Fast Thyristor
Type TFIS133-400-12

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

Mean on-state current	I_{TAV}	400 A
Repetitive peak off-state voltage	V_{DRM}	1000...1200 V
Repetitive peak reverse voltage	V_{RRM}	
Turn-off time	t_q	5.00, 6.30, 8.00, 10.0 μs

V_{DRM}, V_{RRM}, V	1000	1100	1200
Voltage code	10	11	12
T_j, °C	–60...+125		

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Mean on-state current	A	358 400 533	T_c= 85 °C; Double side cooled; T_c= 78 °C; Double side cooled; T_c= 55 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	628	T_c= 78 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	5.5 6.5	$T_j=T_{j\,max}$ 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
			6.0 7.0	$T_j=T_{j\,max}$ 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=1 A/μs
I^2t	Safety factor	$A^2s \cdot 10^3$	150 210	$T_j=T_{j\,max}$ 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
			140 200	$T_j=T_{j\,max}$ 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	1000...1200	$T_{j\,min}< T_j <T_{j\,max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	1100...1300	$T_{j\,min}< T_j <T_{j\,max}$; 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	6	$T_j=T_{j\,max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	3	$T_j=T_{j\,max}$ 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}=900 A; Gate pulse: $I_G=I_{FGM}$; 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	9.0...11.0	
a	Acceleration	m/s²	50	Device clamped

CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V_{TM}	Peak on-state voltage, max	V	3.30	T_j=25 °C; I_{TM}=1256 A	
$V_{T(TO)}$	On-state threshold voltage, max	V	1.775	$T_j=T_{j\,max}$; $0.5\pi I_{TAV} < I_T < 1.5\pi I_{TAV}$	
r_T	On-state slope resistance, max	mΩ	1.155		
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	70	$T_j=T_{j\,max}$; $V_D=V_{DRM}$; $V_R=V_{RRM}$	
$(dv_D/dt)_{crit}$	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	0.40	$T_j=T_{j\,max}$; $V_D=0.67 \cdot V_{DRM}$; Direct gate current	
I_{GD}	Gate non-trigger direct current, min	mA	70.00		
SWITCHING					
t_{gd}	Delay time, max	µs	0.70	T_j=25 °C; V_D=600 V; $I_{TM}=I_{TAV}$; di/dt=200 A/µs; Gate pulse: $I_G=I_{FGM}$; V_G=20 V; t_{GP}=50 µs; di_G/dt=2 A/µs	
t_{gt}	Turn-on time[2]), max	µs	1.25, 1.60, 2.00, 2.50		
t_q	Turn-off time[3]), max	µs	5.00, 6.30, 8.00, 10.0	dv_D/dt=50 V/µs;	$T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; di_R/dt=-10 A/µs; V_R=100V; $V_D=0.67 \cdot V_{DRM}$
			6.30; 8.00, 10.00, 12.5	dv_D/dt=200 V/µs;	
Q_{rr}	Total recovered charge, max	µC	60	$T_j=T_{j\,max}$; $I_{TM}=I_{TAV}$; di_R/dt=-50 A/µs; V_R=100 V	
t_{rr}	Reverse recovery time, typ	µs	1.85		
I_{rrM}	Peak reverse recovery current, max	A	65		

THERMAL					
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0400	Direct current	Double side cooled
R_{thjc-A}			0.0880		Anode side cooled
R_{thjc-K}			0.0720		Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0060	Direct current	
MECHANICAL					
w	Weight, max	g	92		
D_s	Surface creepage distance	mm (inch)	10.30 (0.405)		
D_a	Air strike distance	mm (inch)	6.30 (0.248)		

PART NUMBERING GUIDE

TFIS	133	400	12	A2	A4	M4	N
1	2	3	4	5	6	7	8

1. TFIS — fast high frequency 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

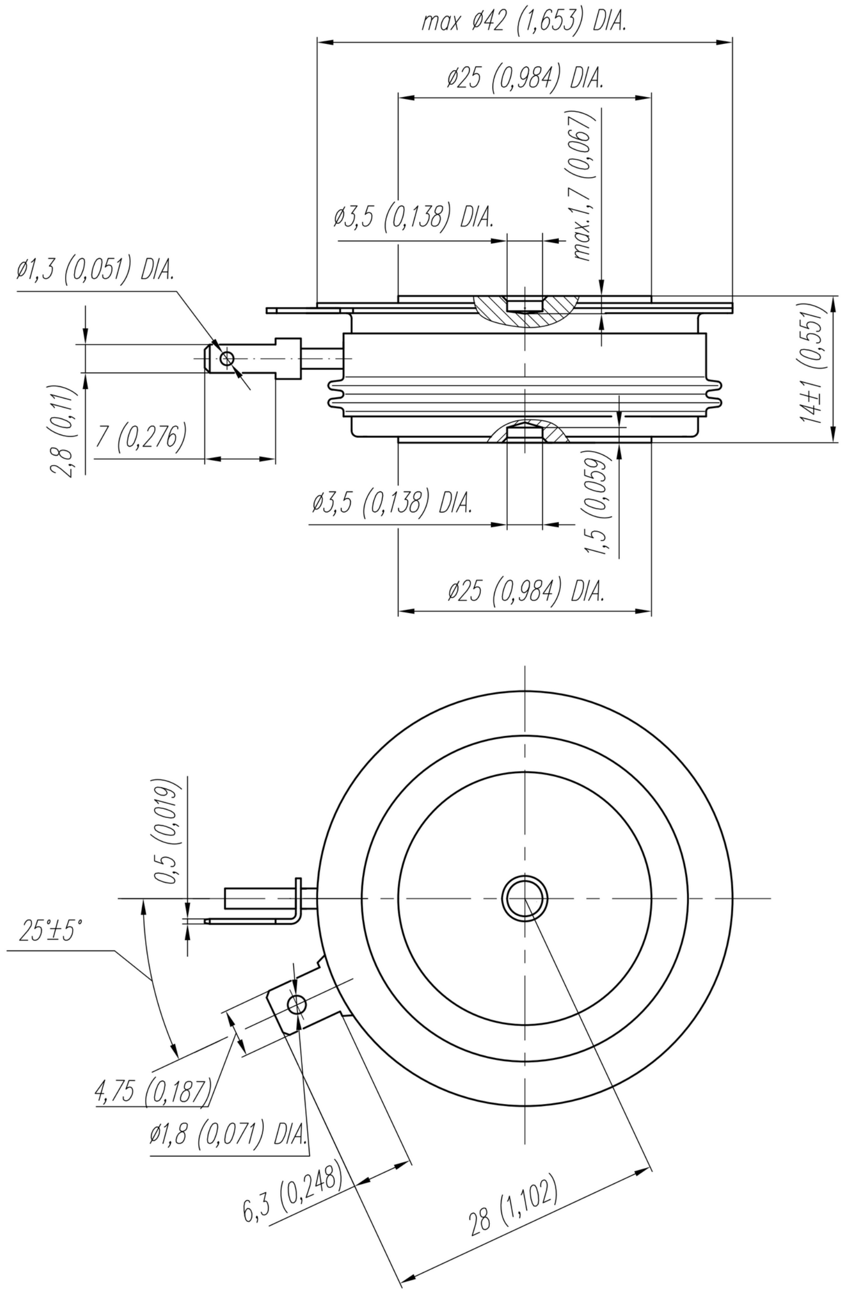
Symbol of group	X4	T4	P4	M4
t_{gt}, µs	1.25	1.60	2.00	2.50

3) Turn-off time (dv_D/dt=50 V/µs)

Symbol of group	E4	C4	B4	A4
t_q, µs	5.00	6.30	8.00	10.0

OVERALL DIMENSIONS

Package type: T.B2



All dimensions in millimeters (inches)

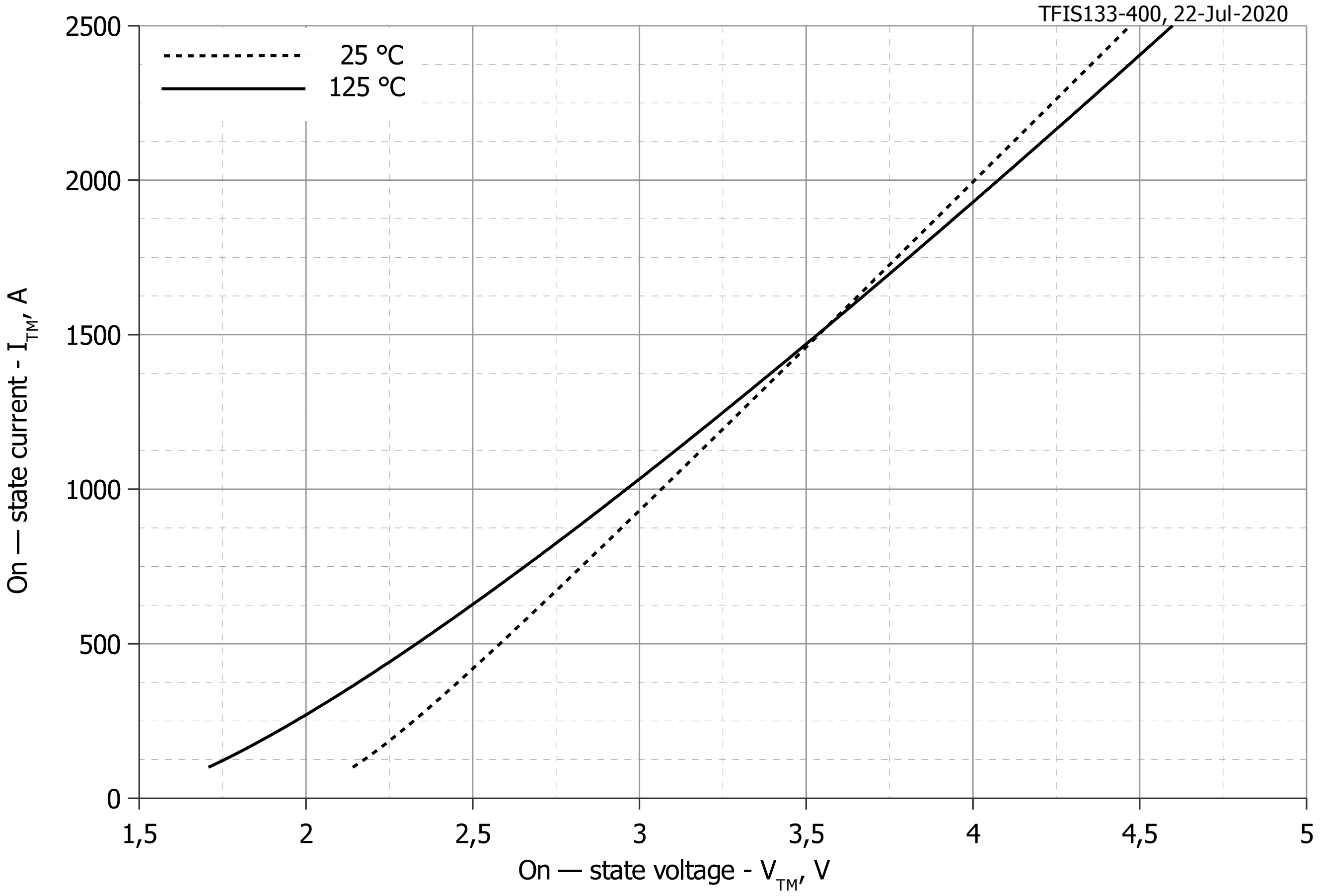


Fig 1 – On-state characteristics of Limit device

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°C	$T_j = T_{j\,max}$
A	1.76894707	1.45654520
B	0.00093748	0.00074239
C	0.06748631	-0.02625939
D	-0.00338307	0.02983140

On-state characteristic model (see Fig. 1)

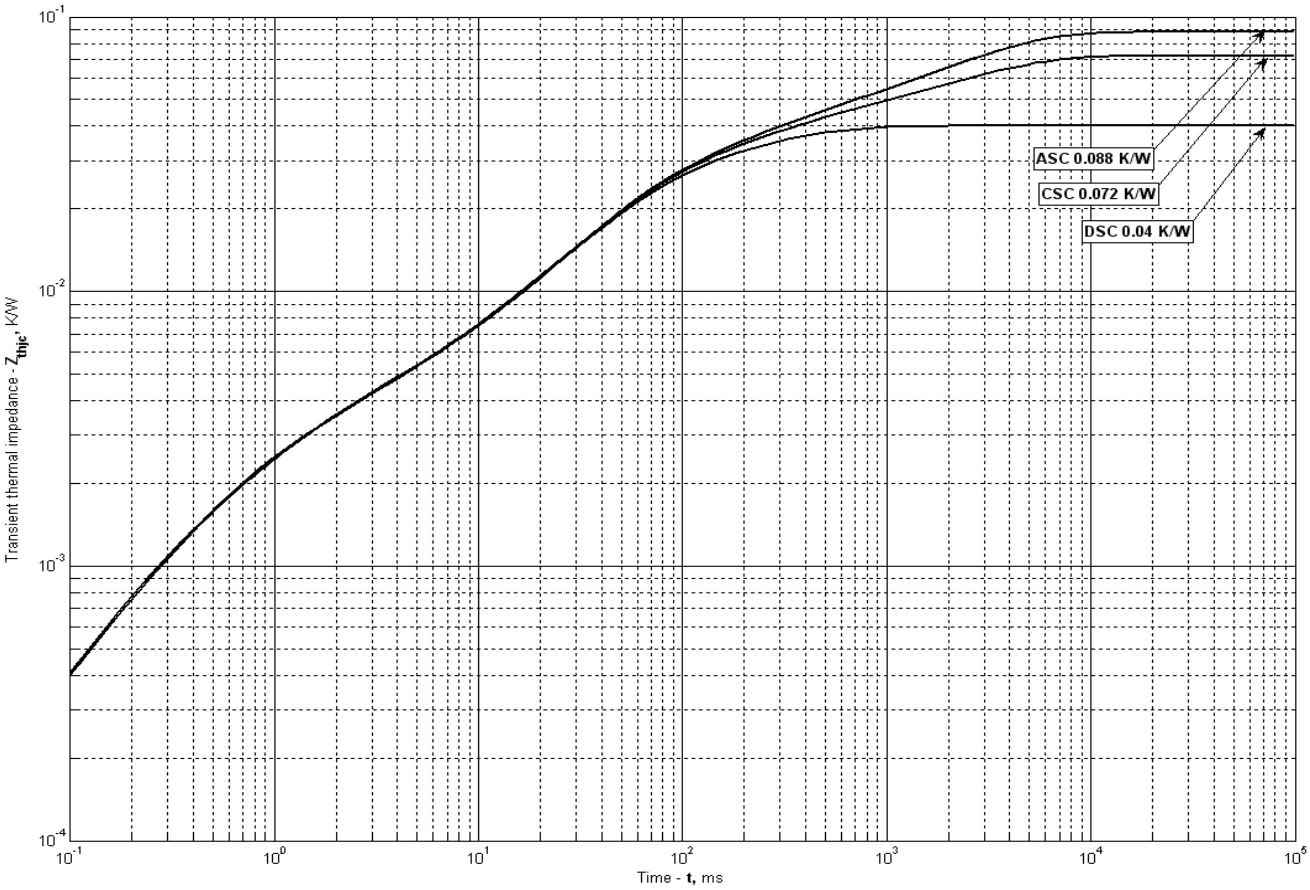


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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.

