



High power cycling capability
Low on-state and switching losses
Designed for traction and industrial applications

Phase Control Thyristor Type T393-3600-36

Maximum allowable mean on-state current		I _{TAV}		3600 A	
Repetitive peak off-state voltage		V _{DRM}		3000...3600 V	
Repetitive peak reverse voltage		V _{RRM}			
Turn-off time		t _q		630 μs	
V _{DRM} , V _{RRM} , V	3000	3200	3400	3600	
Voltage code	30	32	34	36	
T _j , °C	-60...+125				

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	3600 4540	$T_c=86\text{ }^{\circ}\text{C}$, Double side cooled $T_c=70\text{ }^{\circ}\text{C}$, Double side cooled 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	5652	$T_c=86\text{ }^{\circ}\text{C}$, Double side cooled 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	72.0 83.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			76.0 87.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
I^2t	Safety factor	$A^2s\cdot 10^3$	25900 34400	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			23900 31400	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	3000...3600	$T_{j\text{ min}}<T_j<T_{j\text{ max}}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	3100...3700	$T_{j\text{ min}}<T_j<T_{j\text{ max}}$; 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	12	$T_j=T_{j\max}$	
V_{RGM}	Peak reverse gate voltage	V	5		
P_G	Gate power dissipation	W	5	$T_j=T_{j\max}$ for DC gate current	
SWITCHING					
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive (f=1 Hz)	A/ μ S	1000	$T_j=T_{j\max}$; $V_D=0.67\cdot V_{DRM}$; $I_{TM}=7200$ A; Gate pulse: $I_G=2$ A; $t_{GP}=50\ \mu$ S; $di_G/dt\geq 2$ A/ μ S	
THERMAL					
T_{stg}	Storage temperature	$^{\circ}$ C	−60...+50		
T_j	Operating junction temperature	$^{\circ}$ C	−60...+125		
MECHANICAL					
F	Mounting force	kN	70.0...90.0		
a	Acceleration	m/s ²	50	Device clamped	

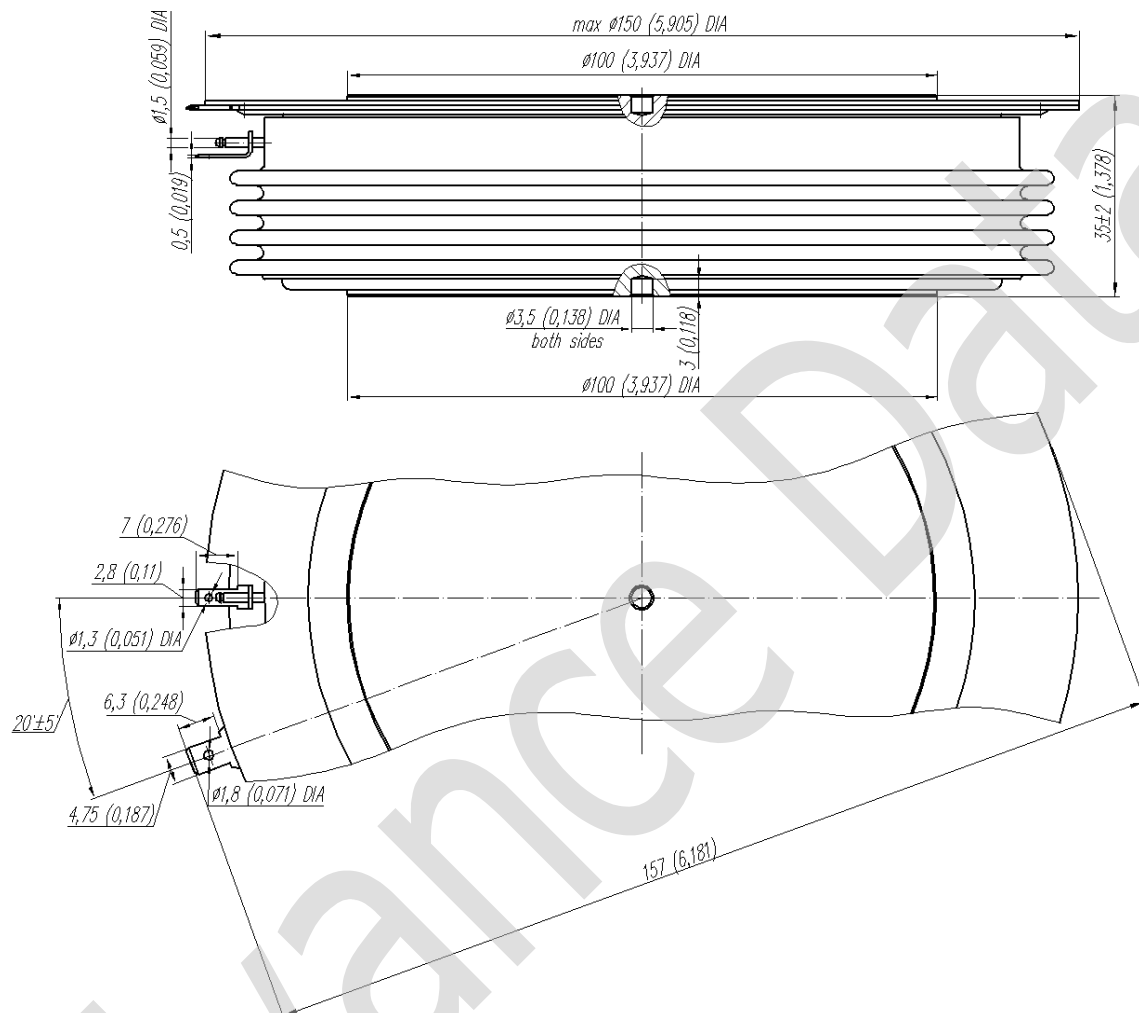
CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V_{TM}	Peak on-state voltage, max	V	1.70	$T_j=25\text{ }^{\circ}\text{C}$; $I_{TM}=6300\text{ A}$	
$V_{T(TO)}$	On-state threshold voltage, max	V	0.90	$T_j=T_{j\text{ max}}$;	
r_T	On-state slope resistance, max	mΩ	0.110	$0.5\pi I_{TAV} < I_T < 1.5\pi I_{TAV}$	
I_L	Latching current, max	mA	1500	$T_j=25\text{ }^{\circ}\text{C}$; $V_D=12\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$	
I_H	Holding current, max	mA	300	$T_j=25\text{ }^{\circ}\text{C}$; $V_D=12\text{ V}$; Gate open	
BLOCKING					
I_{DRM}, I_{RRM}	Repetitive peak off-state and Repetitive peak reverse currents, max	mA	300	$T_j=T_{j\text{ max}}$; $V_D=V_{DRM}$; $V_R=V_{RRM}$	
$(dv_D/dt)_{crit}$	Critical rate of rise of off-state voltage ¹⁾ , min	V/μs	500, 1000, 1600	$T_j=T_{j\text{ max}}$; $V_D=0.67\cdot V_{DRM}$; Gate open	
TRIGGERING					
V_{GT}	Gate trigger direct voltage, max	V	5.00 3.00 2.00	$T_j= T_{j\text{ min}}$ $T_j=25\text{ }^{\circ}\text{C}$ $T_j= T_{j\text{ max}}$	$V_D=12\text{ V}$; $I_D=3\text{ A}$; Direct gate current
I_{GT}	Gate trigger direct current, max	mA	500 300 200	$T_j= T_{j\text{ min}}$ $T_j= 25\text{ }^{\circ}\text{C}$ $T_j= T_{j\text{ max}}$	
V_{GD}	Gate non-trigger direct voltage, min	V	0.35	$T_j=T_{j\text{ max}}$; $V_D=0.67\cdot V_{DRM}$;	
I_{GD}	Gate non-trigger direct current, min	mA	15.00	Direct gate current	
SWITCHING					
t_{gd}	Delay time, max	μs	3.00	$T_j=25\text{ }^{\circ}\text{C}$; $V_D=1500\text{ V}$; $I_{TM}=I_{TAV}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 2\text{ A}/\mu\text{s}$	
t_q	Turn-off time ²⁾ , max	μs	630	$dv_D/dt=50\text{ V}/\mu\text{s}$; $T_j=T_{j\text{ max}}$; $I_{TM}=I_{TAV}$; $di_R/dt=-10\text{ A}/\mu\text{s}$; $V_R=100\text{ V}$; $V_D=0.67\text{ }V_{DRM}$	
Q_{rr}	Recovered charge, max	μC	7000	$T_j=T_{j\text{ max}}$; $I_{TM}=1000\text{ A}$;	
t_{rr}	Reverse recovery time, max	μs	68	$di_R/dt=-5\text{ A}/\mu\text{s}$;	
I_{rr}	Reverse recovery current, max	A	205	$V_R=100\text{ V}$	

