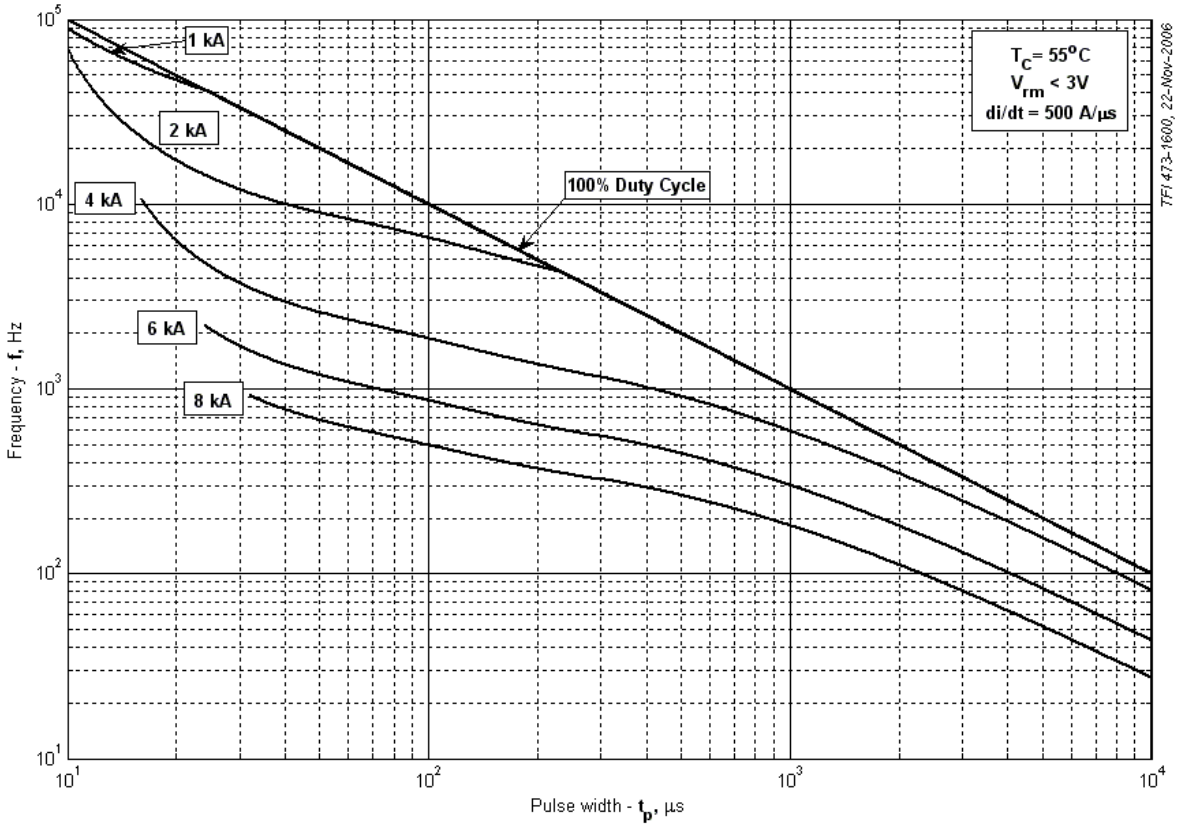


Fig 15 – Square wave frequency ratings

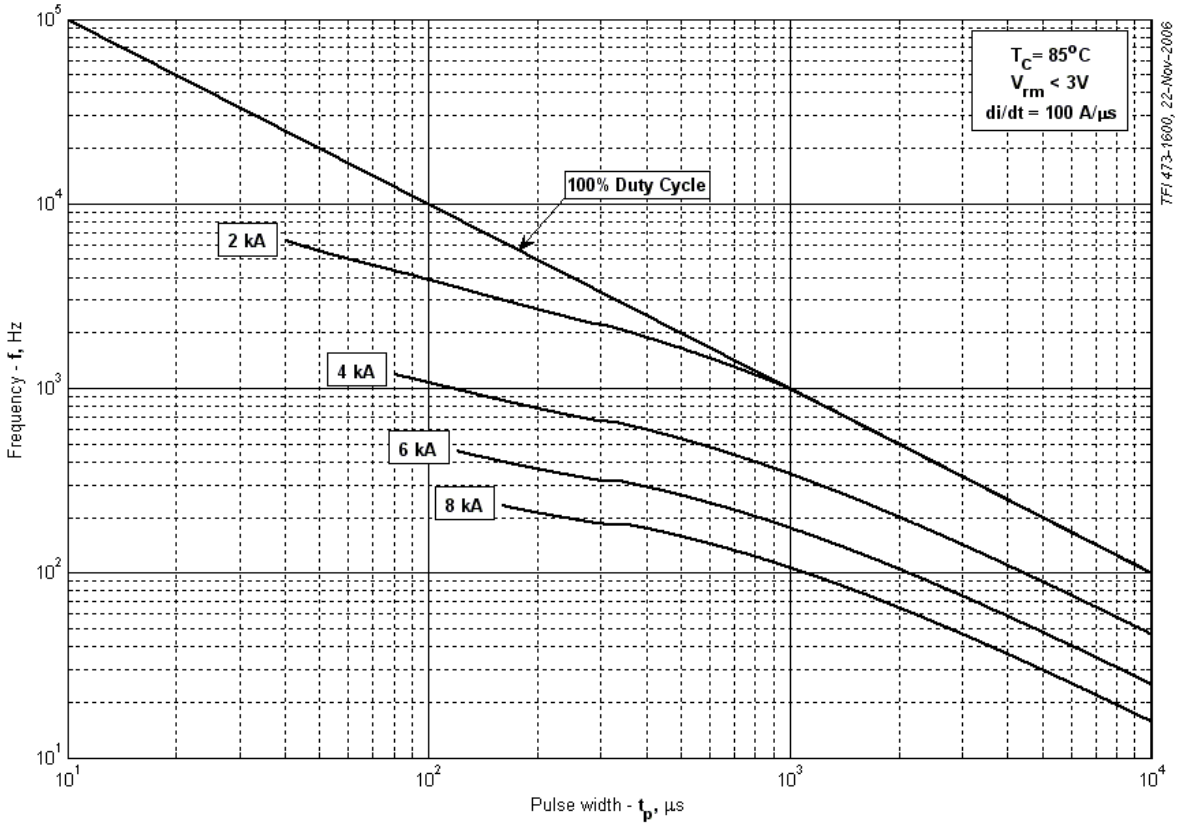