τ_i = Time constatnt of r_{th} term.

DC Double side cooled

i	1	2	3	4	5	6
R_i, K/W	0.01423	0.01906	0.003576	0.002535	-4.666e-005	0.0006479
τ_i, s	0.265	0.05901	0.03499	0.001252	0.000001	0.0002488

DC Anode side cooled

i	1	2	3	4	5	6
R_i, K/W	0.04804	0.001789	0.01342	0.02147	0.001374	0.001945
τ_i, s	2.651	0.4195	0.2622	0.05451	0.002585	0.0005847

DC Cathode side cooled

i	1	2	3	4	5	6
R_i, K/W	0.03216	0.01306	0.002934	0.02064	0.001493	0.001786
τ_i, s	2.647	0.2831	0.1455	0.05284	0.002255	0.0005519

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

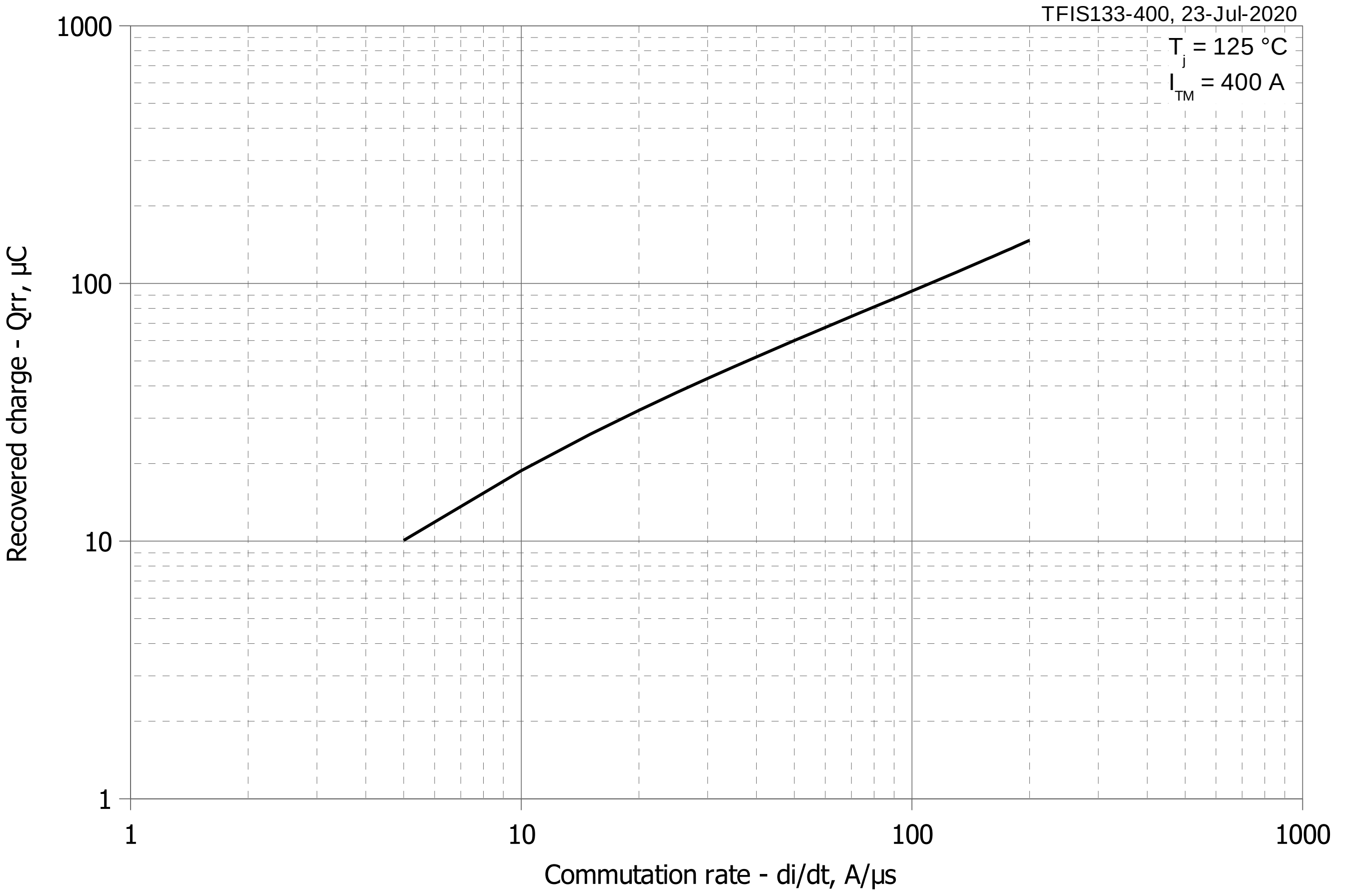


Fig 3 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

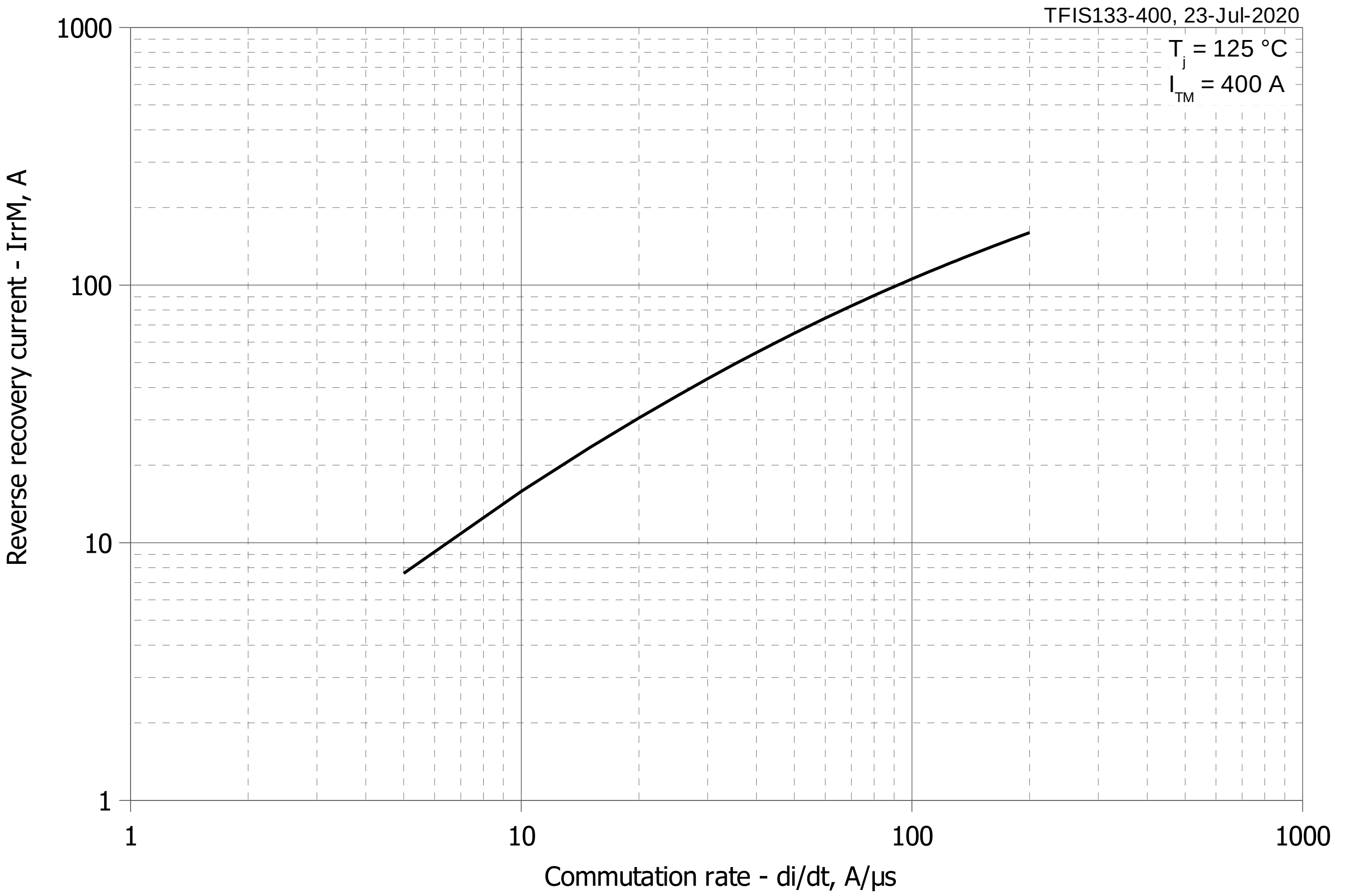


Fig 4 – Maximum reverse recovery current I_{rrM} vs. commutation rate di_R/dt

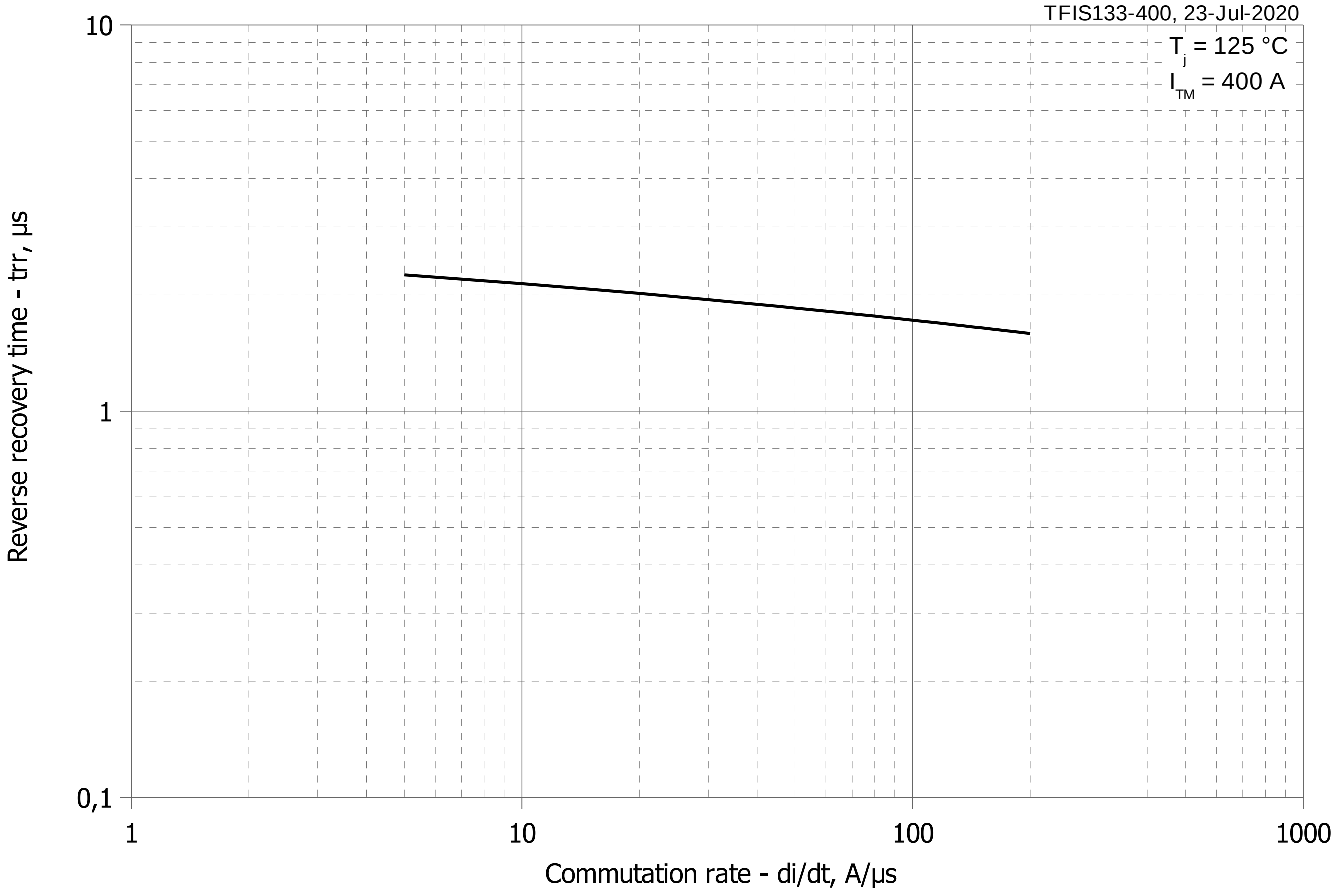


Fig 5 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