THERMAL					
R _{thjc}	Thermal resistance, junction to case, max	°C/W	0.0057	Direct current	Double side cooled
R _{thjc-A}			0.0125		Anode side cooled
R _{thjc-K}			0.0103		Cathode side cooled
R _{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0010	Direct current	
MECHANICAL					
m	Weight, max	g	2720		
D _s	Surface creepage distance	mm (inch)	62.09 (2.444)		
D _a	Air strike distance	mm (inch)	23.40 (0.921)		

PART NUMBERING GUIDE						
T	393	3600	36	A2	C2	N
1	2	3	4	5	6	7
1. Phase Control Thyristor						
2. Design version						
3. Mean on-state current, A						
4. Voltage code						
5. Critical rate of rise of off-state voltage, V/μs						
6. Turn-off time (dv _D /dt=50 V/μs)						
7. Ambient conditions: N – normal; T – tropical						

NOTES			
1) Critical rate of rise of off-state voltage			
Symbol of Group	E2	A2	T1
(dv _D /dt) _{crit} , V/μs	500	1000	1600
2) Turn-off time (dv _D /dt=50 V/μs)			
Symbol of Group	C2		
t _q , μs	630		



All dimensions in millimeters (inches)

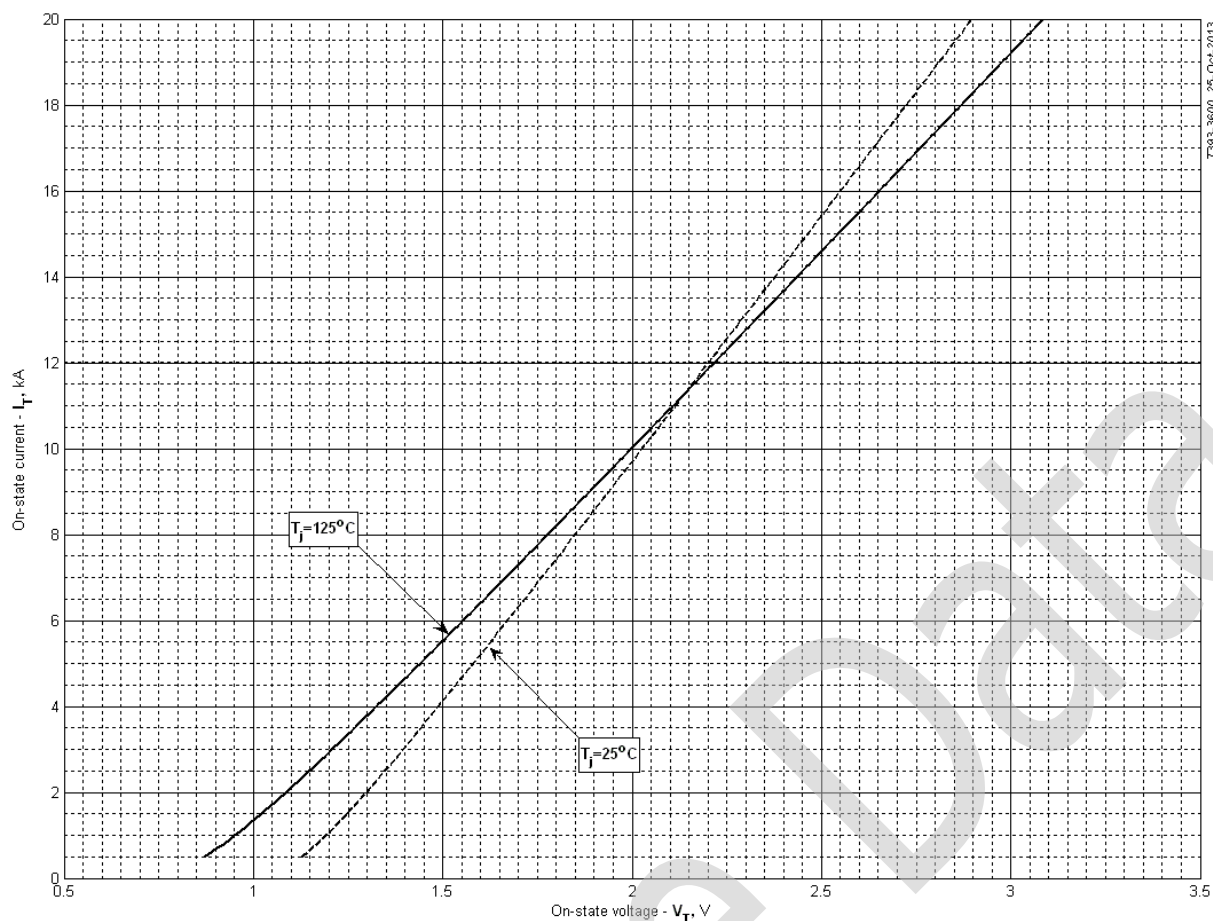


Fig 1 – On-state characteristics of Limit device

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	0.852713	1.112428
B	0.116208	0.092643
C	0.193655	0.144998
D	-0.152139	-0.113913

On-state characteristic model (see Fig. 1)