Fig 16 – Square wave frequency ratings

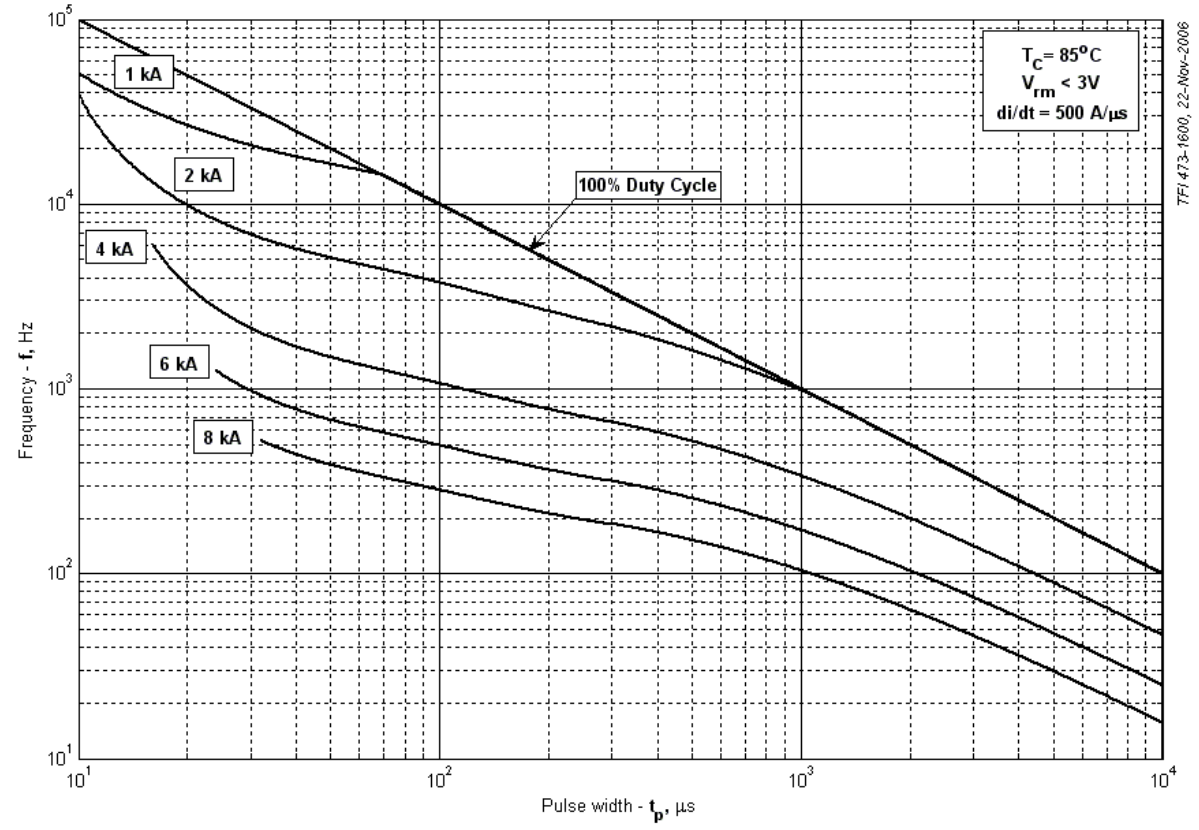


Fig 17 – Square wave frequency ratings