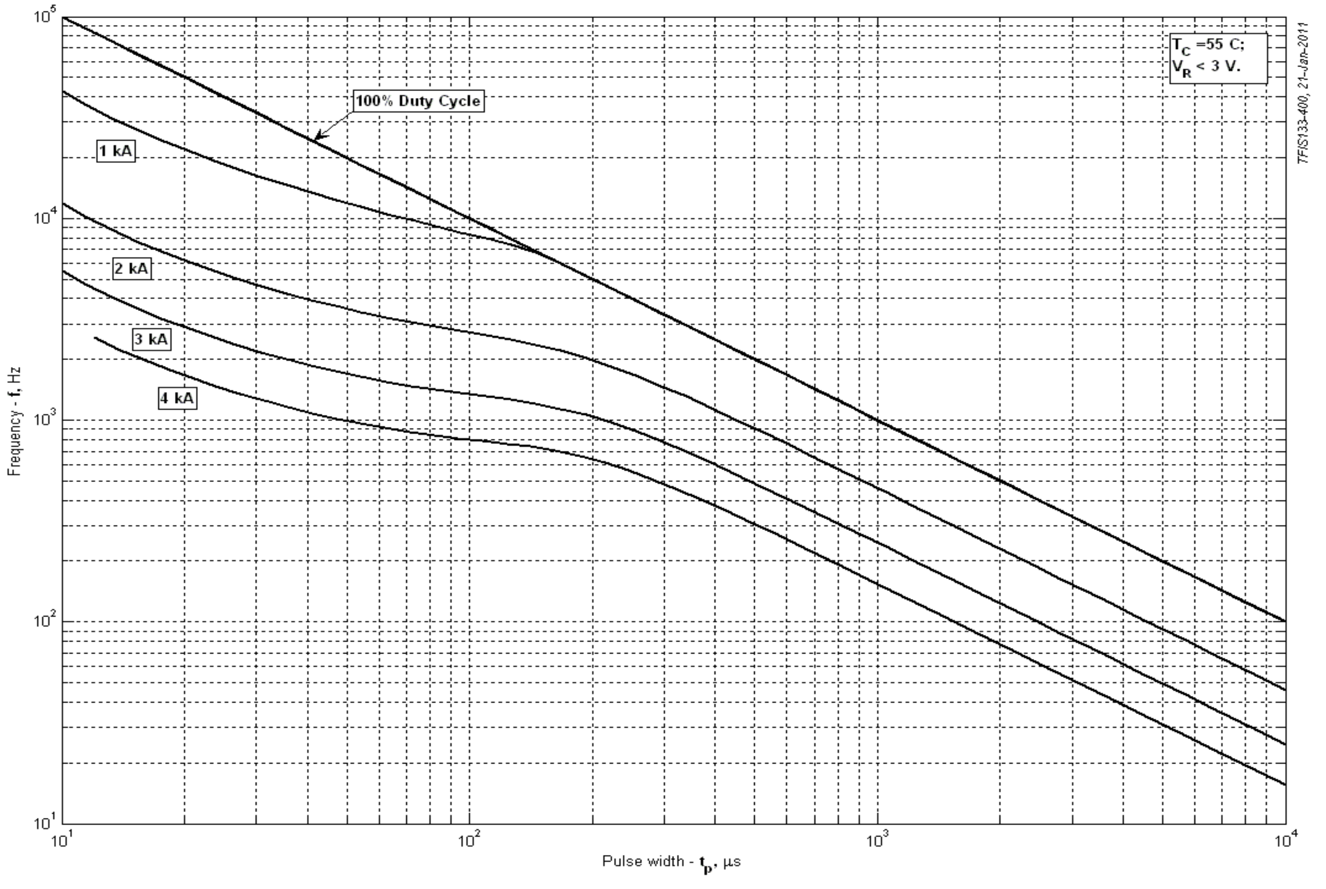


Fig 6 - Sine wave frequency ratings

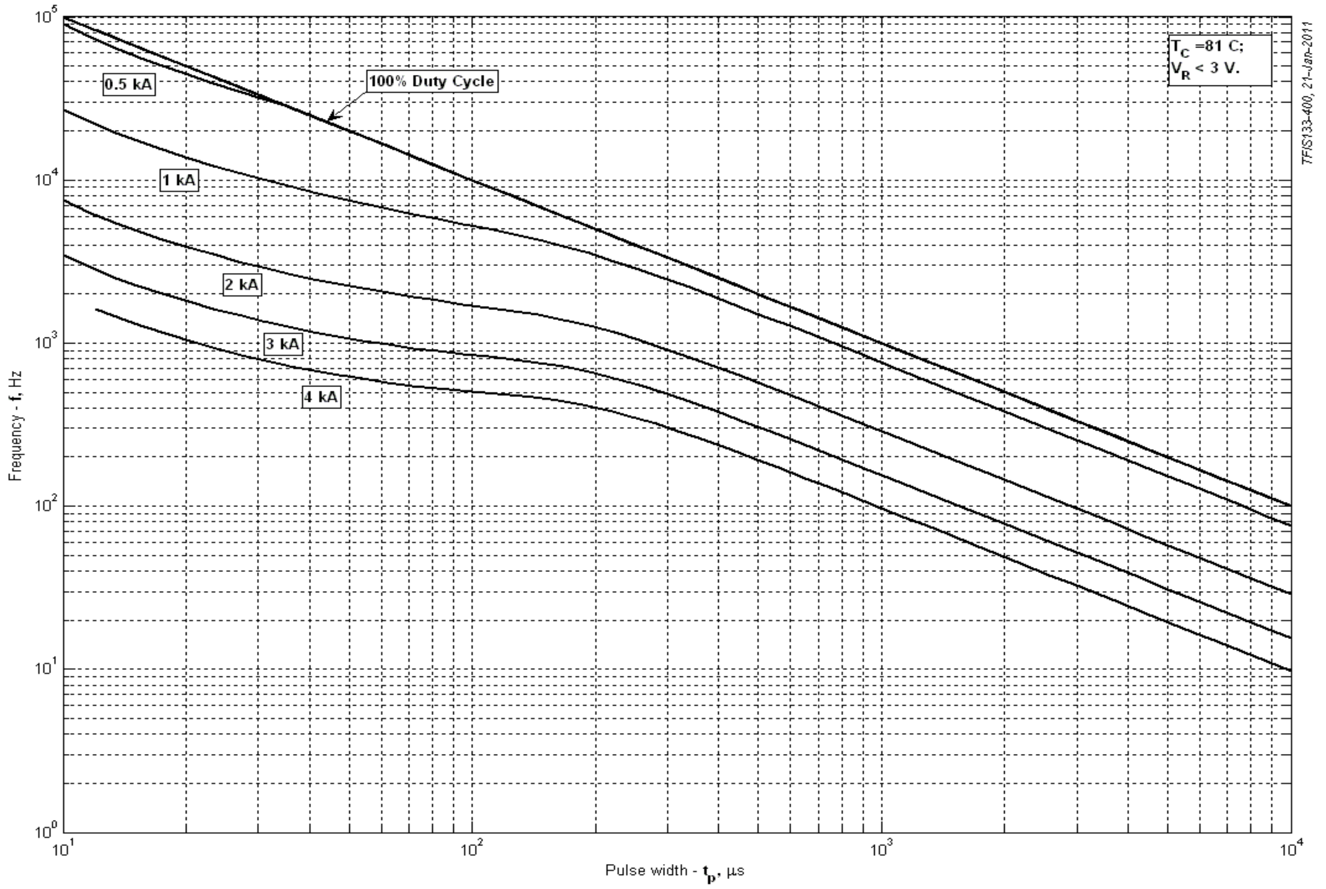


Fig 7 - Sine wave frequency ratings

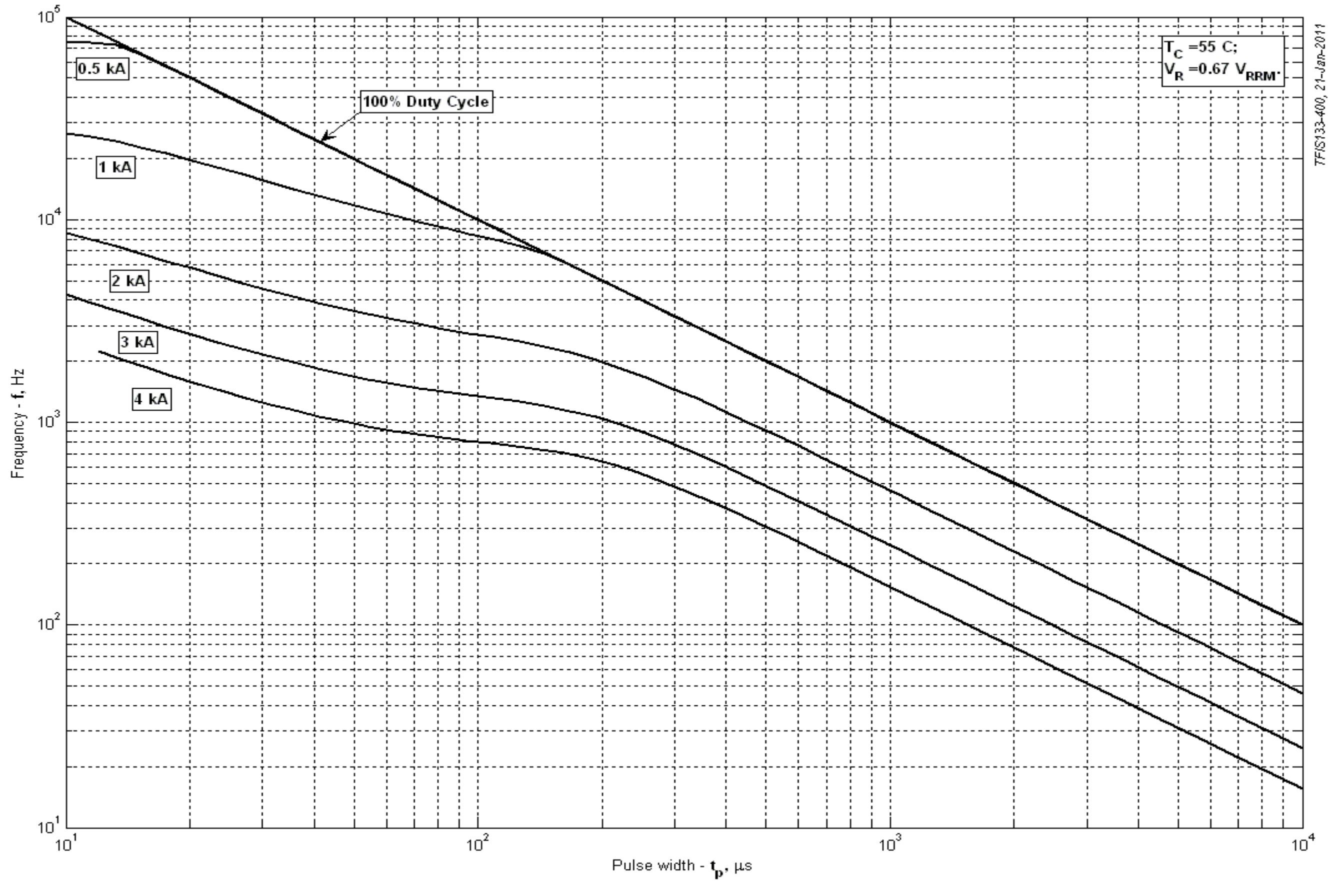


Fig 8 - Sine wave frequency ratings

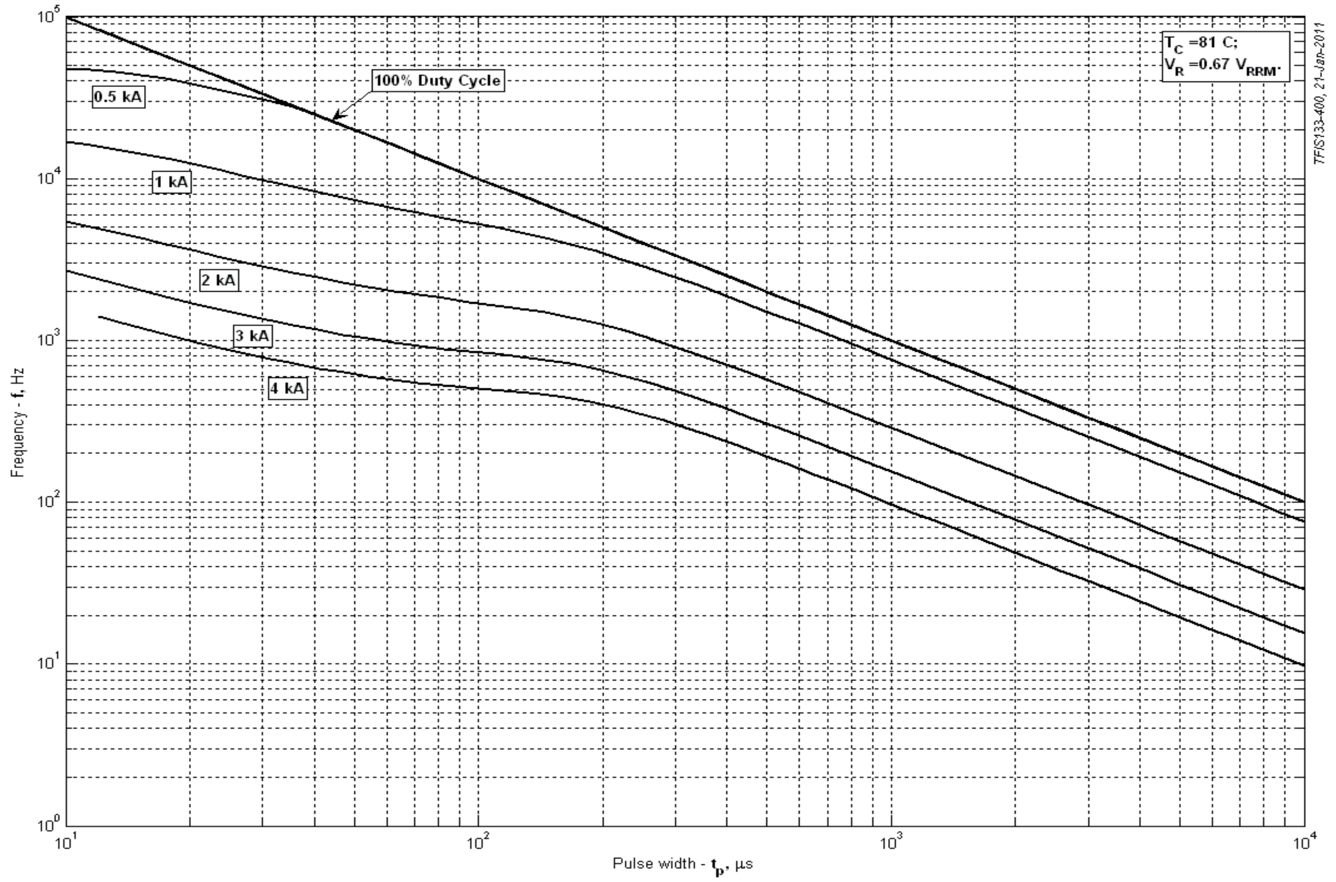


Fig 9 - Sine wave frequency ratings

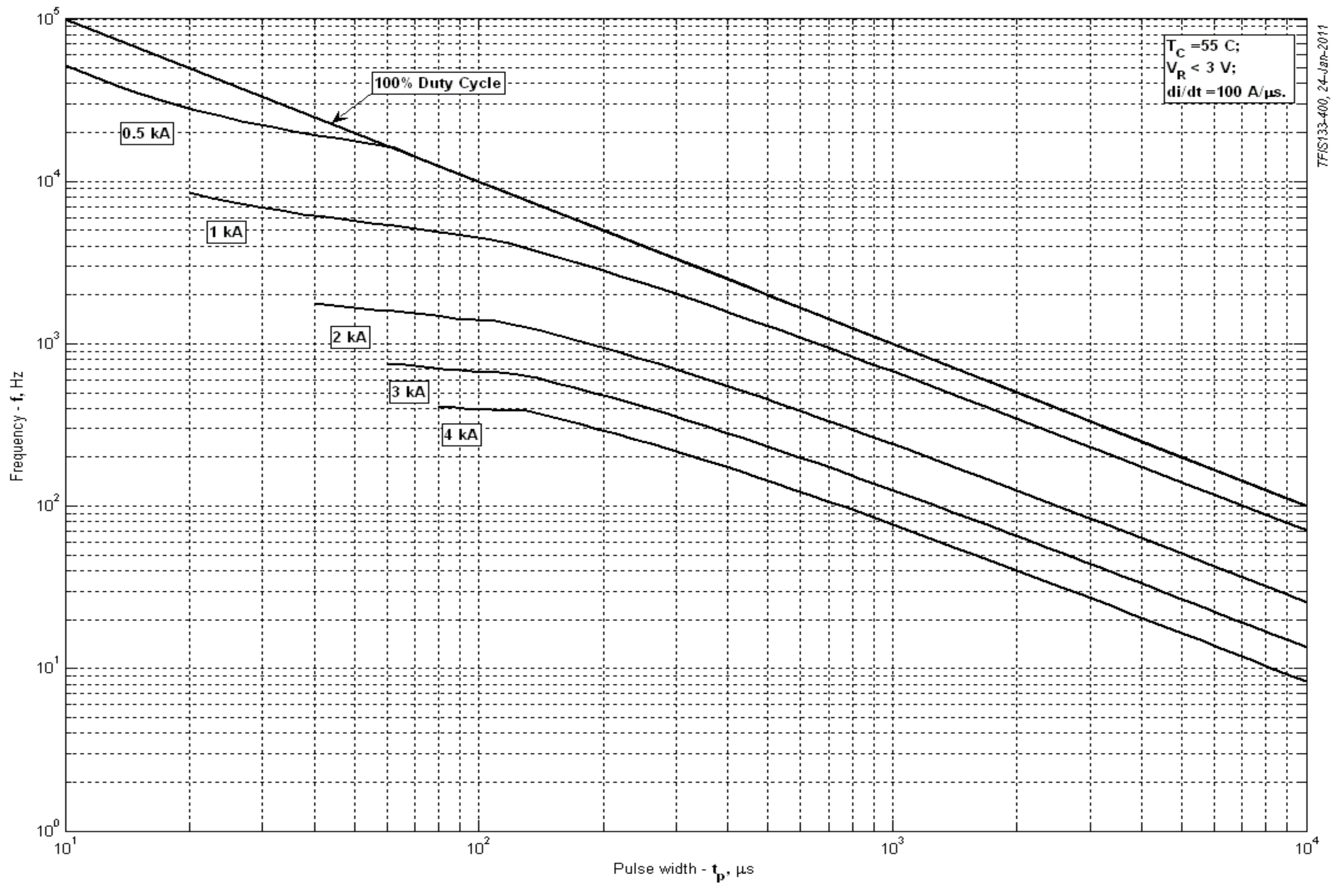


Fig 10 - Square wave frequency ratings

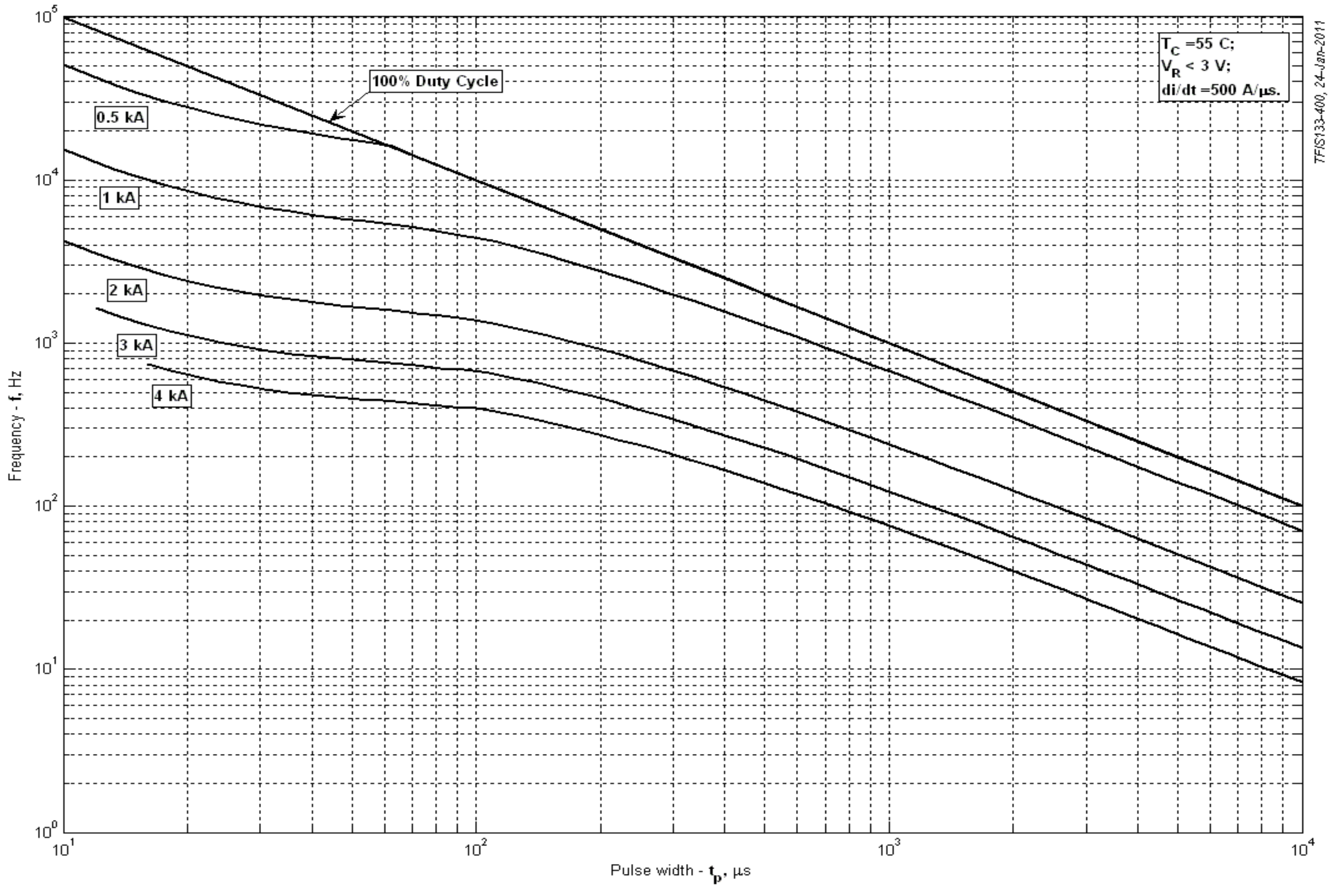