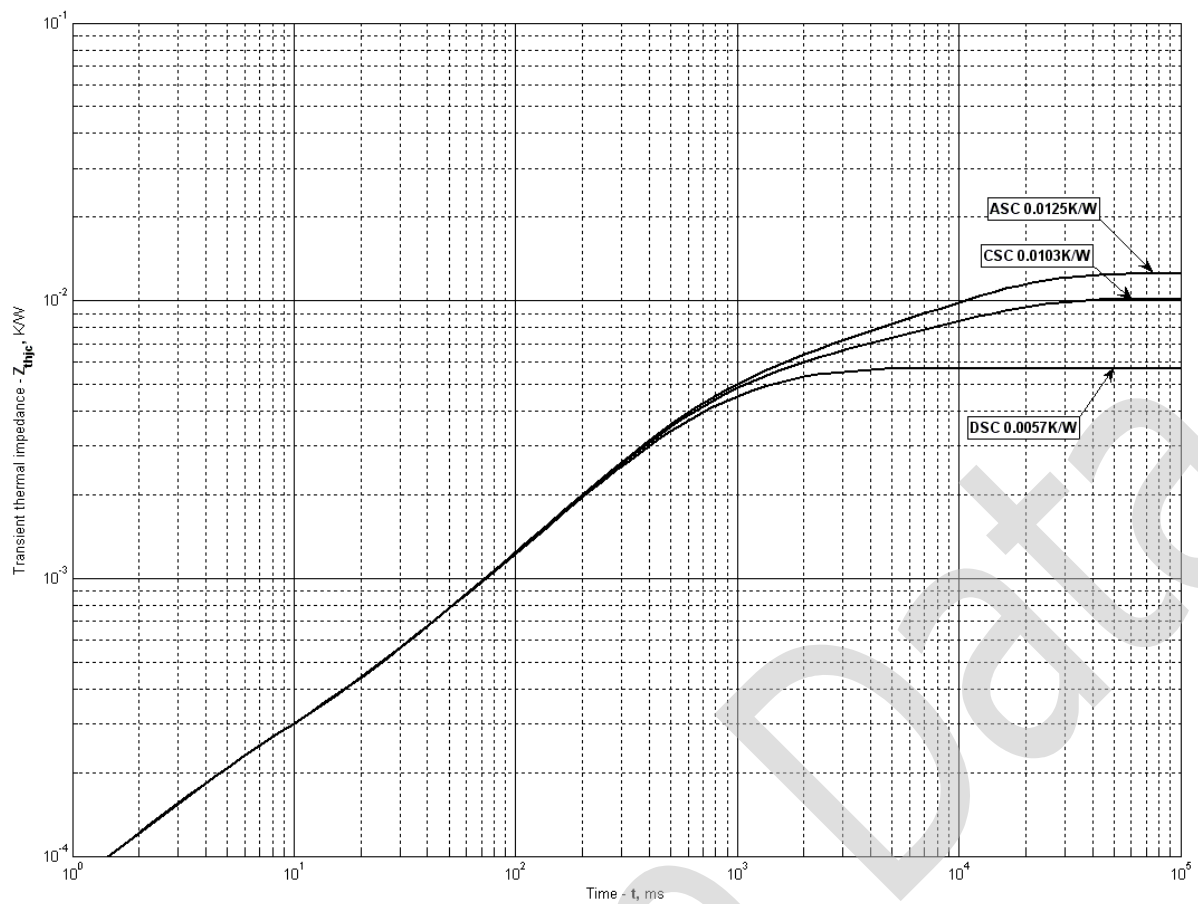


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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.

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
$R_i, K/W$	0.002457	-0.003548	0.002909	0.0002069	3.51e-005	0.00364
τ_i, s	1.062	0.005022	0.3787	0.0257	0.0003732	0.004916

DC Cathode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.004458	0.002601	0.002763	0.0001806	0.0001224	3.094e-005
τ_i, s	1.06	1.100	0.3794	0.0291	0.003057	0.0003374

DC Anode side cooled

i	1	2	3	4	5	6
$R_i, K/W$	0.006812	0.002637	0.002729	0.0001806	0.000122	3.069e-005
τ_i, s	1.06	1.131	0.3835	0.02886	0.003033	0.0003349