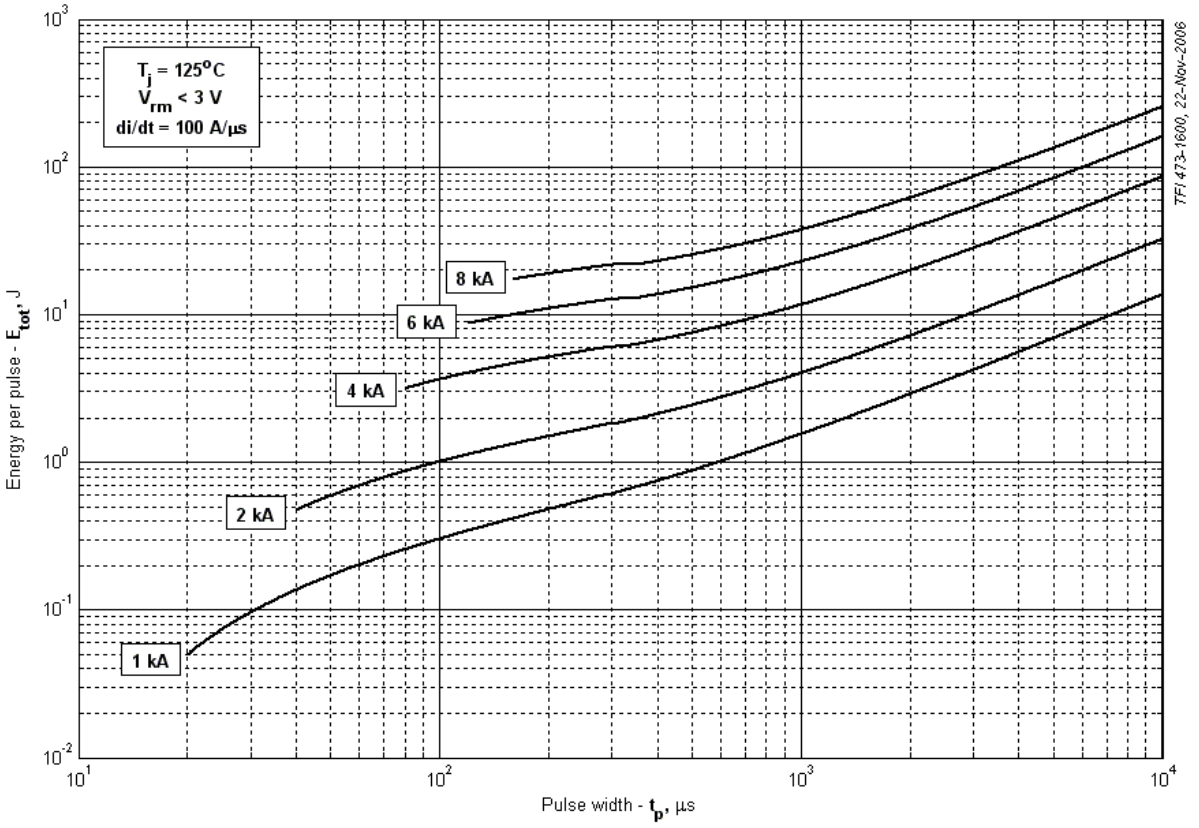


Fig 18 – Square wave energy per pulse

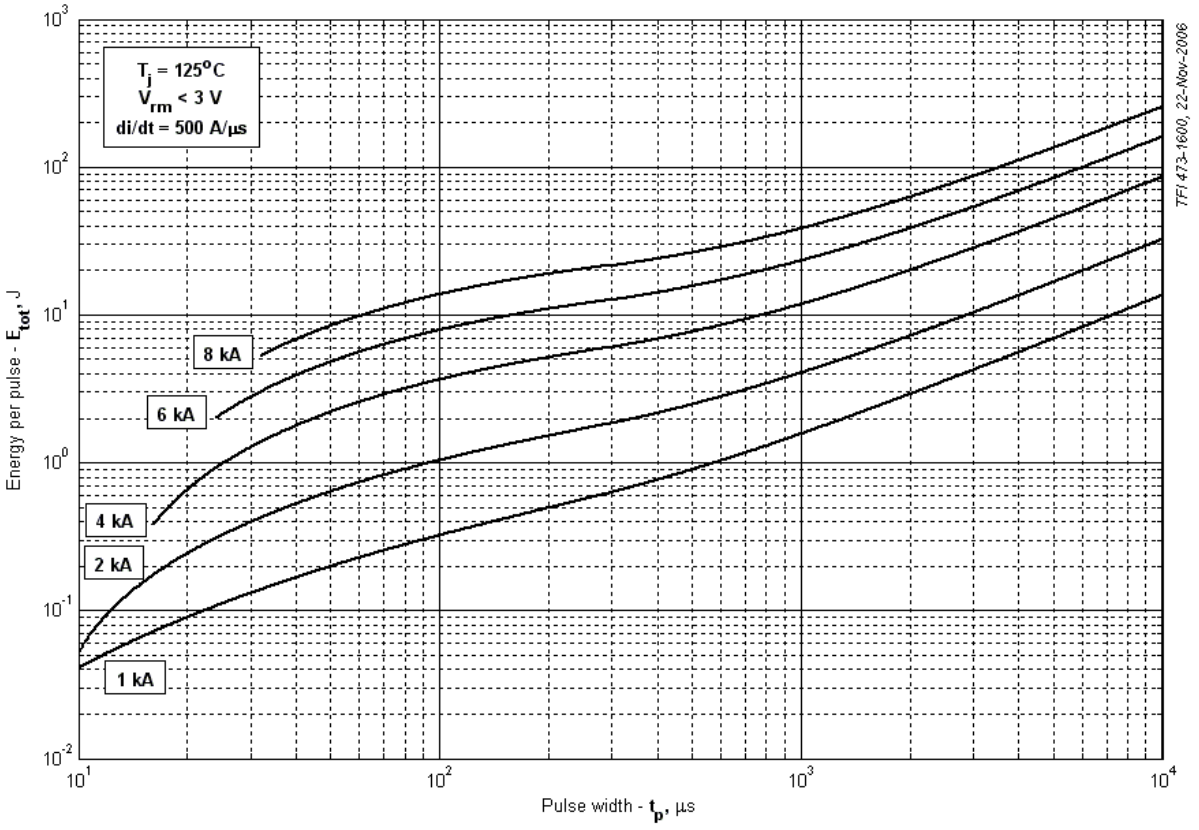


Fig 19 – Square wave energy per pulse

