



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

Phase Control Thyristor Type T453-1000-24

Maximum allowable mean on-state current					I _{TAV}		1000 A					
Repetitive peak off-state voltage					V _{DRM}		1000...2400 V					
Repetitive peak reverse voltage					V _{RRM}							
Turn-off time					t _q		160*, 200*, 250, 320, 400, 500 μs					
V _{DRM} , V _{RRM} , V	1000	1100	1200	1300	1400	1500	1600	1800	2000	2200	2400	
Voltage code	10	11	12	13	14	15	16	18	20	22	24	
T _{ij} , °C	-60...+125											

* - for thyristors the range of voltage codes (10-18)

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I _{TAV}	Maximum allowable mean on-state current	A	1000 1243	T _c =95 °C, Double side cooled T _c =85 °C, Double side cooled 180° half-sine wave; 50 Hz	
I _{TRMS}	RMS on-state current	A	1570	T _c =95 °C, Double side cooled 180° half-sine wave; 50 Hz	
I _{TSM}	Surge on-state current	kA	25.0 29.0	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 =2 A; t _{GP} =50 μs; di _G /dt≥1 A/μs
			26.0 30.0	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 =2 A; t _{GP} =50 μs; di _G /dt≥1 A/μs
I ² t	Safety factor	A ² s·10 ³	3100 4200	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 =2 A; t _{GP} =50 μs; di _G /dt≥1 A/μs
			2800 3700	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 =2 A; 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...2400	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...2500	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	8	$T_j = T_{j\max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	4	$T_j = T_{j\max}$ 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	2000	$T_j = T_{j\max}$; $V_D = 0.67 \cdot V_{DRM}$; $I_{TM} = 6000$ A; Gate pulse: $I_G = 2$ A; $t_{GP} = 50$ μ 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	24.0...28.0	
a	Acceleration	m/s ²	50	Device clamped

CHARACTERISTICS

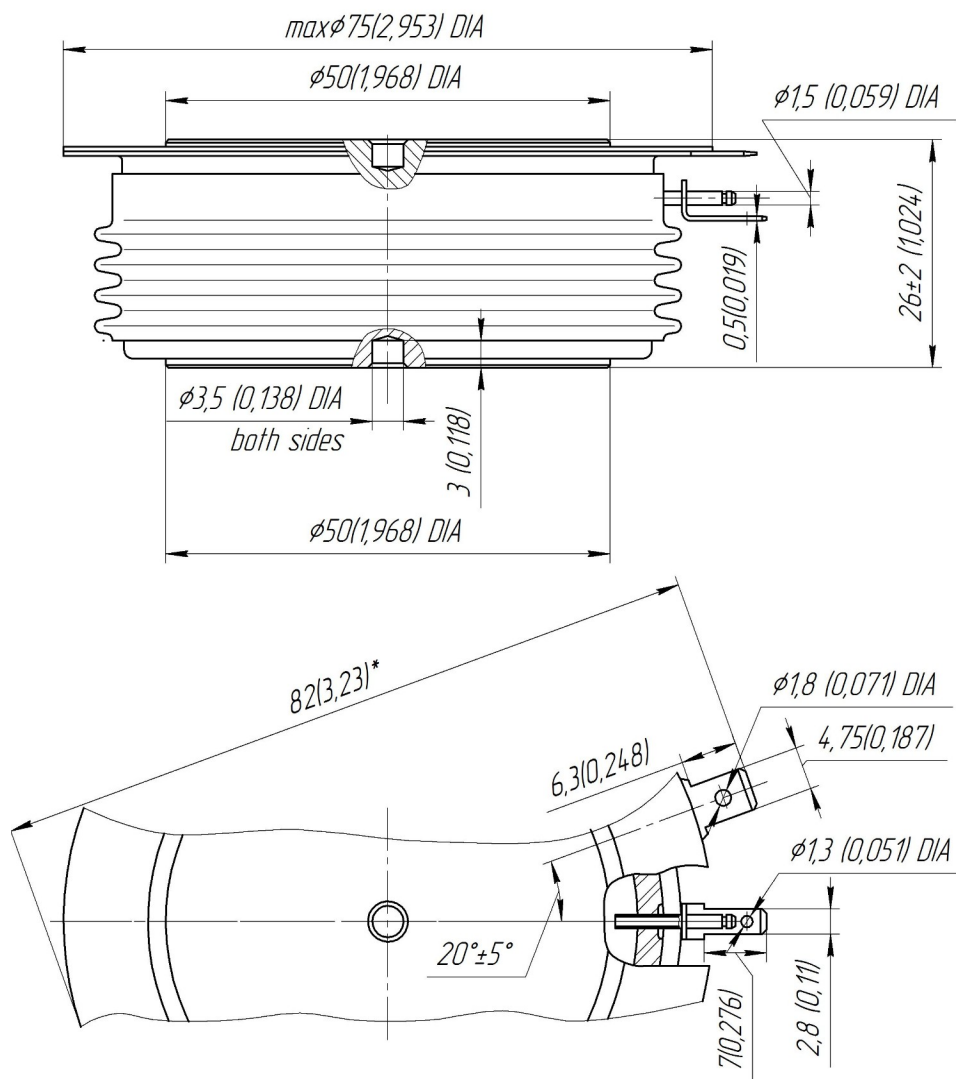
Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V _{TM}	Peak on-state voltage, max	V	1.75	T _j =25 °C; I _{TM} =3140 A	
V _{T(TO)}	On-state threshold voltage, max	V	0.967	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.269	0.5 π I _{TAV} < I _T < 1.5 π I _{TAV}	
I _L	Latching current, max	mA	1500	T _j =25 °C; V _D =12 V; Gate pulse: I _G =2 A; t _{GP} =50 μs; di _G /dt≥1 A/μs	
I _H	Holding current, max	mA	300	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	1.00	T _j =25 °C; V _D =1000 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time, max	μs	5.00	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 ²⁾ , max	μs	160*, 200*, 250, 320, 400, 500	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}	
Q _{rr}	Recovered charge, max	μC	2700	T _j =T _{j max} ; I _{TM} =2000 A;	
t _{rr}	Reverse recovery time, max	μs	30	di _R /dt=-10 A/μs;	
I _{rr}	Reverse recovery current, max	A	180	V _R =100 V;	