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

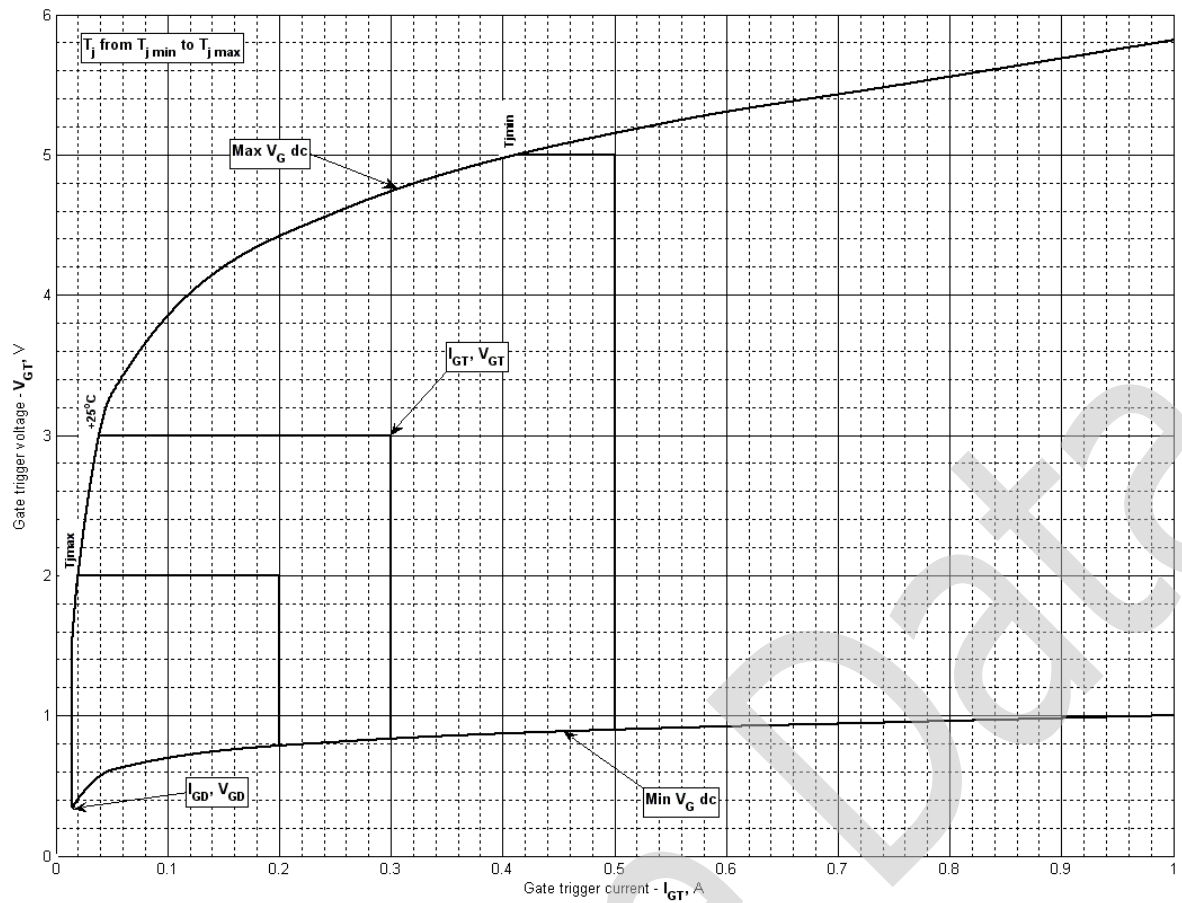


Fig 3 – Gate characteristics – Trigger limits

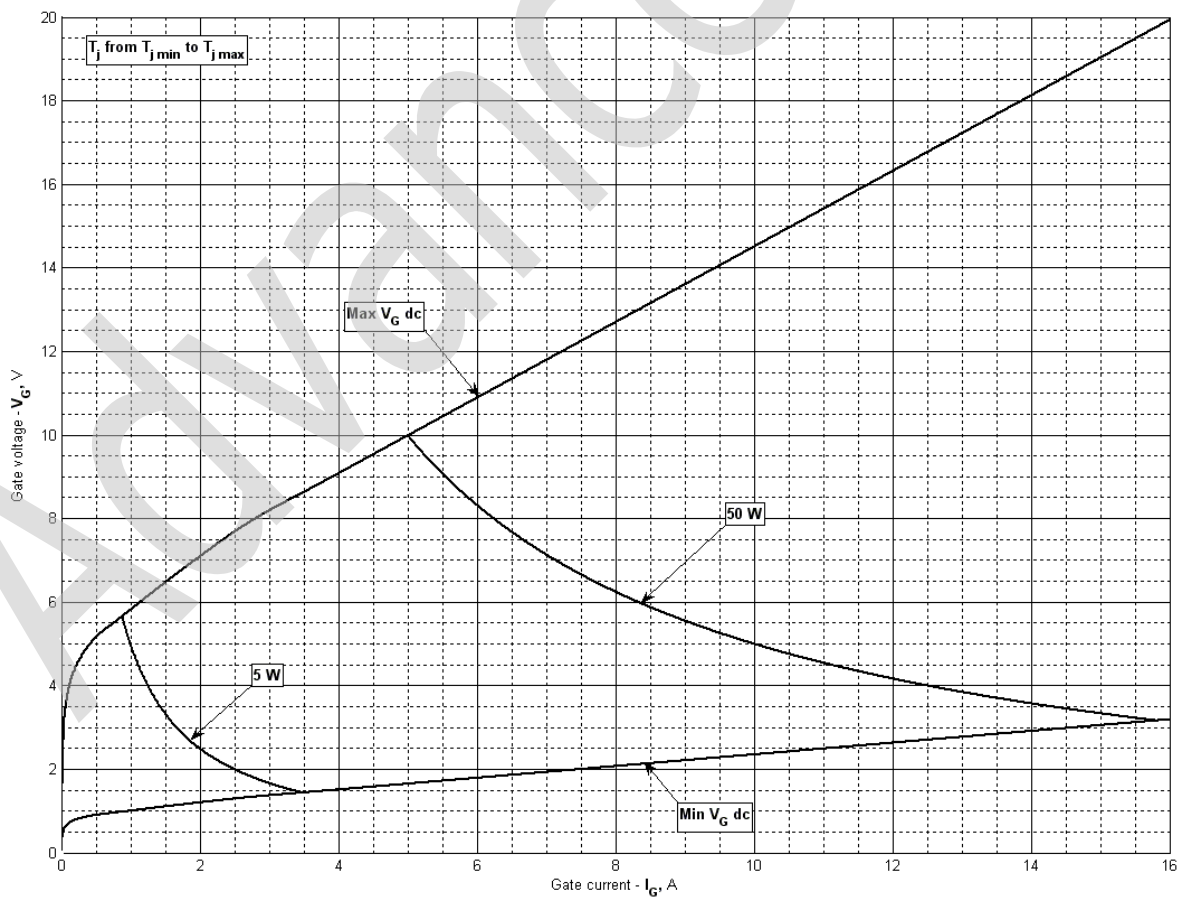


Fig 4 - Gate characteristics – Power curves

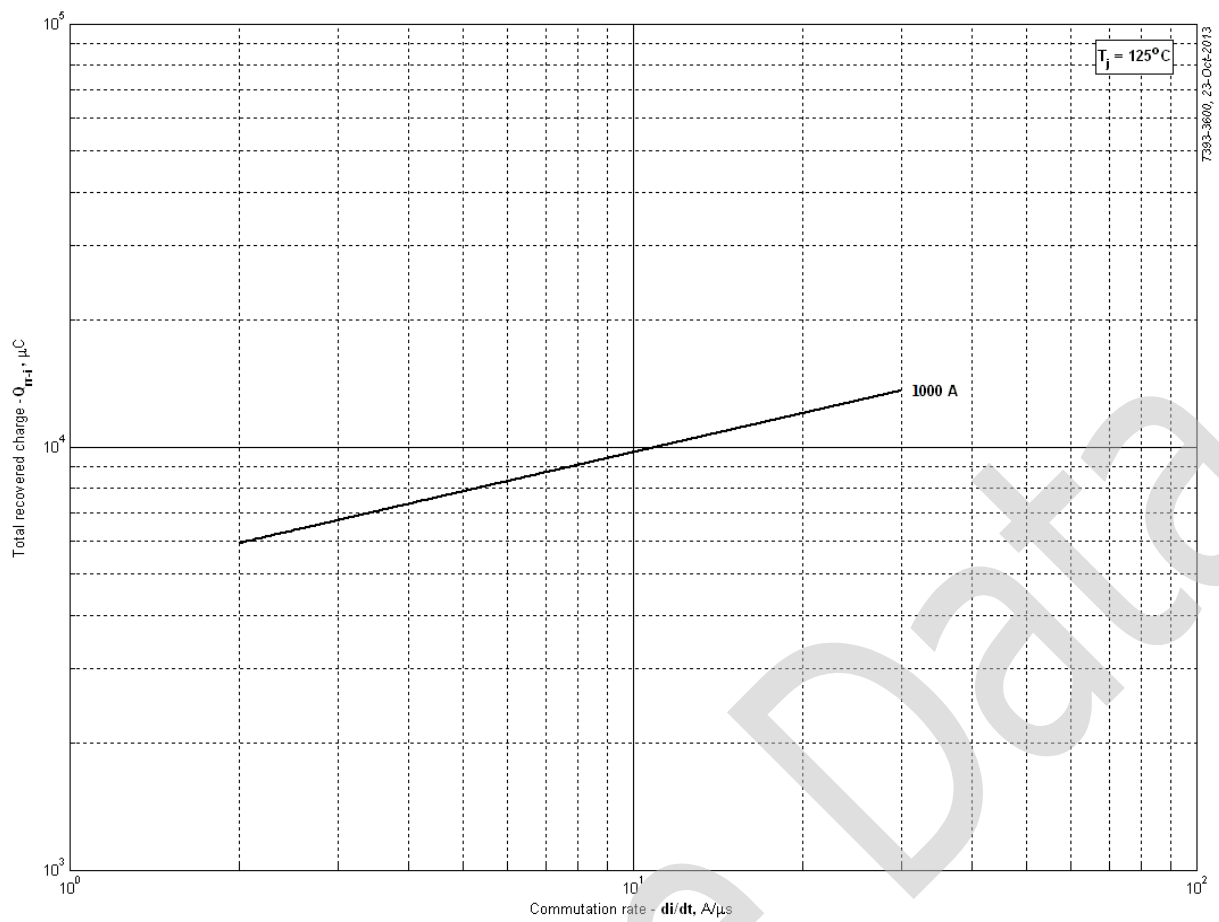