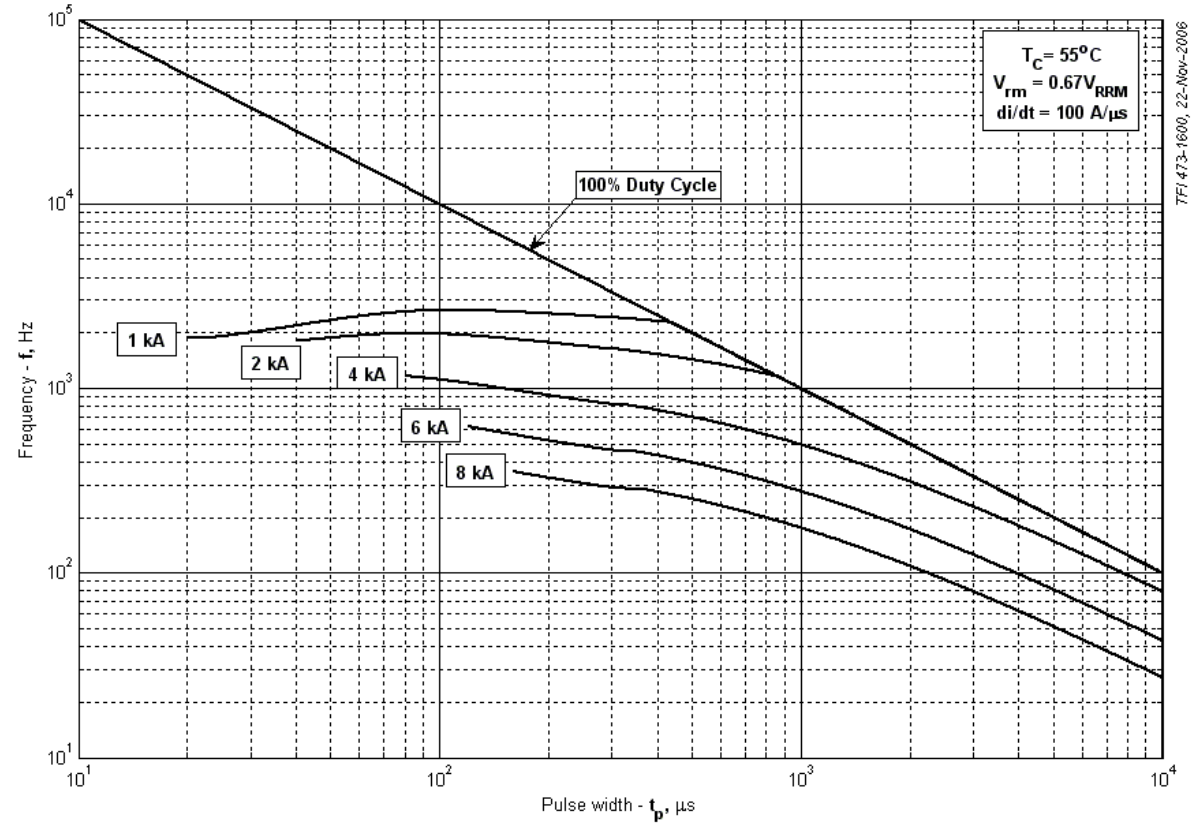


Fig 20 – Square wave frequency ratings

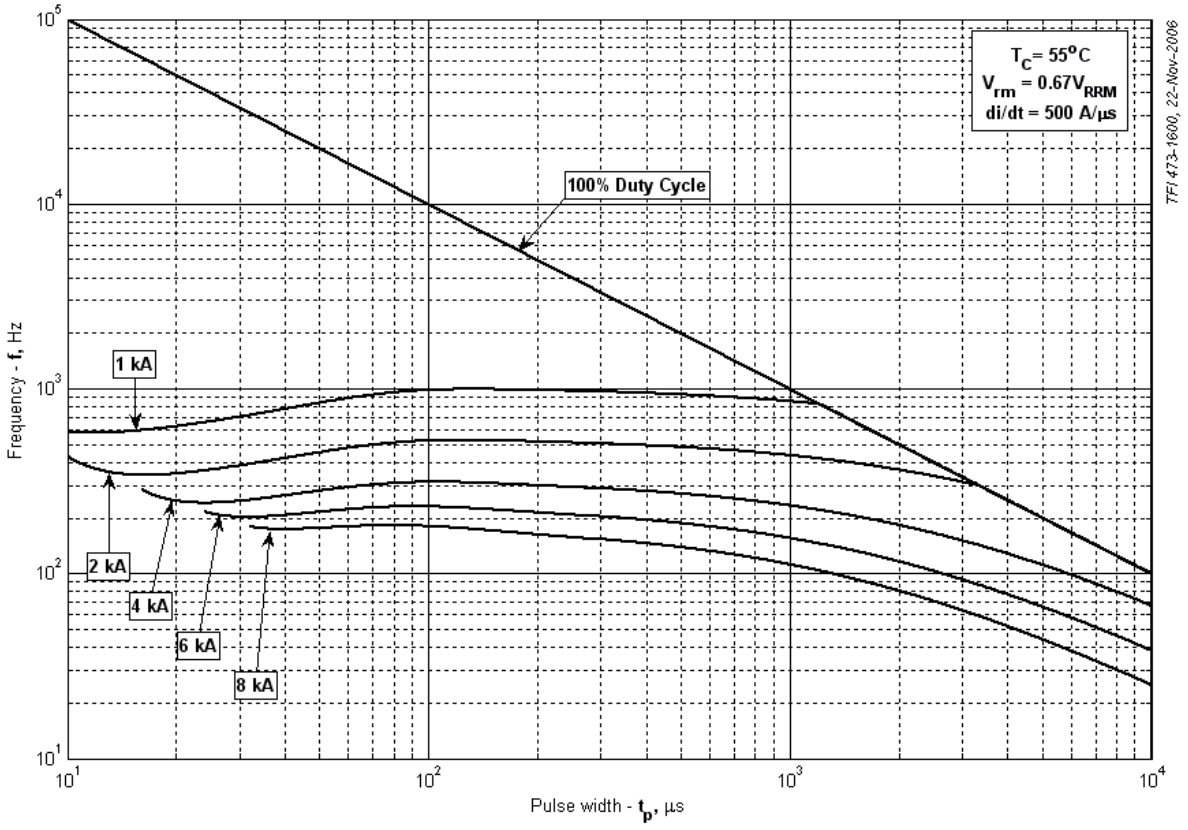