Fig 11 - Square wave frequency ratings

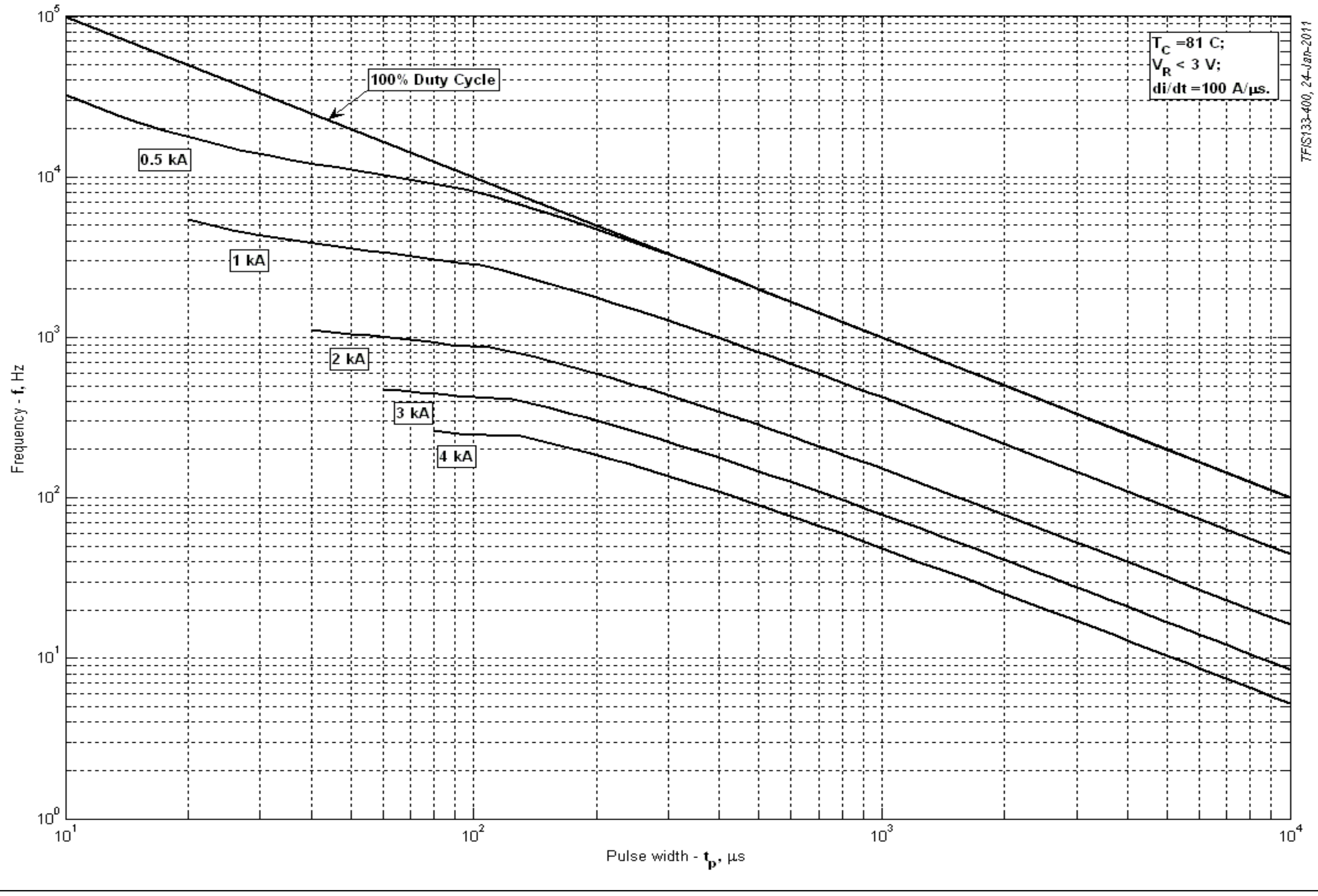


Fig 12 - Square wave frequency ratings

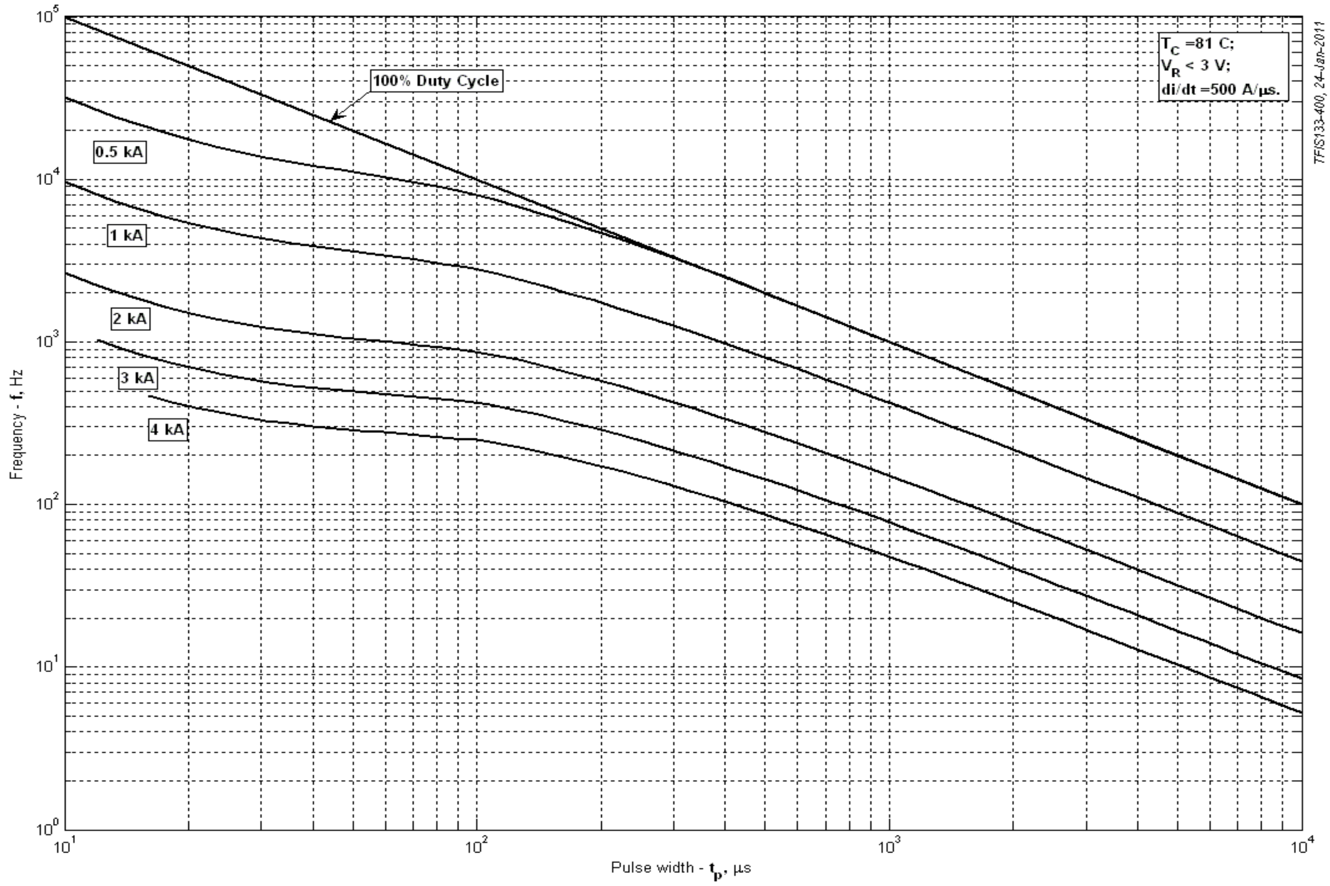


Fig 13 - Square wave frequency ratings

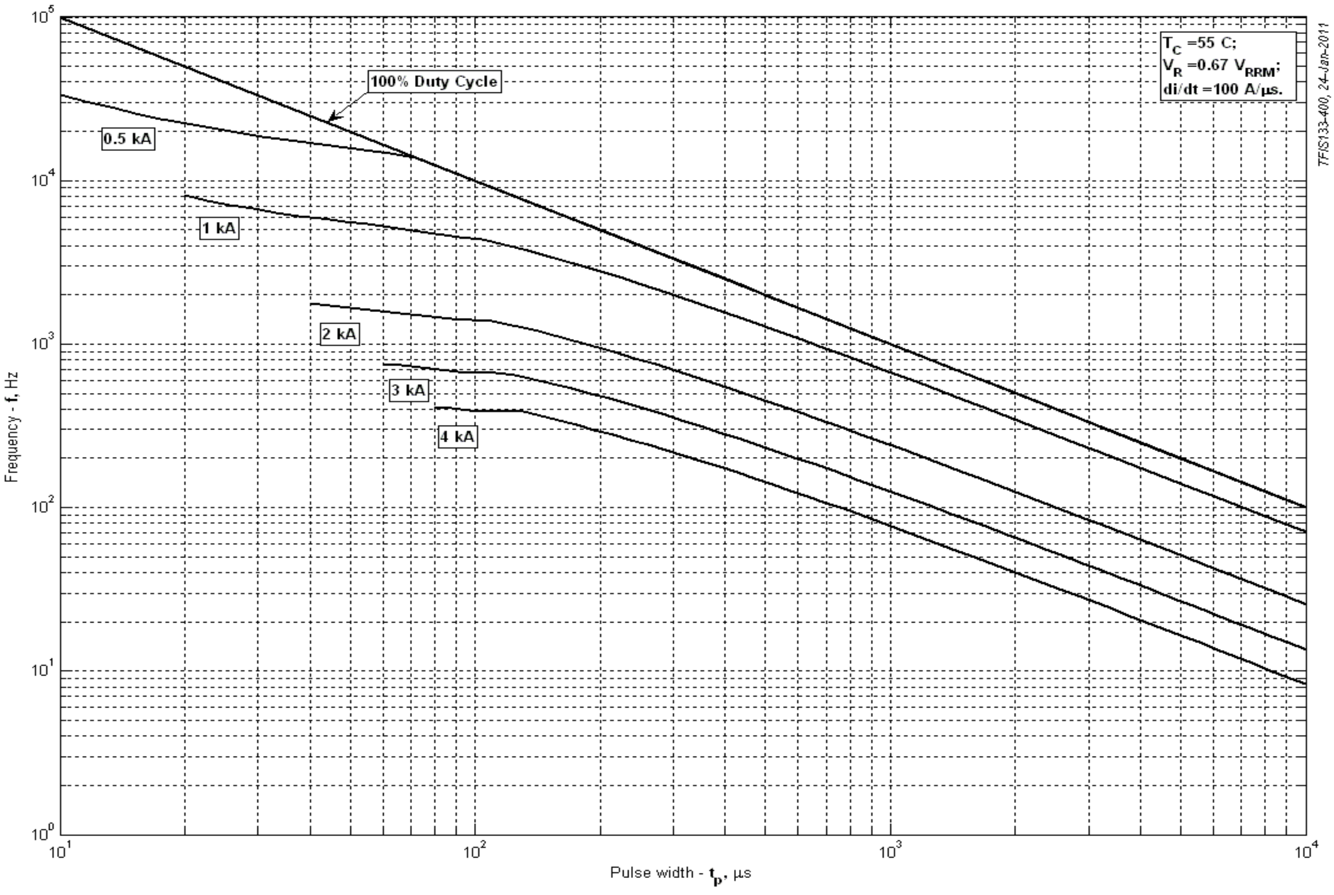


Fig 14 - Square wave frequency ratings

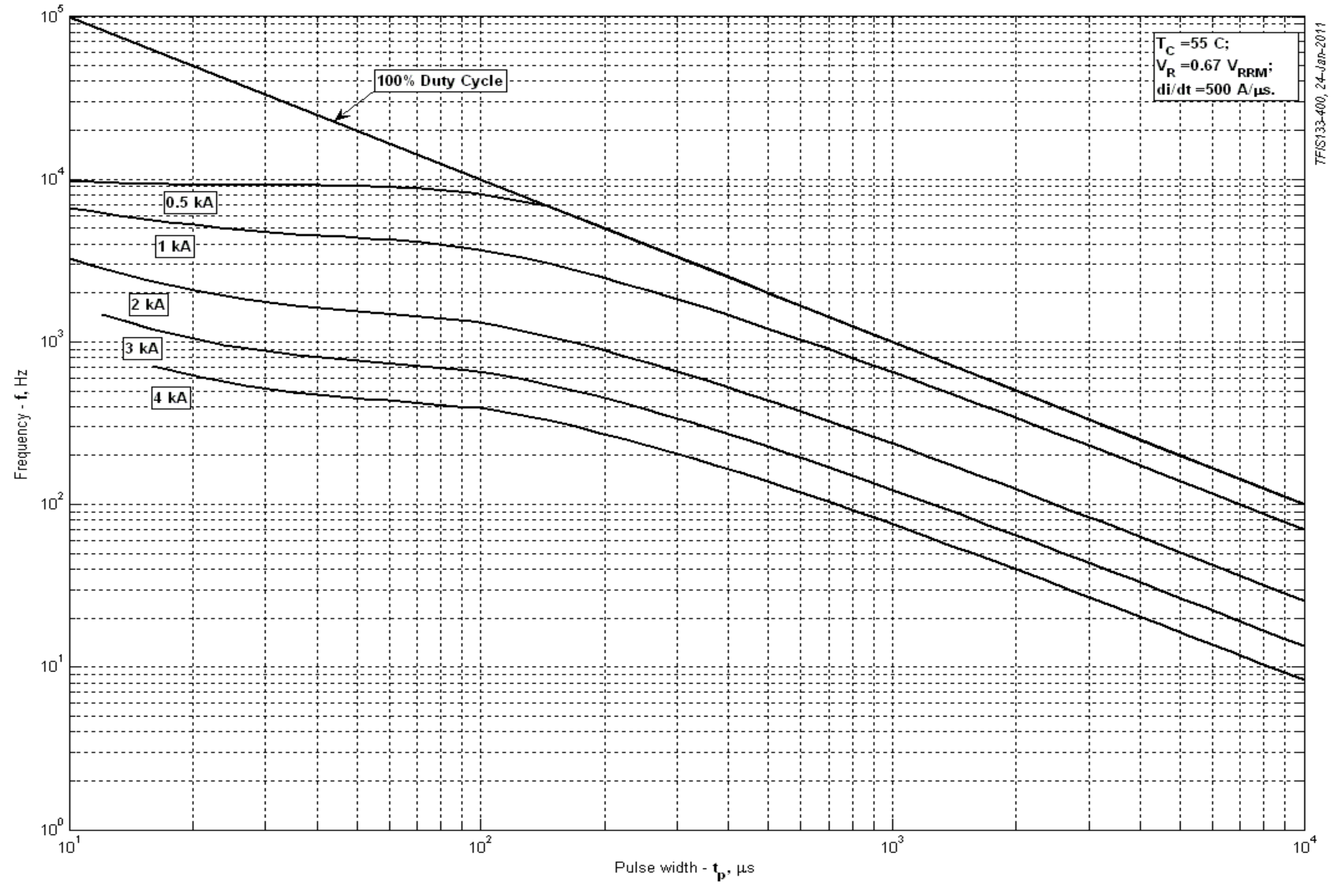


Fig 15 - Square wave frequency ratings

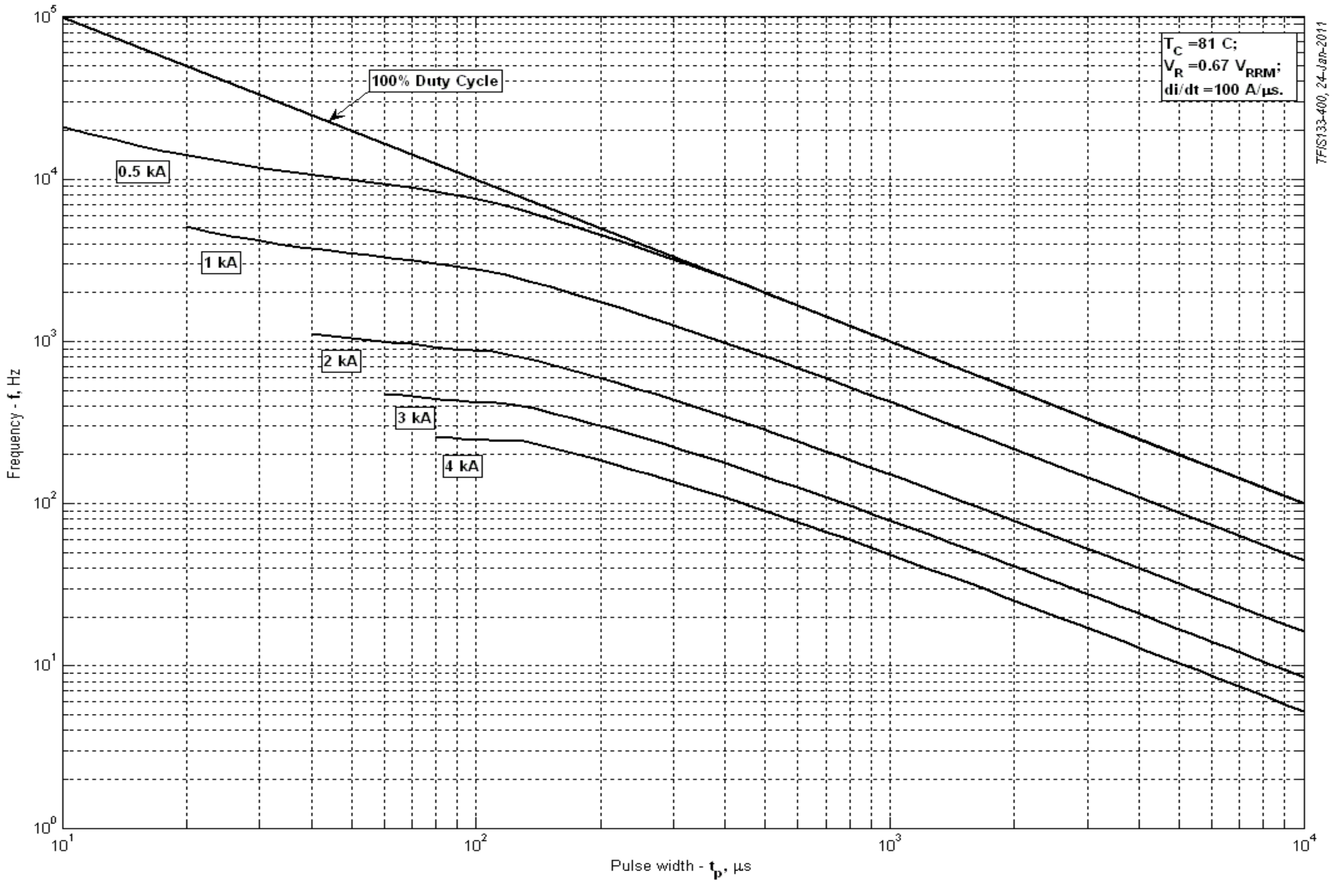