Fig 5 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

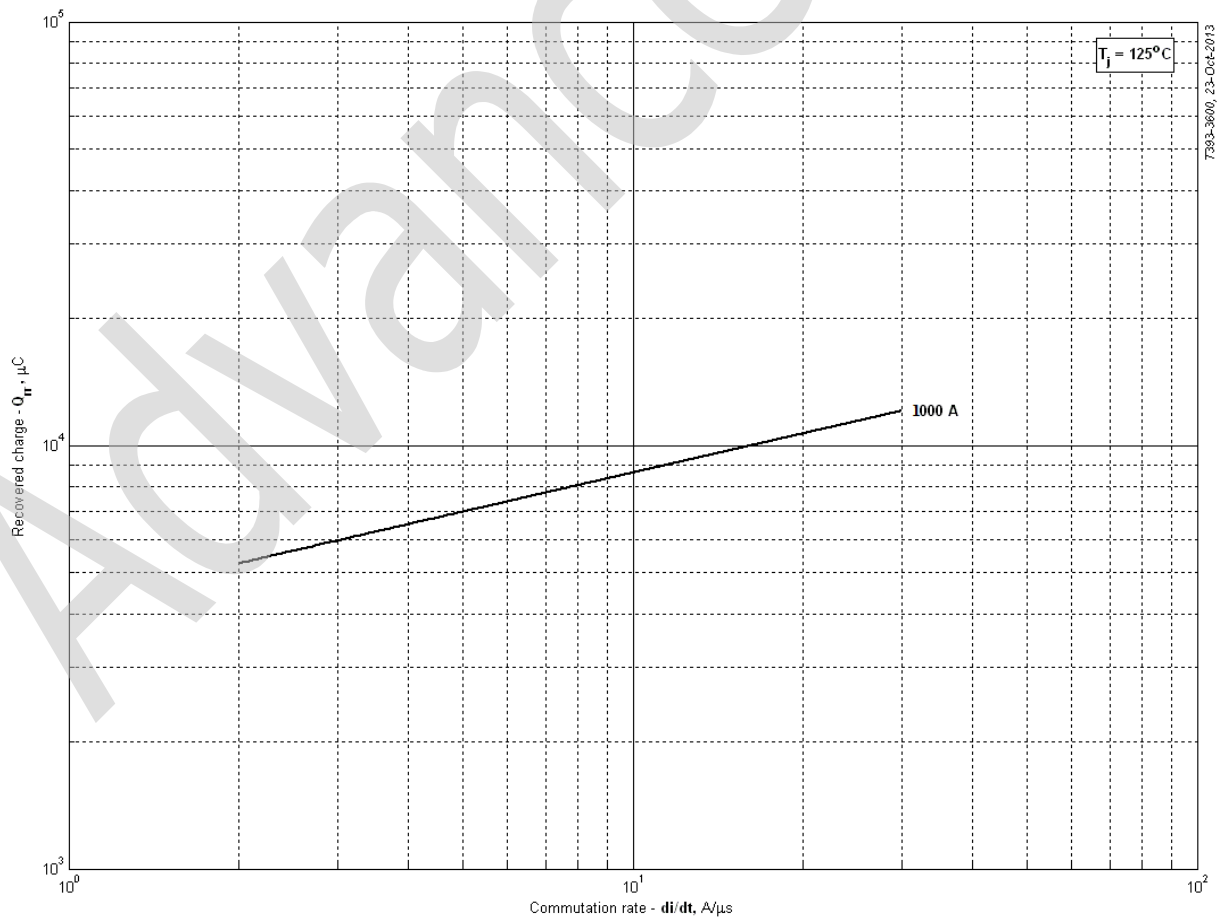


Fig 6 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

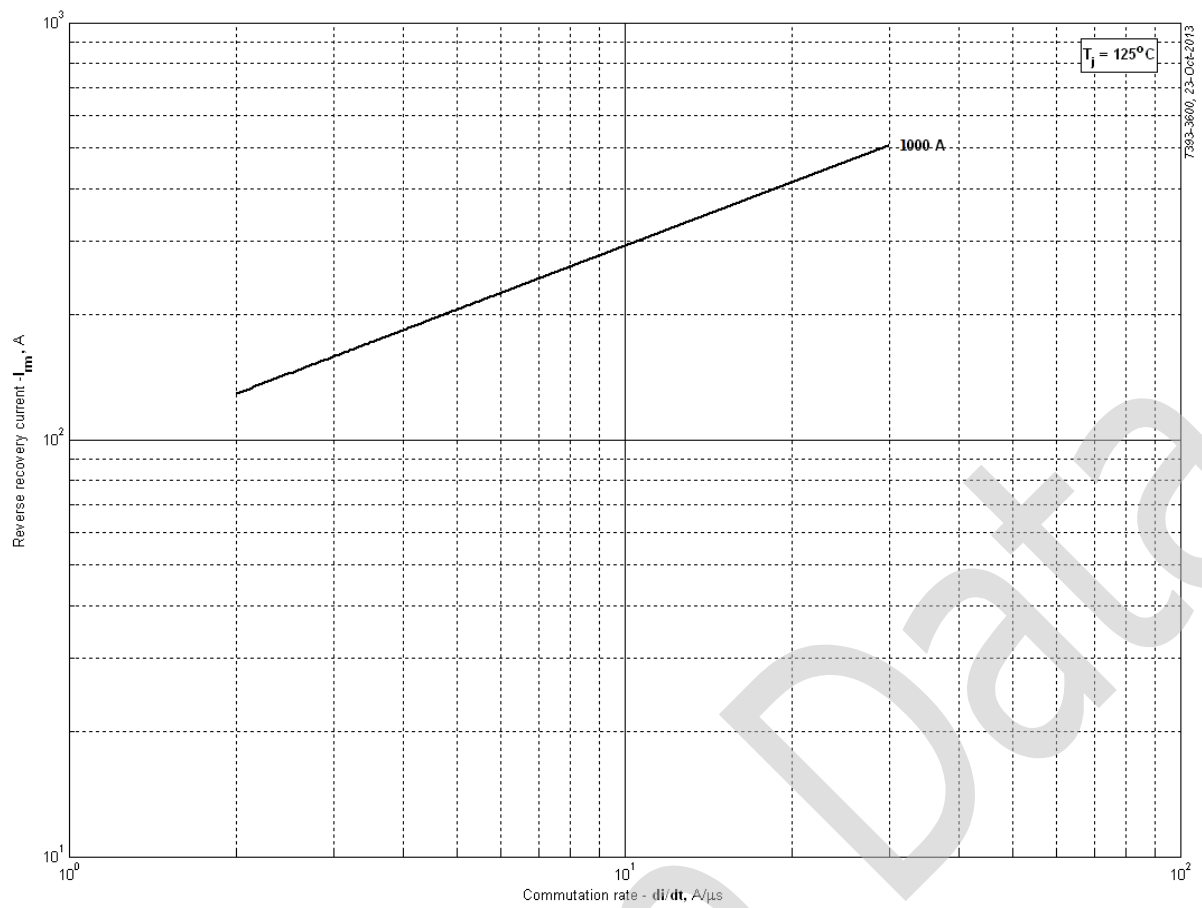


Fig 7 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

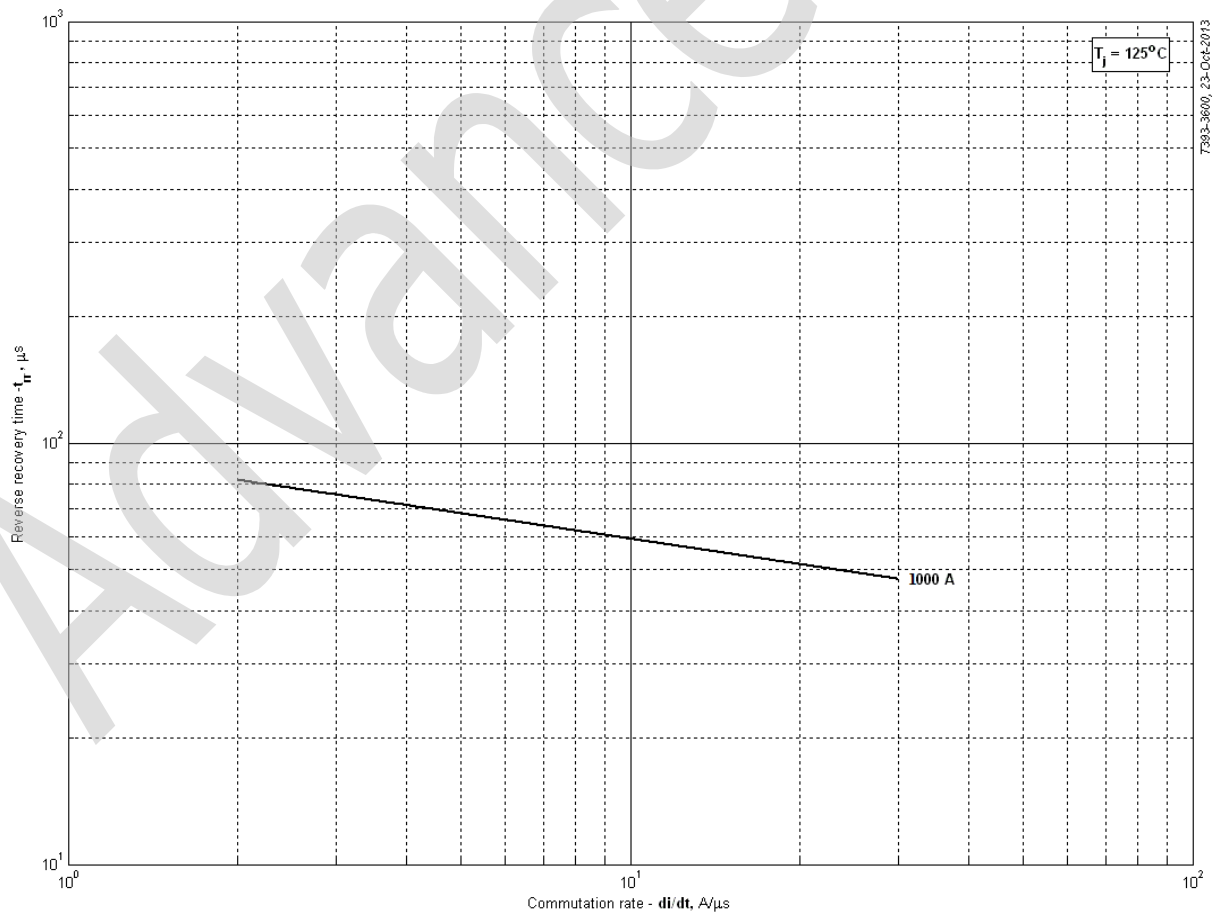