Fig 21 – Square wave frequency ratings

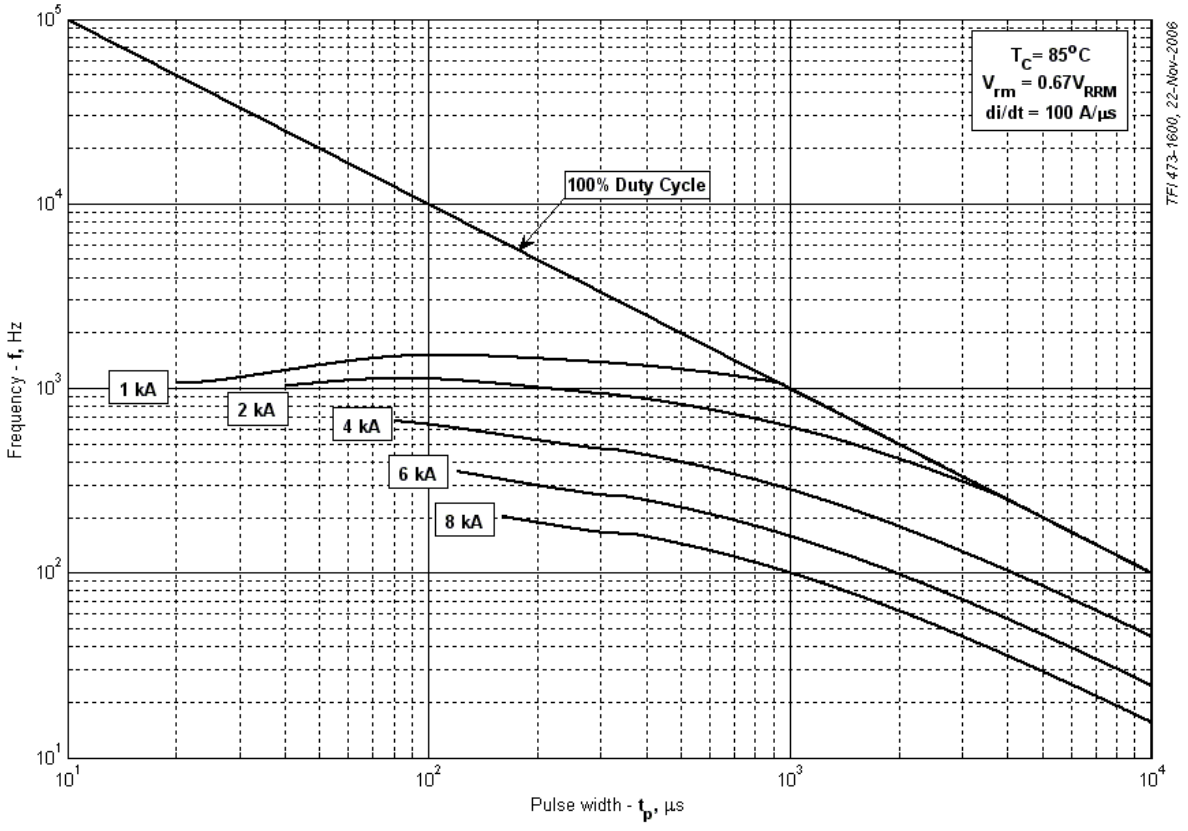


Fig 22 – Square wave frequency ratings