Fig 16 - Square wave frequency ratings

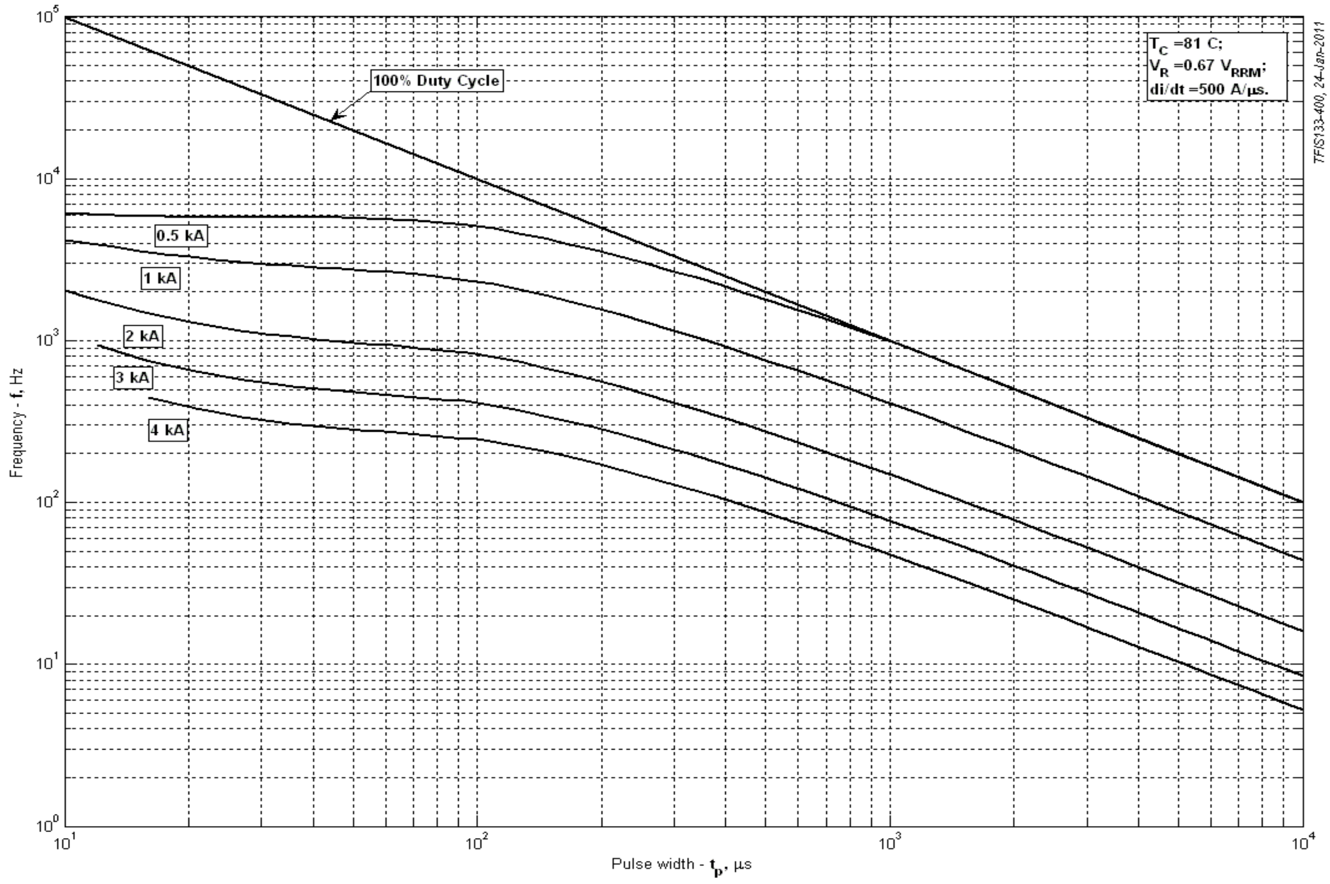


Fig 17 - Square wave frequency ratings

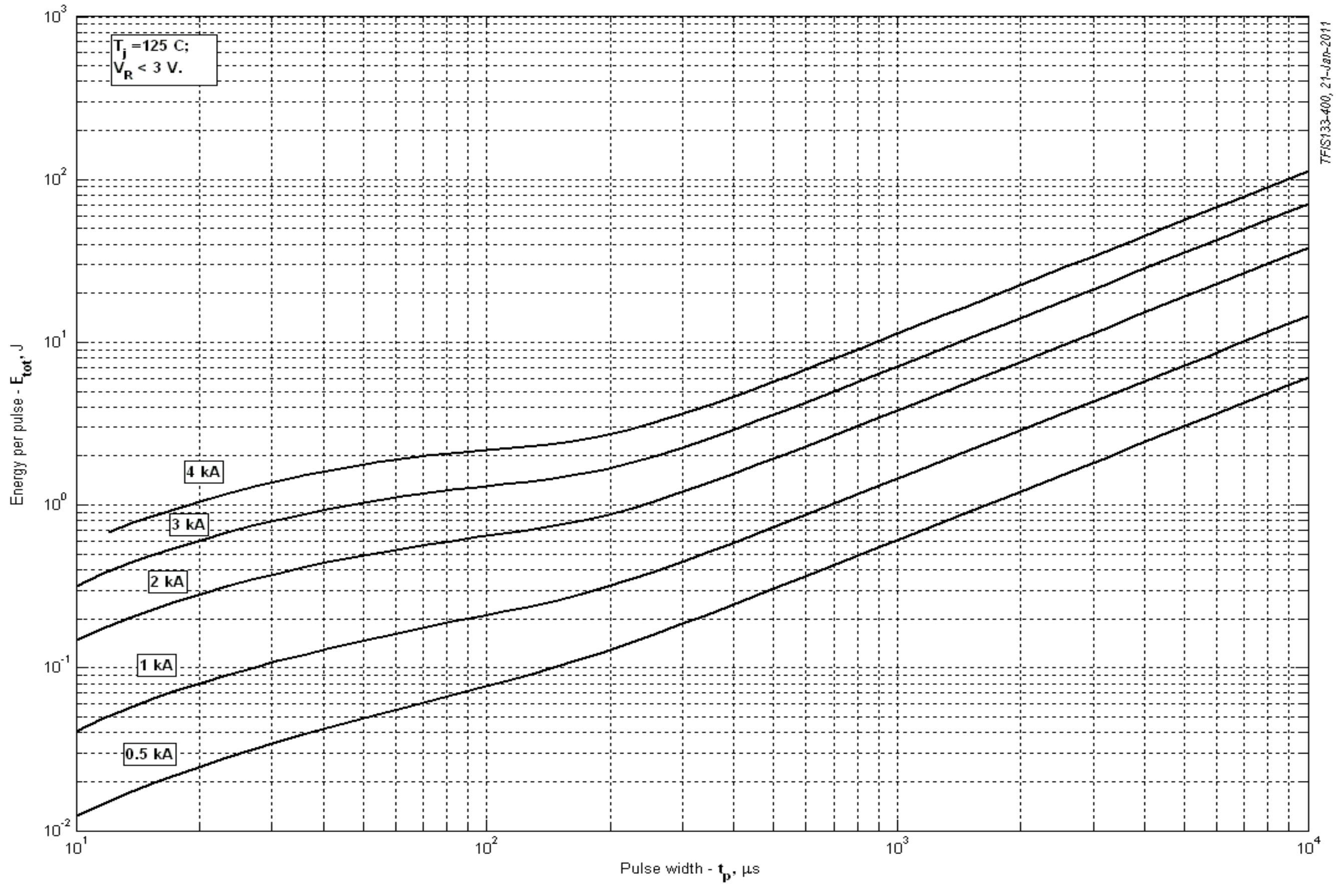


Fig 18 - Sine wave loss energy per pulse

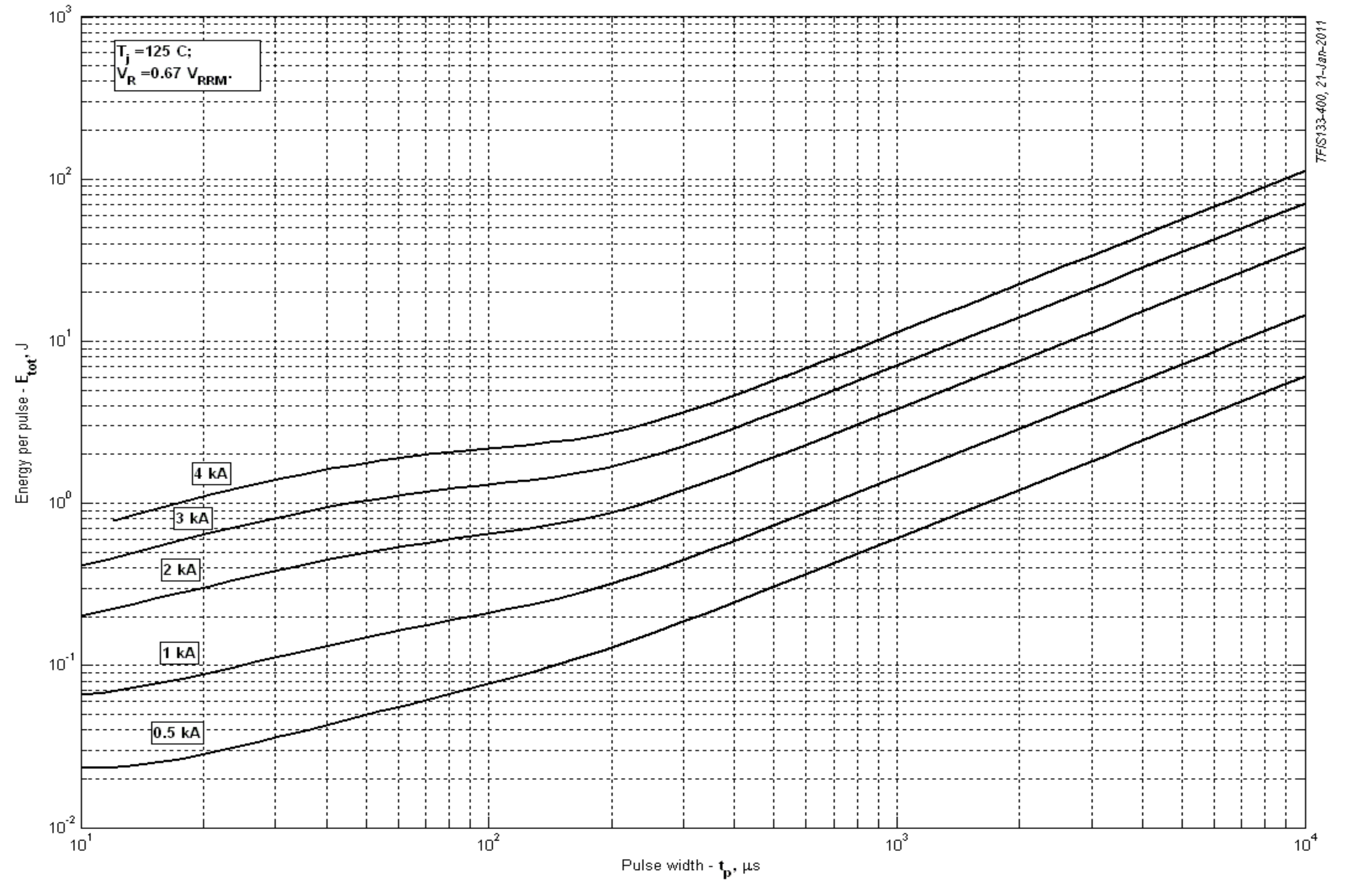


Fig 19 - Sine wave loss energy per pulse

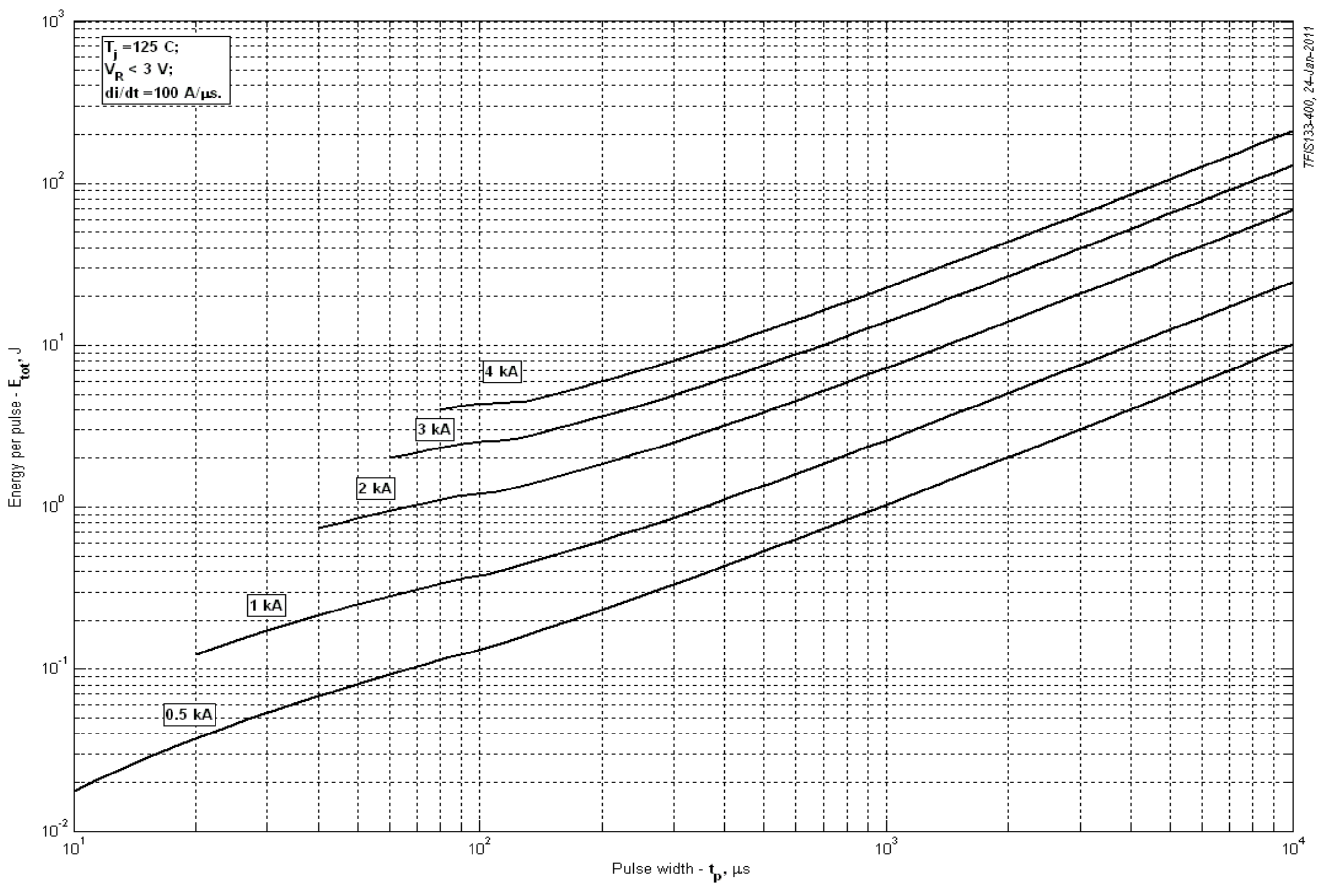


Fig 20 - Square wave loss energy per pulse

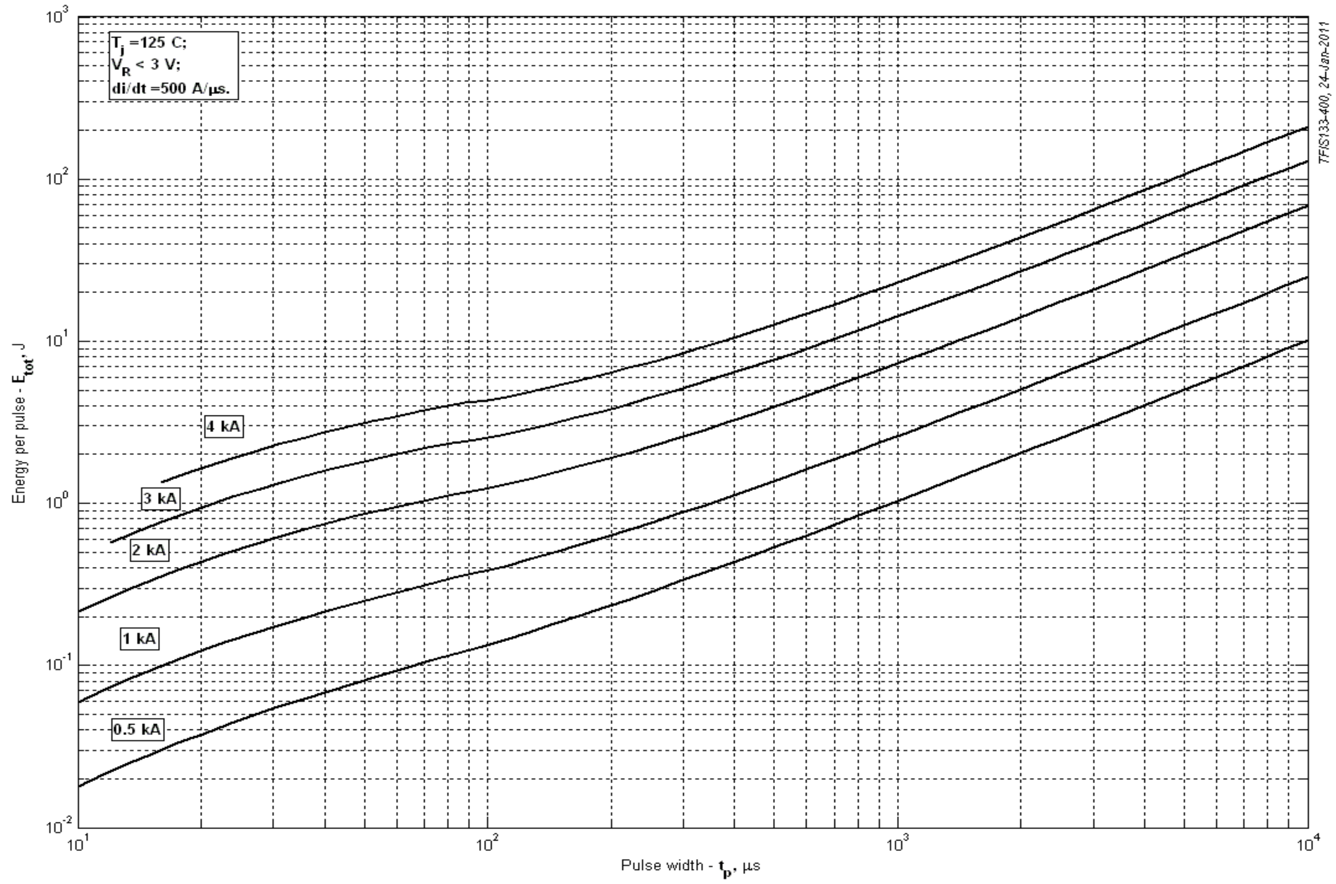


Fig 21 - Square wave loss energy per pulse