Fig 8 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

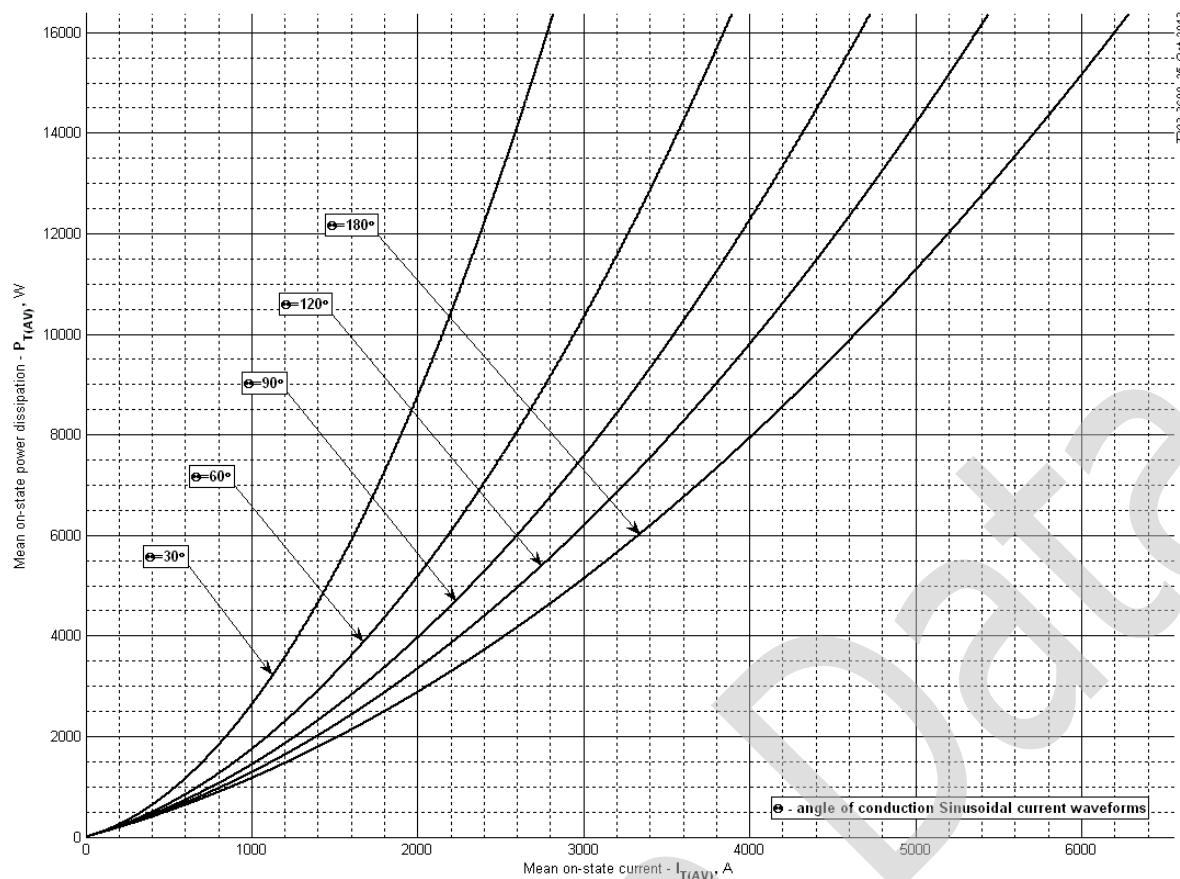


Fig. 9 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

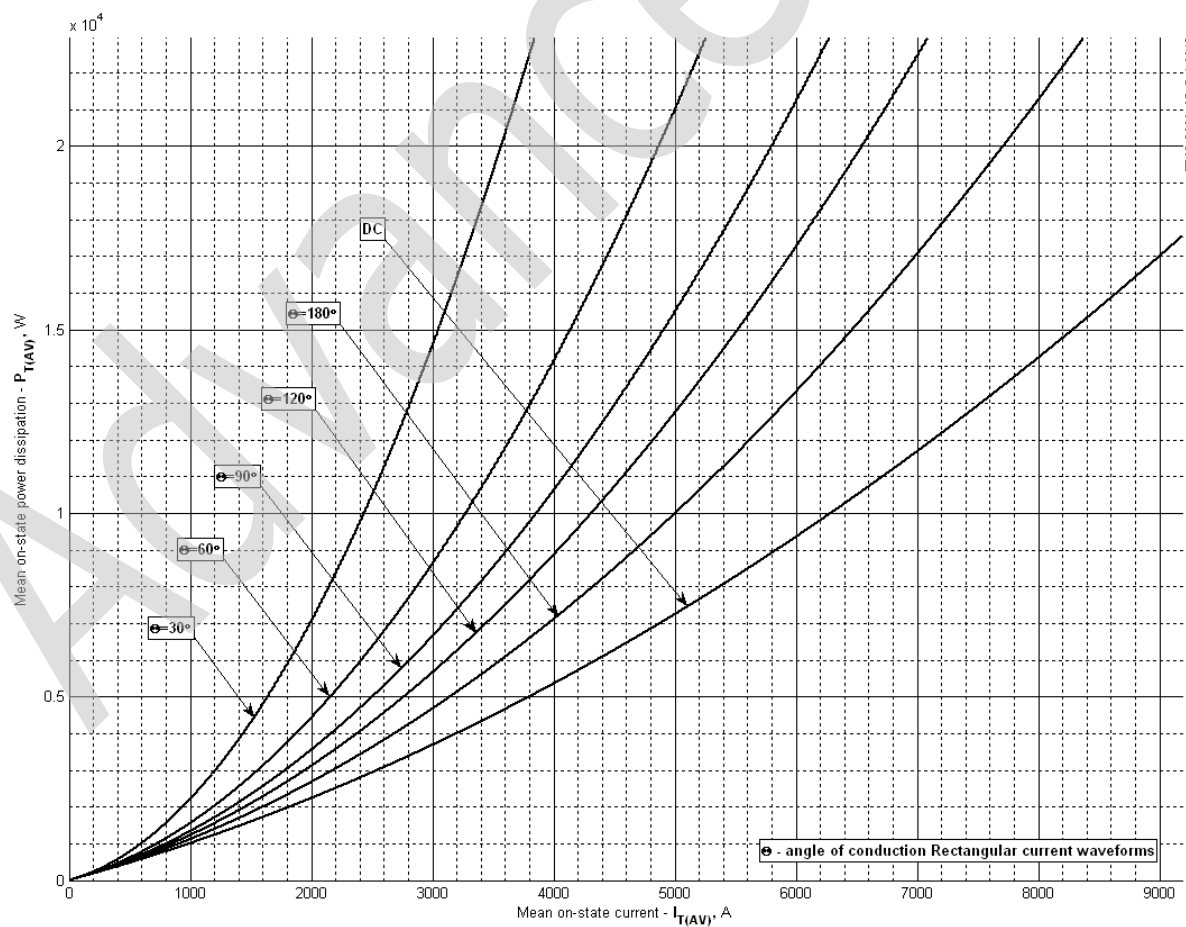


Fig. 10 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

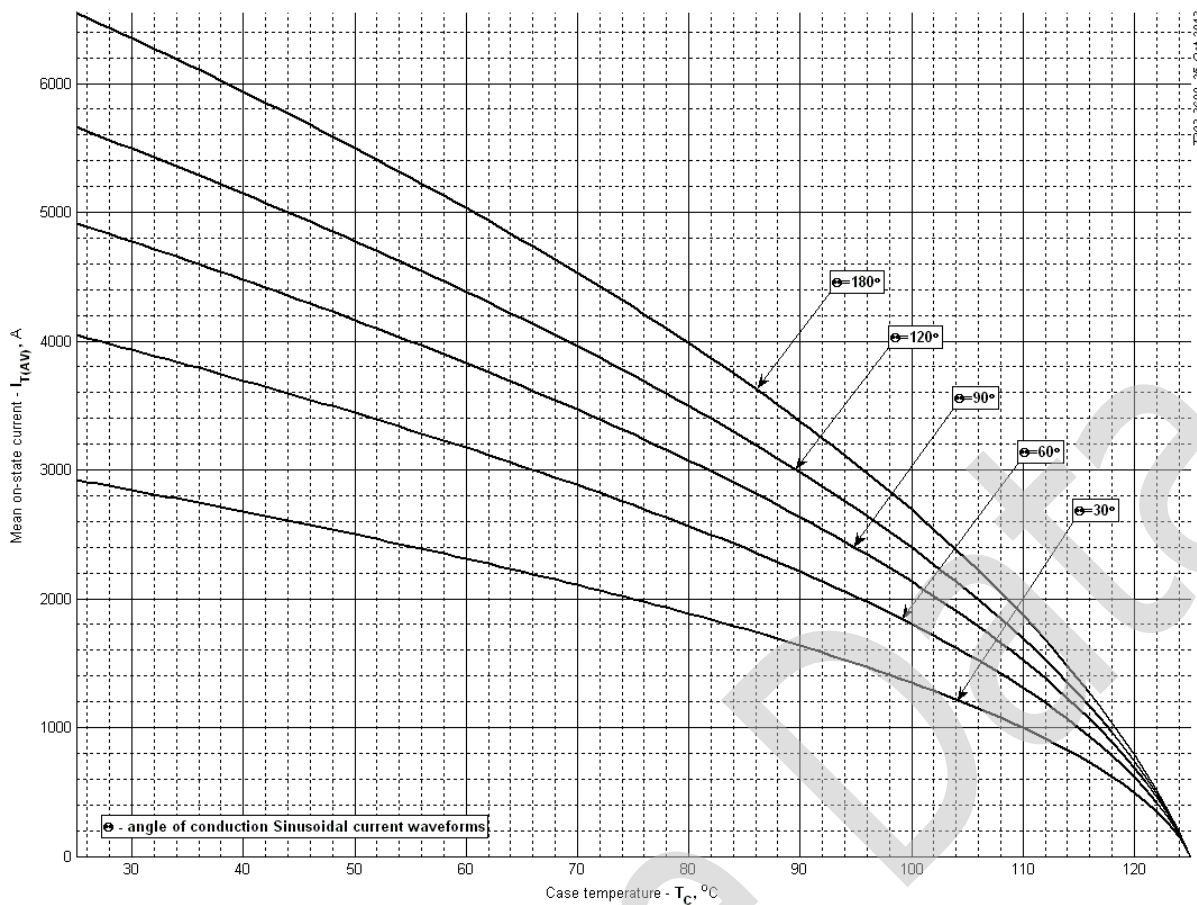