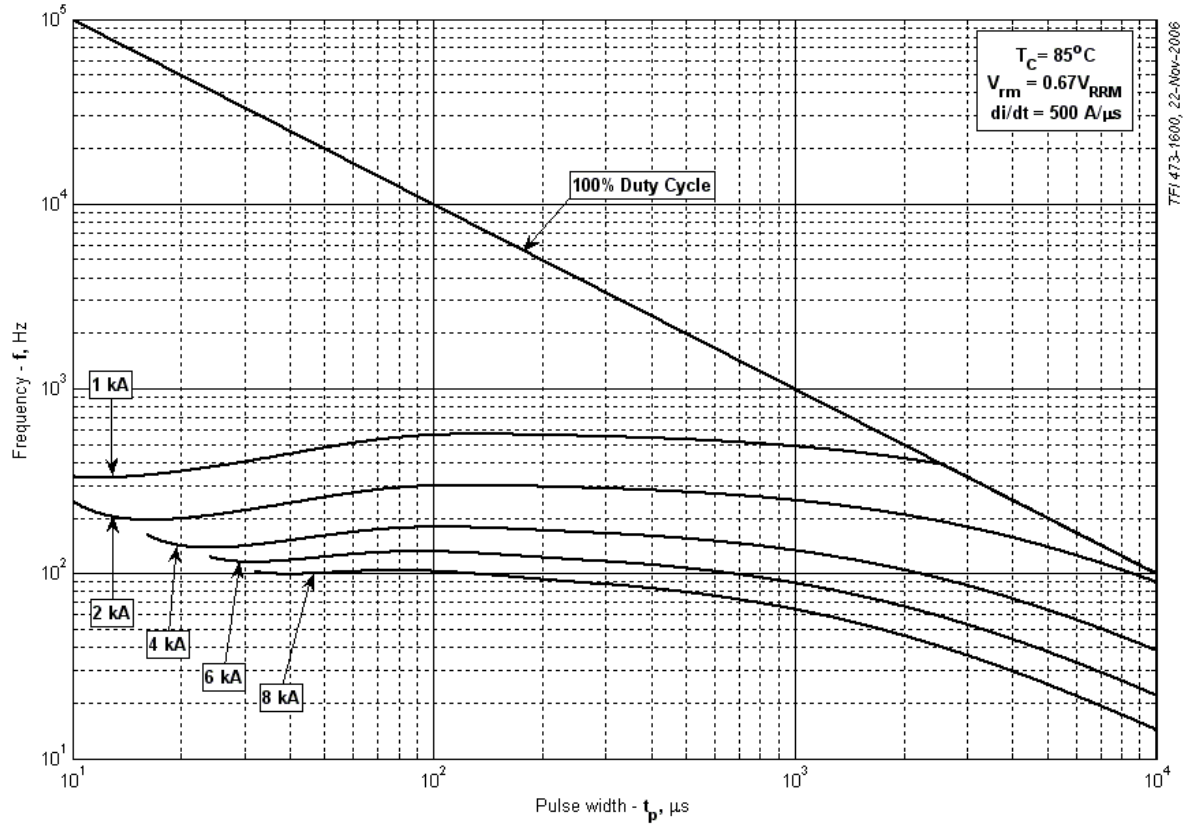


Fig 23 – Square wave frequency ratings

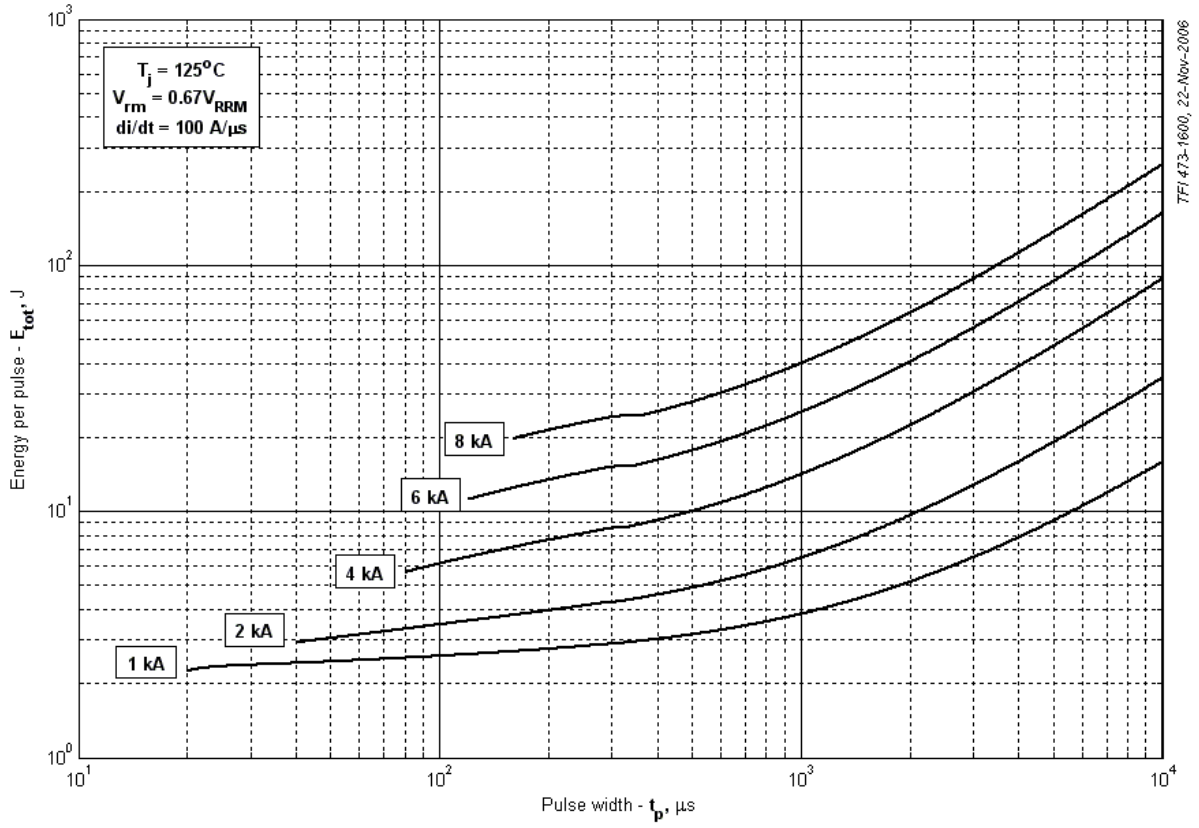