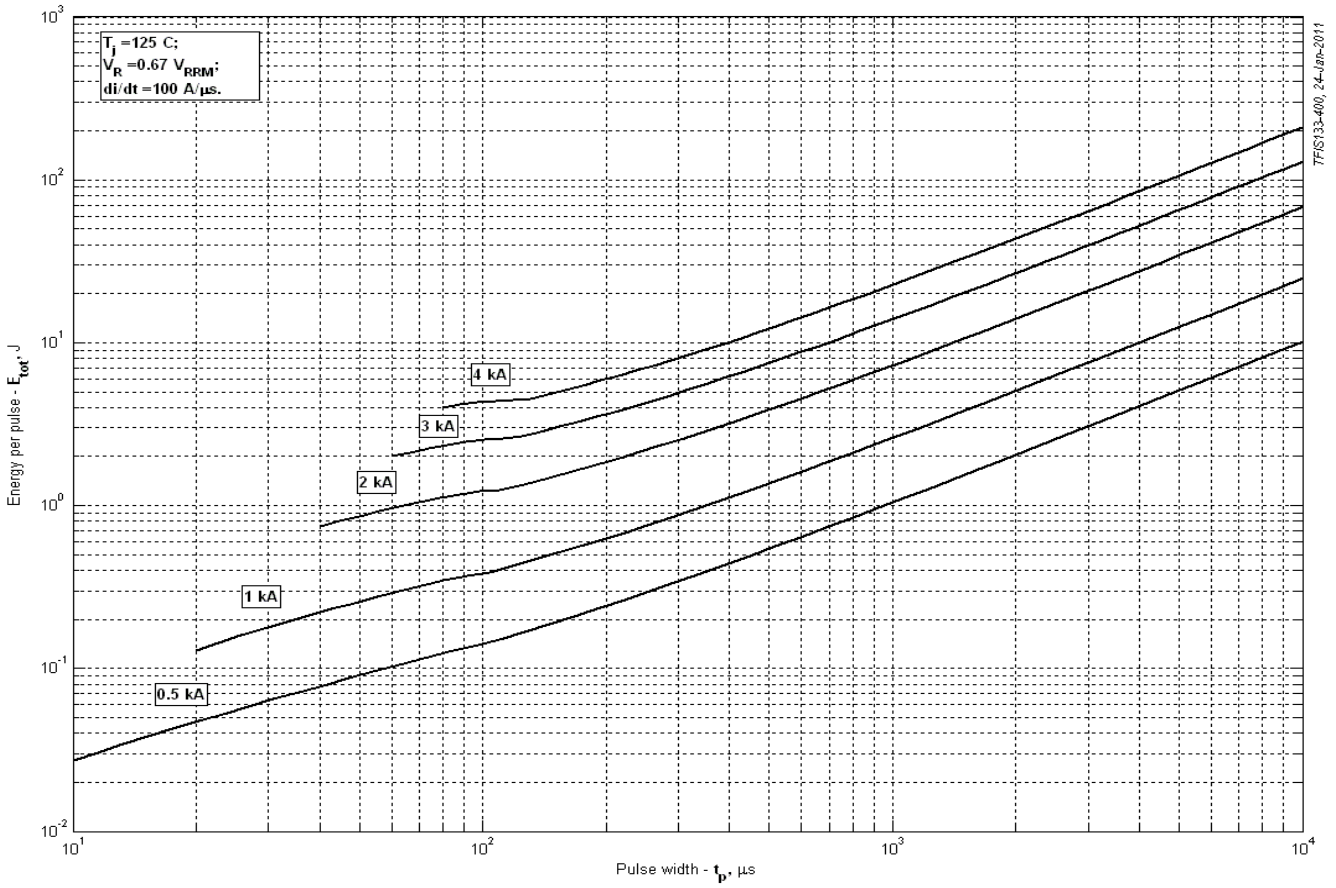


Fig 22 - Square wave loss energy per pulse

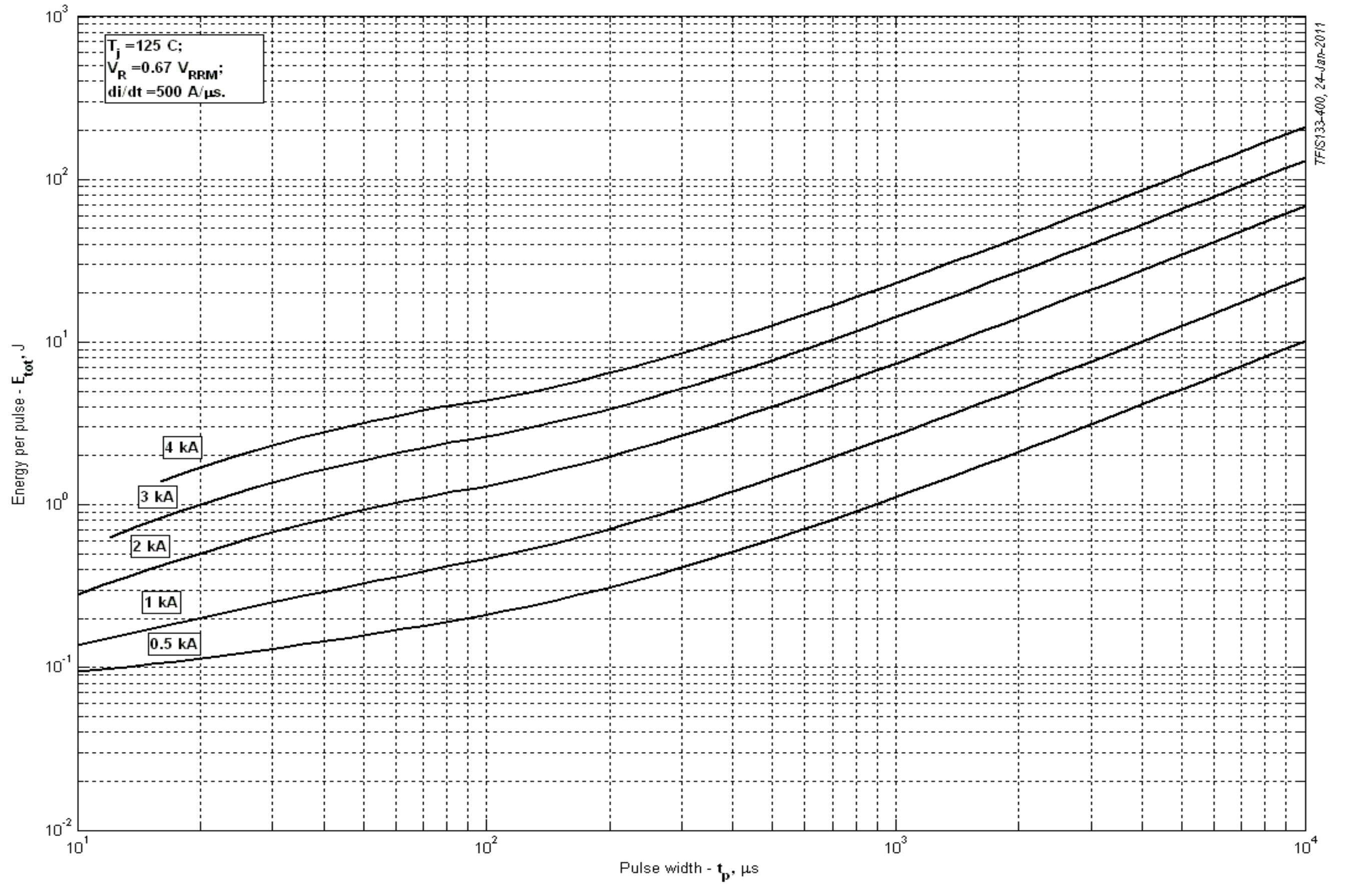


Fig 23 - Square wave loss energy per pulse

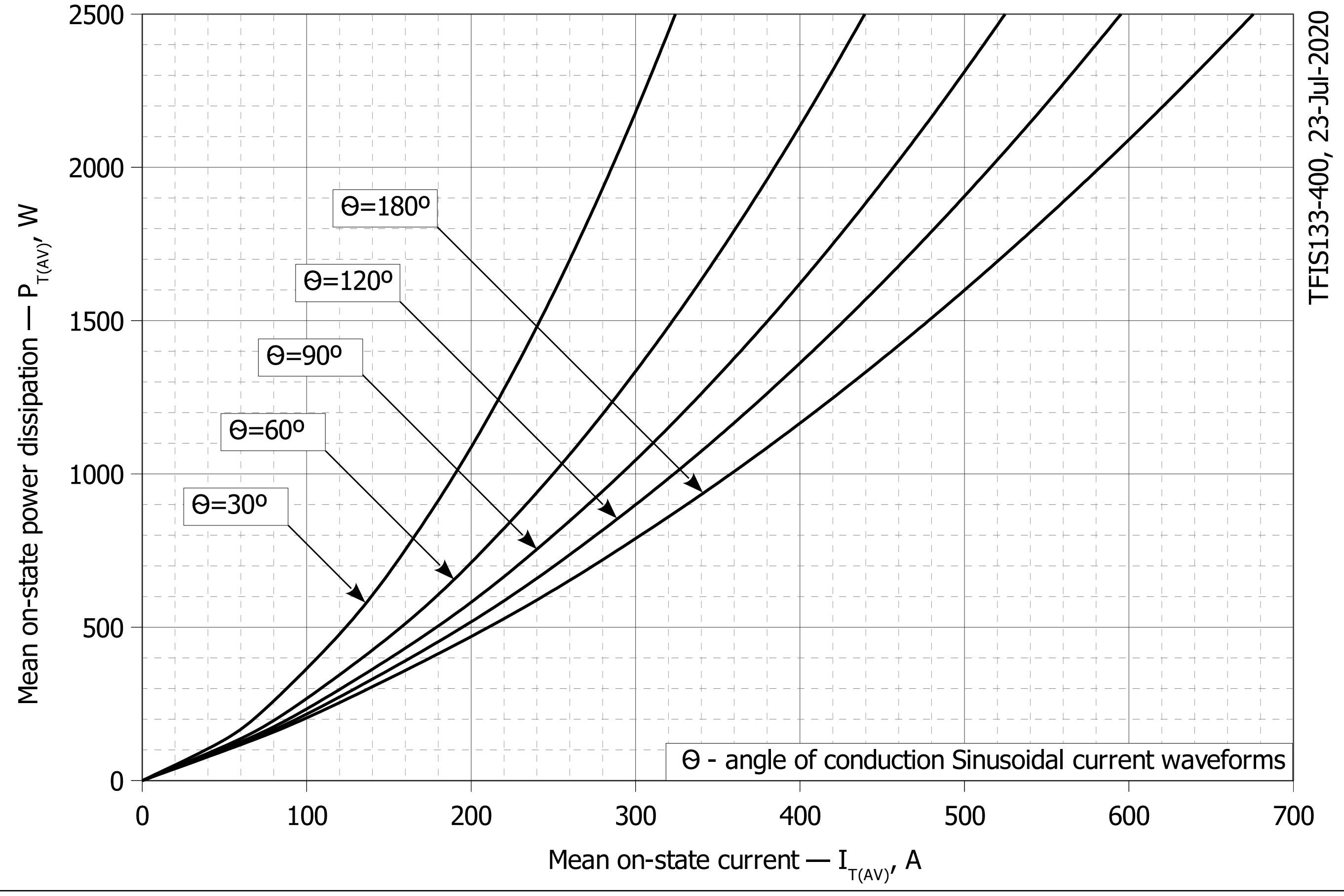


Fig. 24 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles (f=50Hz, DSC)

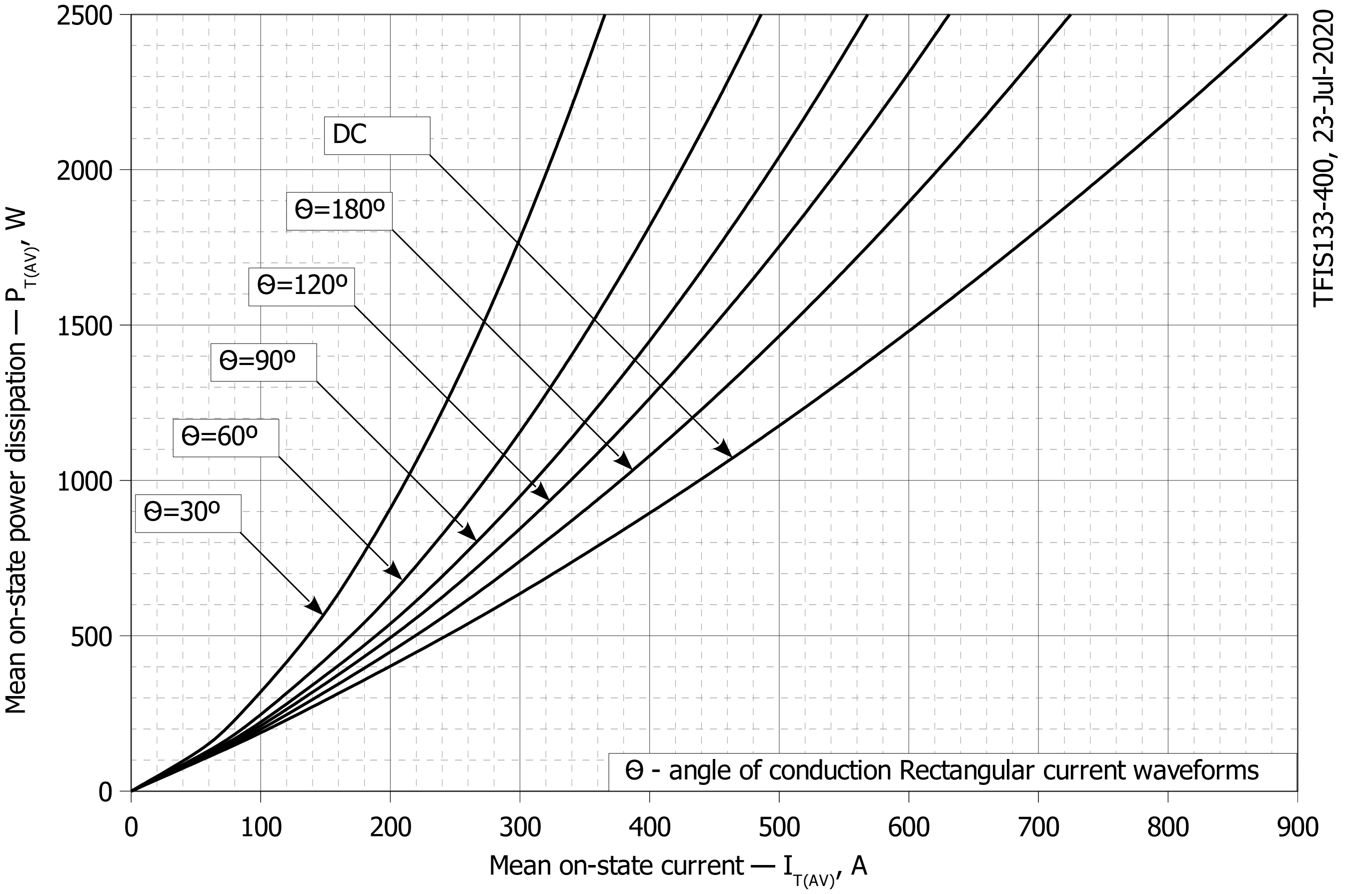


Fig. 25 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC (f=50Hz, DSC)