Fig. 11 – Mean on-state current I_{TAV} vs. case temperature T_C for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

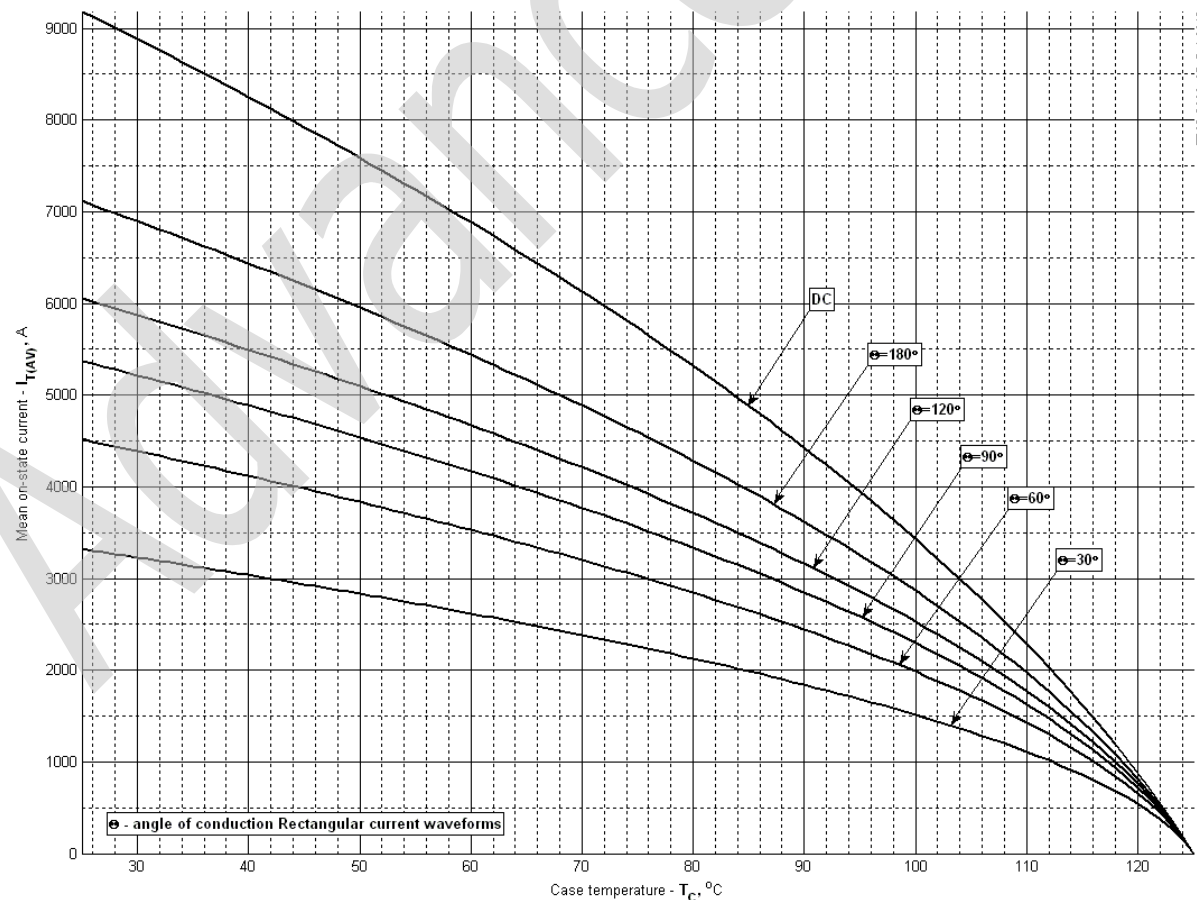


Fig. 12 - Mean on-state current I_{TAV} vs. case temperature T_C for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