Fig 24 – Square wave energy per pulse

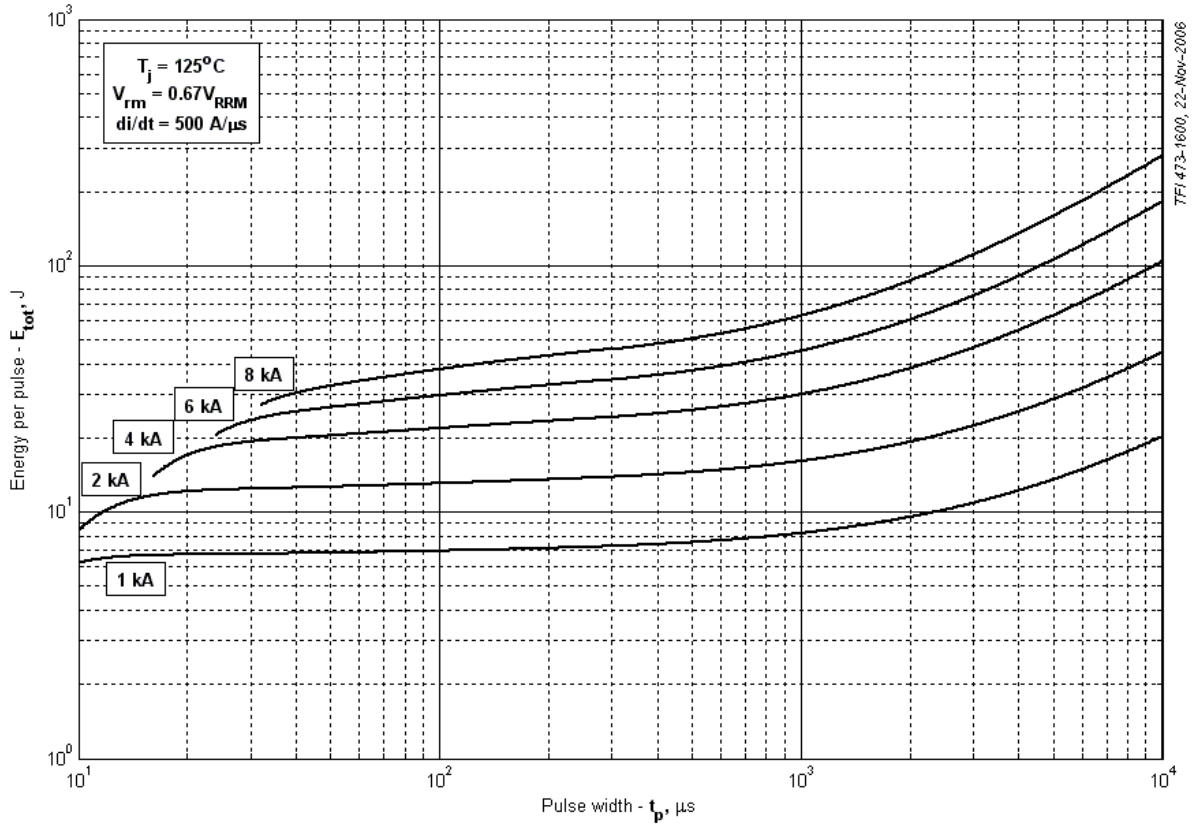


Fig 25 – Square wave energy per pulse

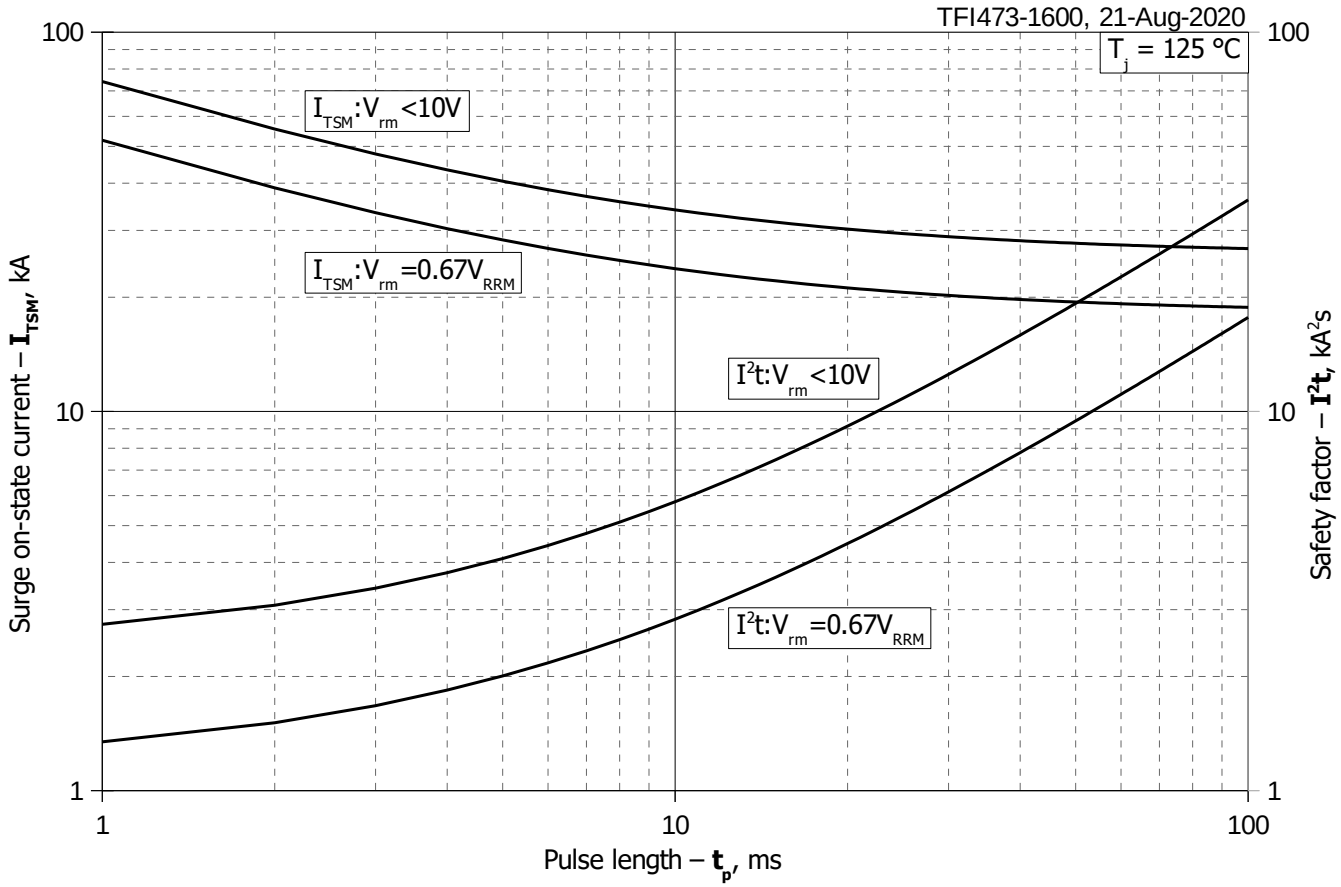