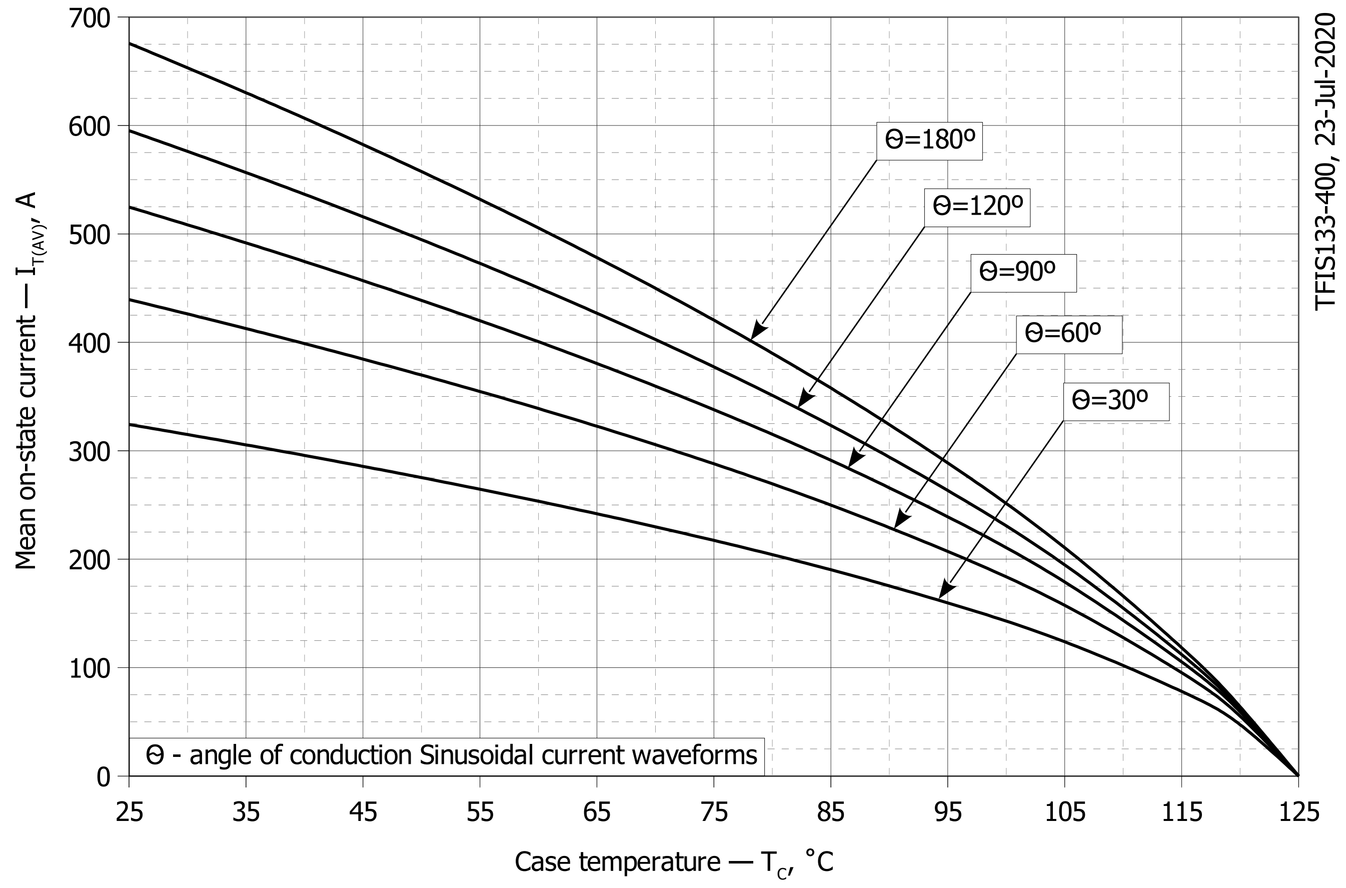


Fig. 26 – Mean on-state current I_{TAV} vs. case temperature T_C for sinusoidal current waveforms at different conduction angles (f=50Hz, DSC)

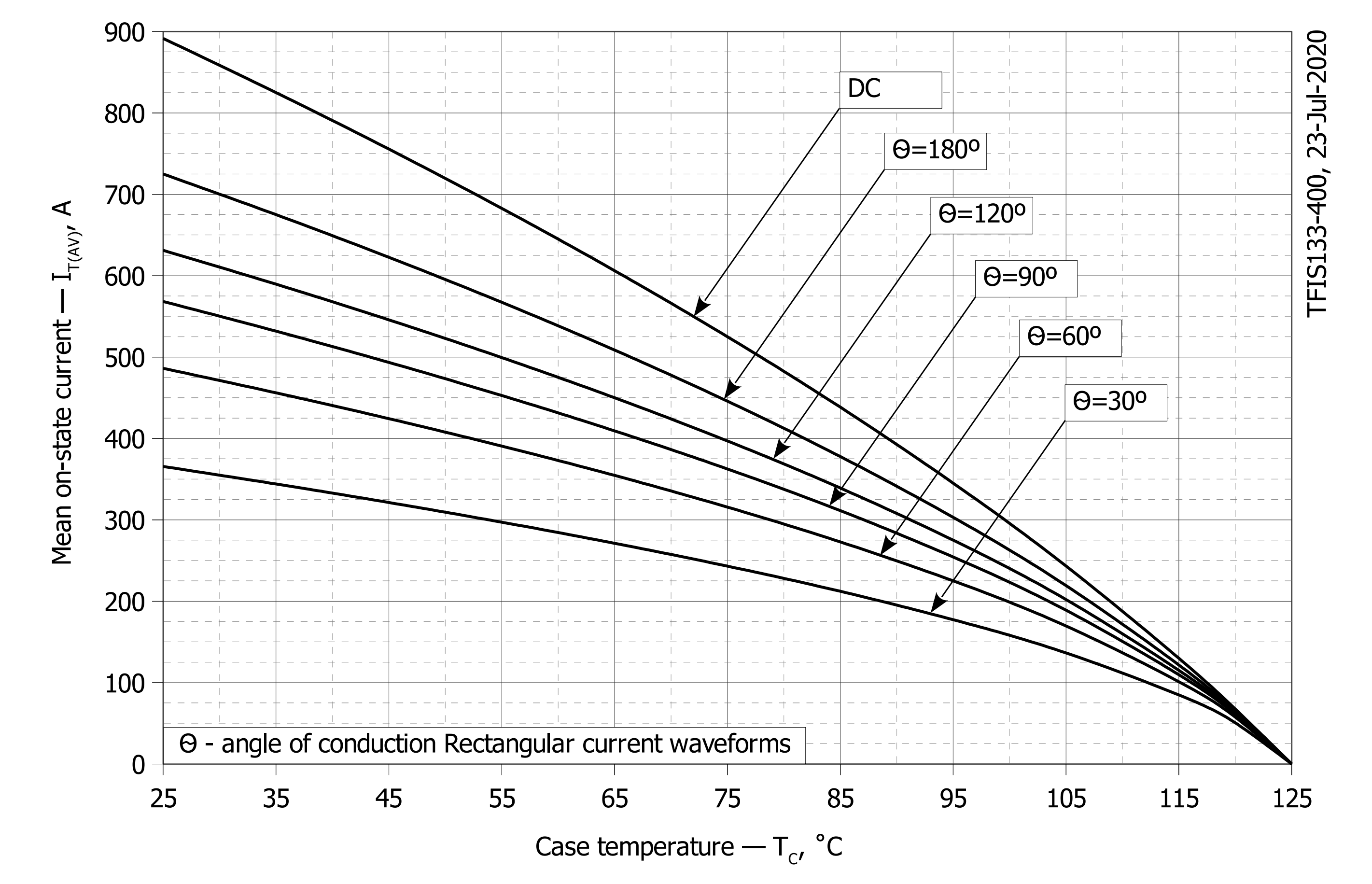


Fig. 27 - Mean on-state current I_{TAV} vs. case temperature T_C for rectangular current waveforms at different conduction angles and for DC (f=50Hz, DSC)

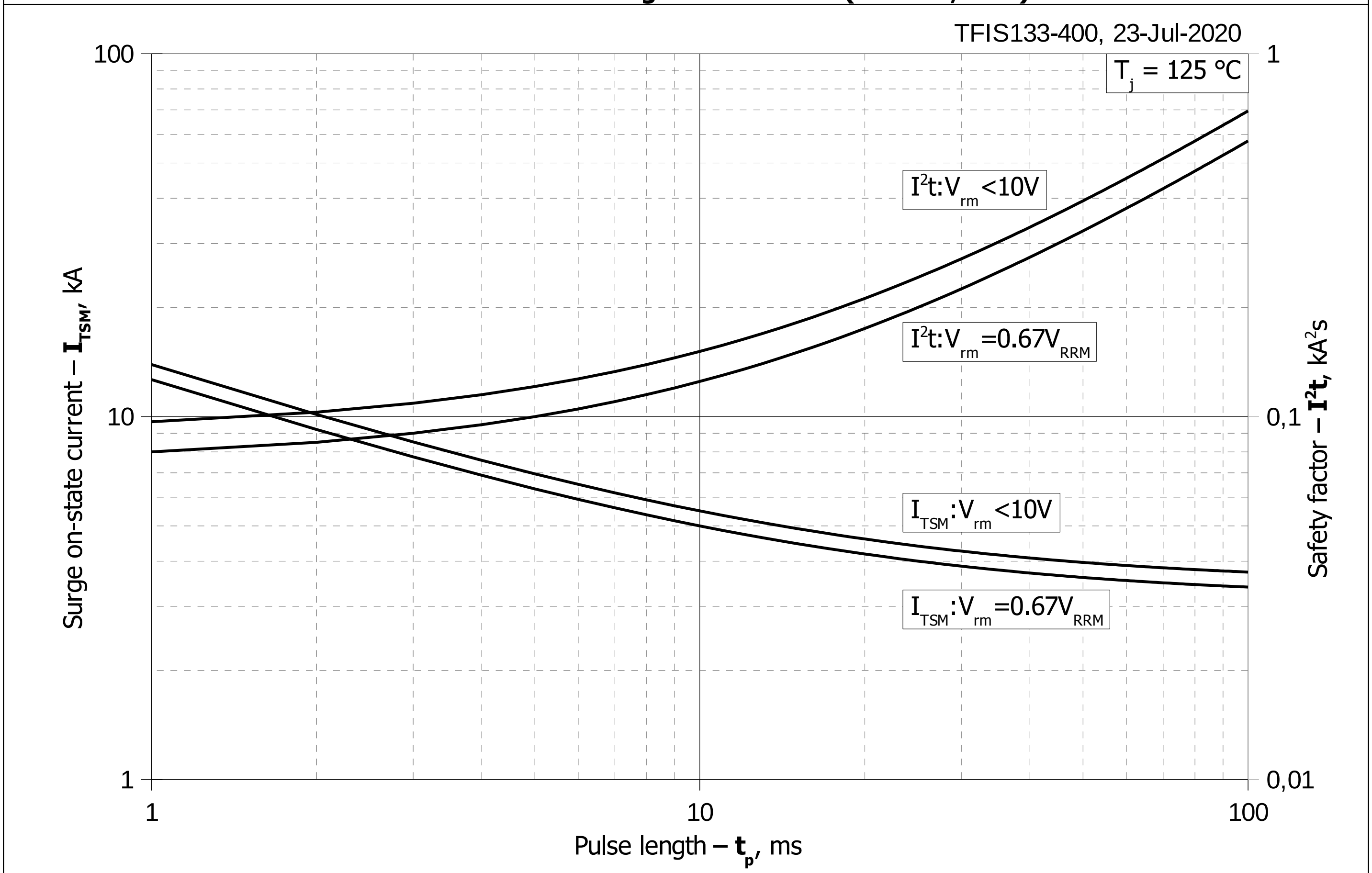


Fig. 28 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

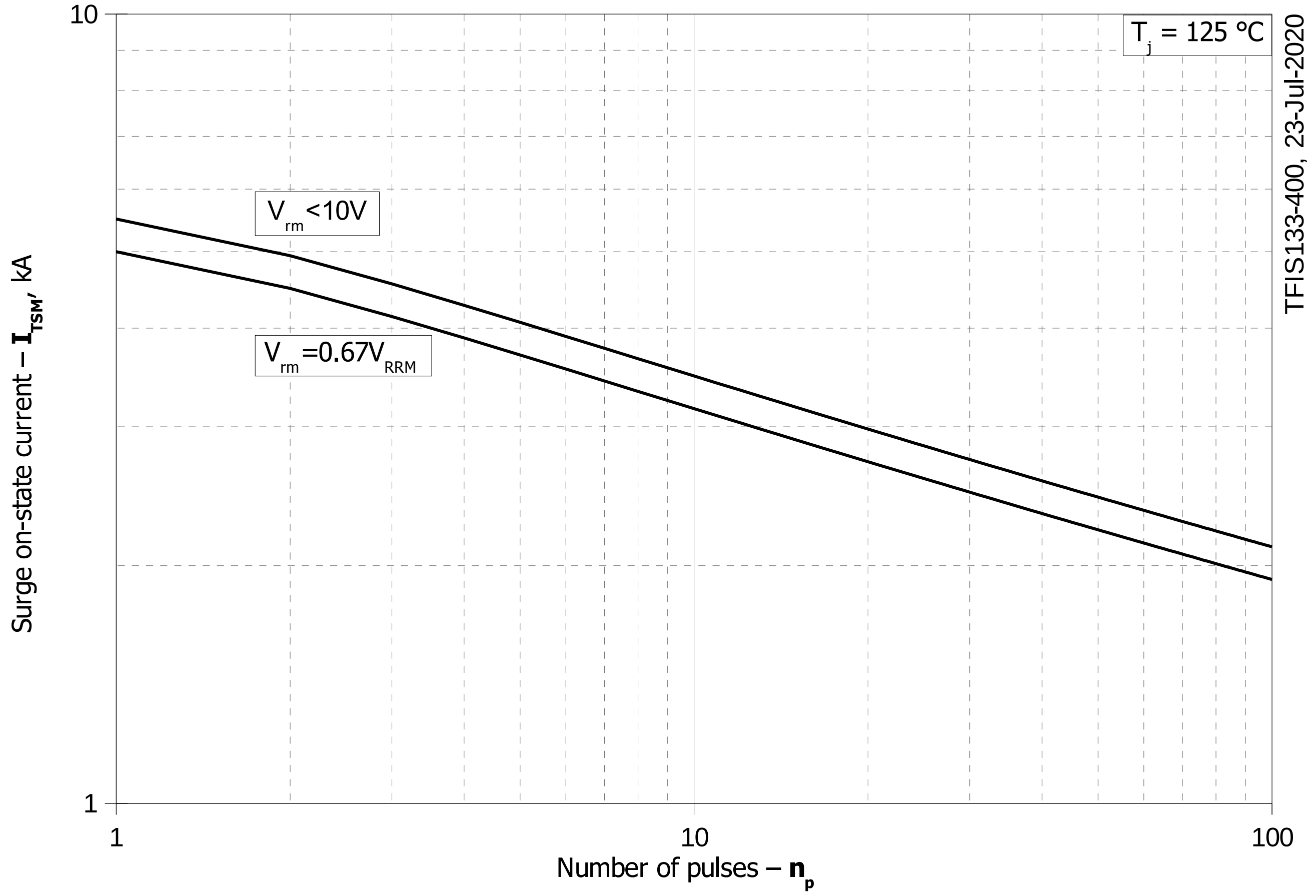


Fig. 29 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p