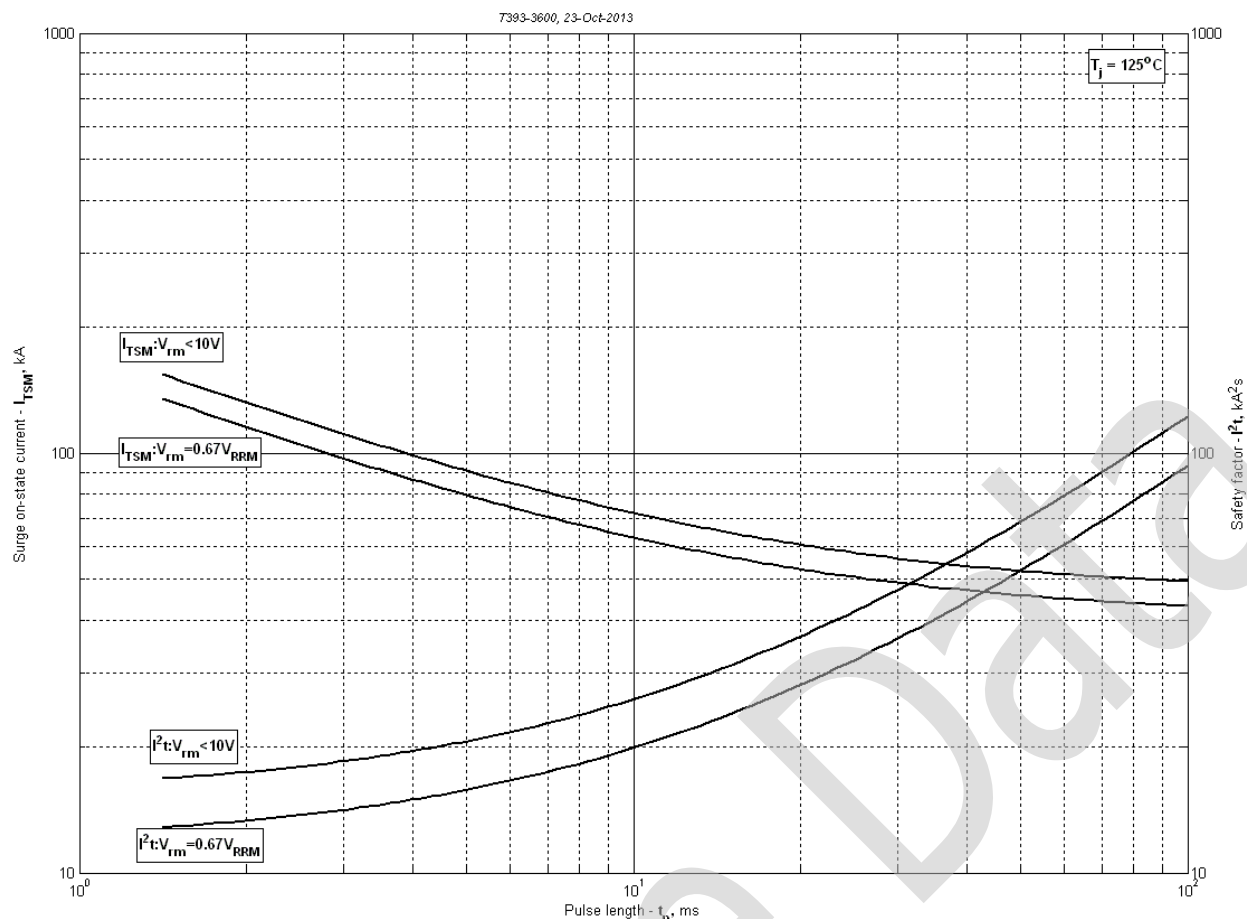


Fig. 13 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

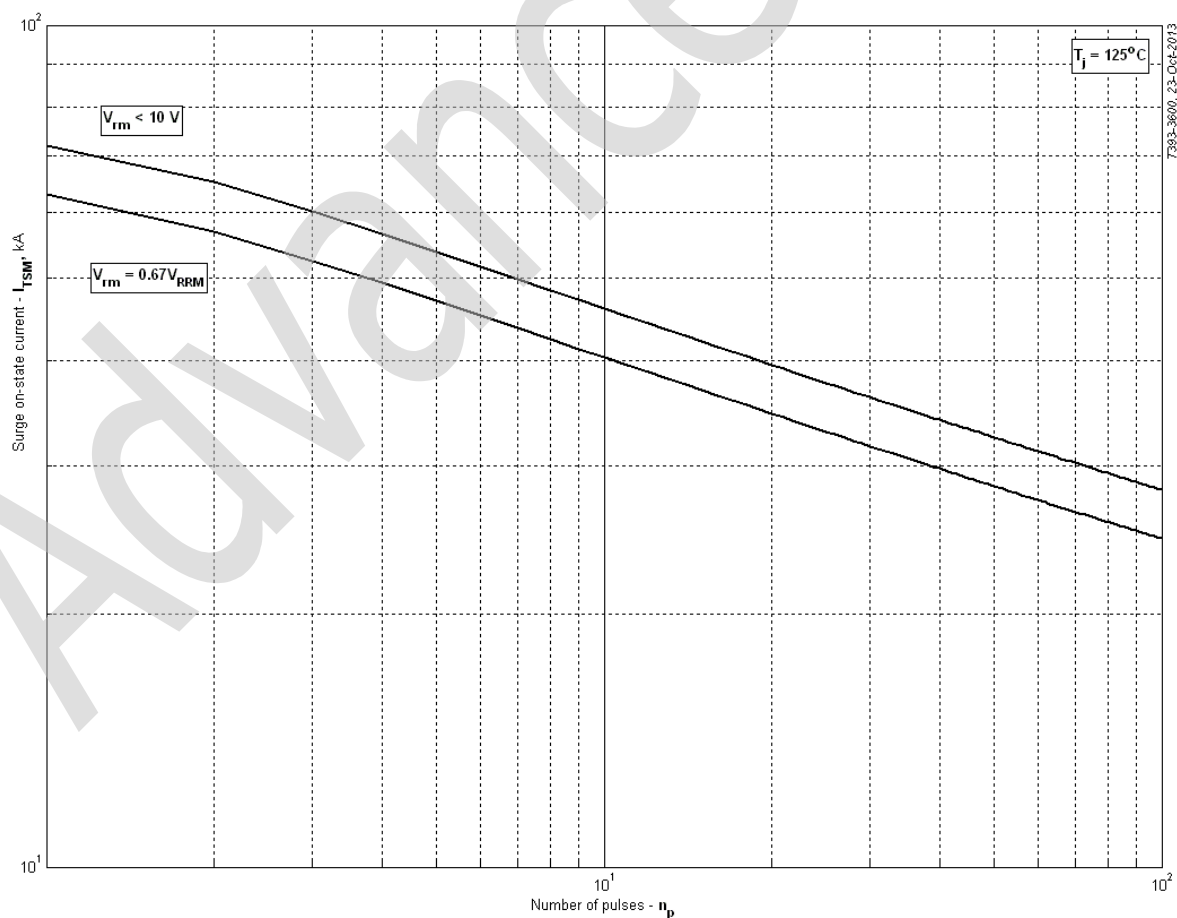


Fig. 14 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p