Fig 26 – Maximum surge and I^2t ratings

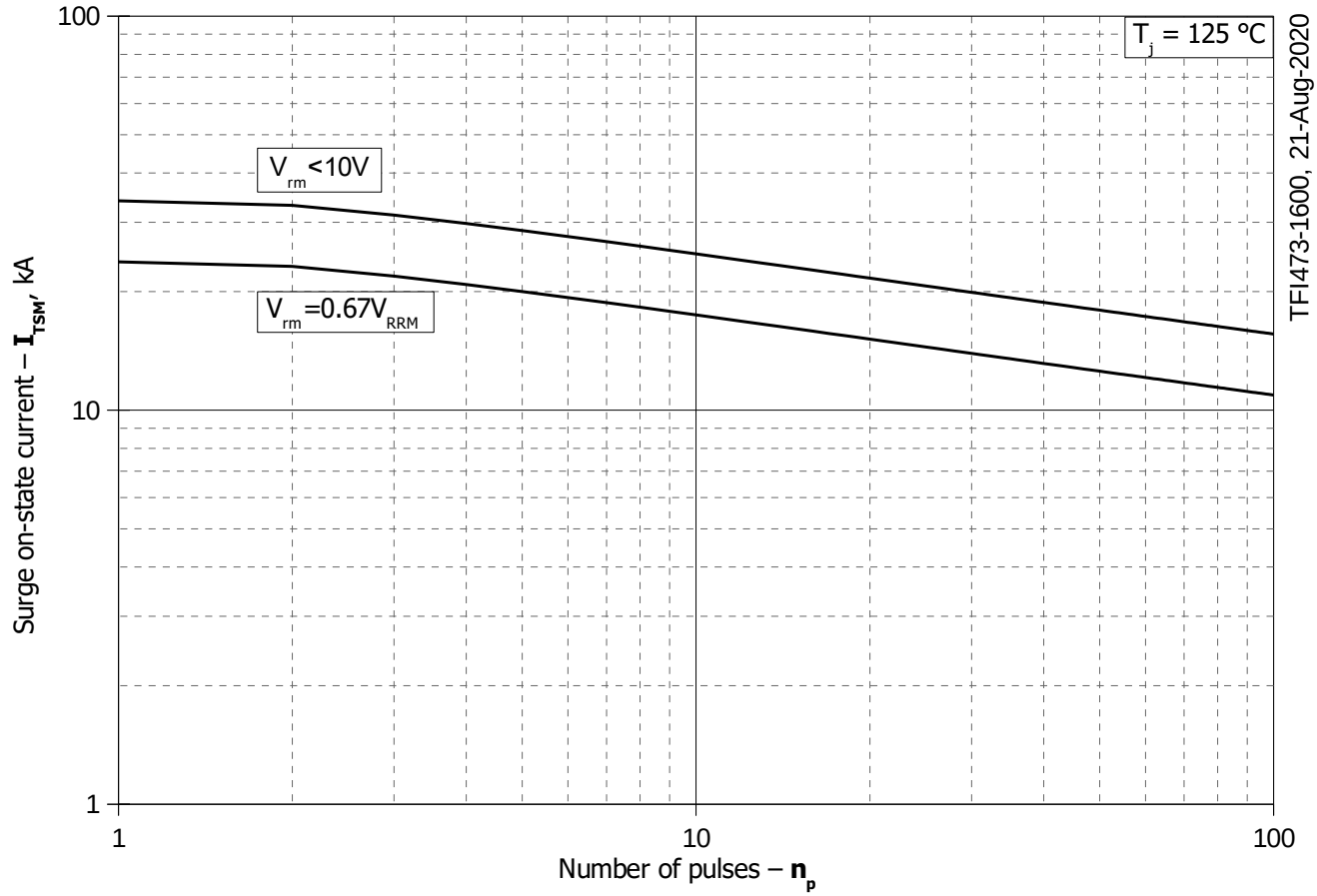


Fig 27 – Maximum surge ratings