THERMAL					
R _{thjc}	Thermal resistance, junction to case, max	°C/W	0.0180	Direct current	Double side cooled
R _{thjc-A}			0.0396		Anode side cooled
R _{thjc-K}			0.0324		Cathode side cooled
R _{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0040	Direct current	
MECHANICAL					
m	Weight, max	g	500		
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							NOTES
T	453	1000	24	A2	E2	N	1) Critical rate of rise of off-state voltage
1	2	3	4	5	6	7	
1. Phase Control Thyristor							2) Turn-off time (dv _D /dt=50 V/μs)
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							

Symbol of Group	P2	K2	E2	A2	T1	P1	M1
(dv _D /dt) _{crit} , V/μs	200	320	500	1000	1600	2000	2500

Symbol of Group	T2	P2	M2	K2	H2	E2
t _q , μs	160*	200*	250	320	400	500



All dimensions in millimeters (inches)

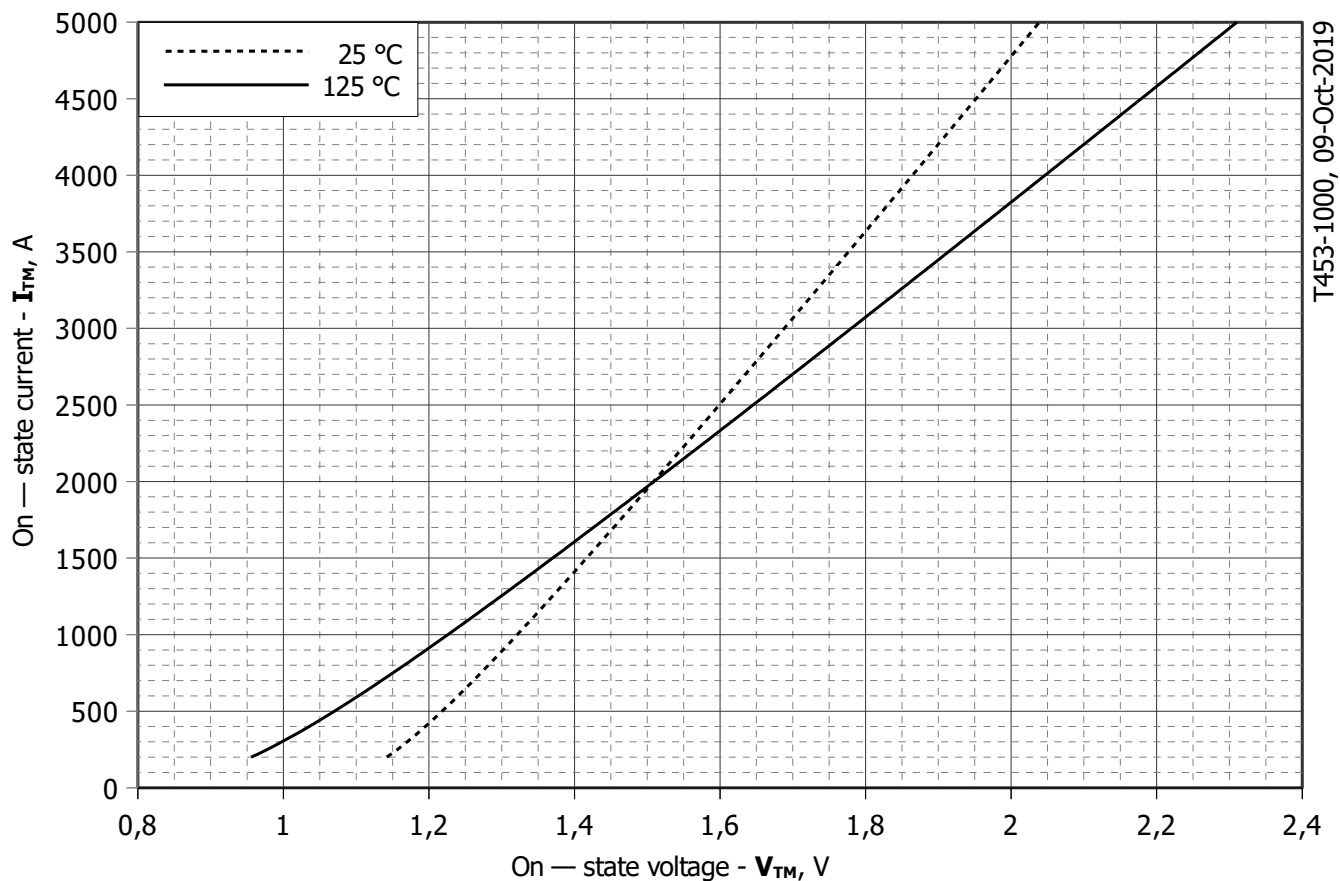


Fig 1 – On-state characteristics of Limit device

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	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\text{ max}}$
A	0.956310000	0.681670000
B	0.000169160	0.000254930
C	0.029034000	0.042284000
D	-0.000147910	-0.000086298

On-state characteristic model (see Fig. 1)

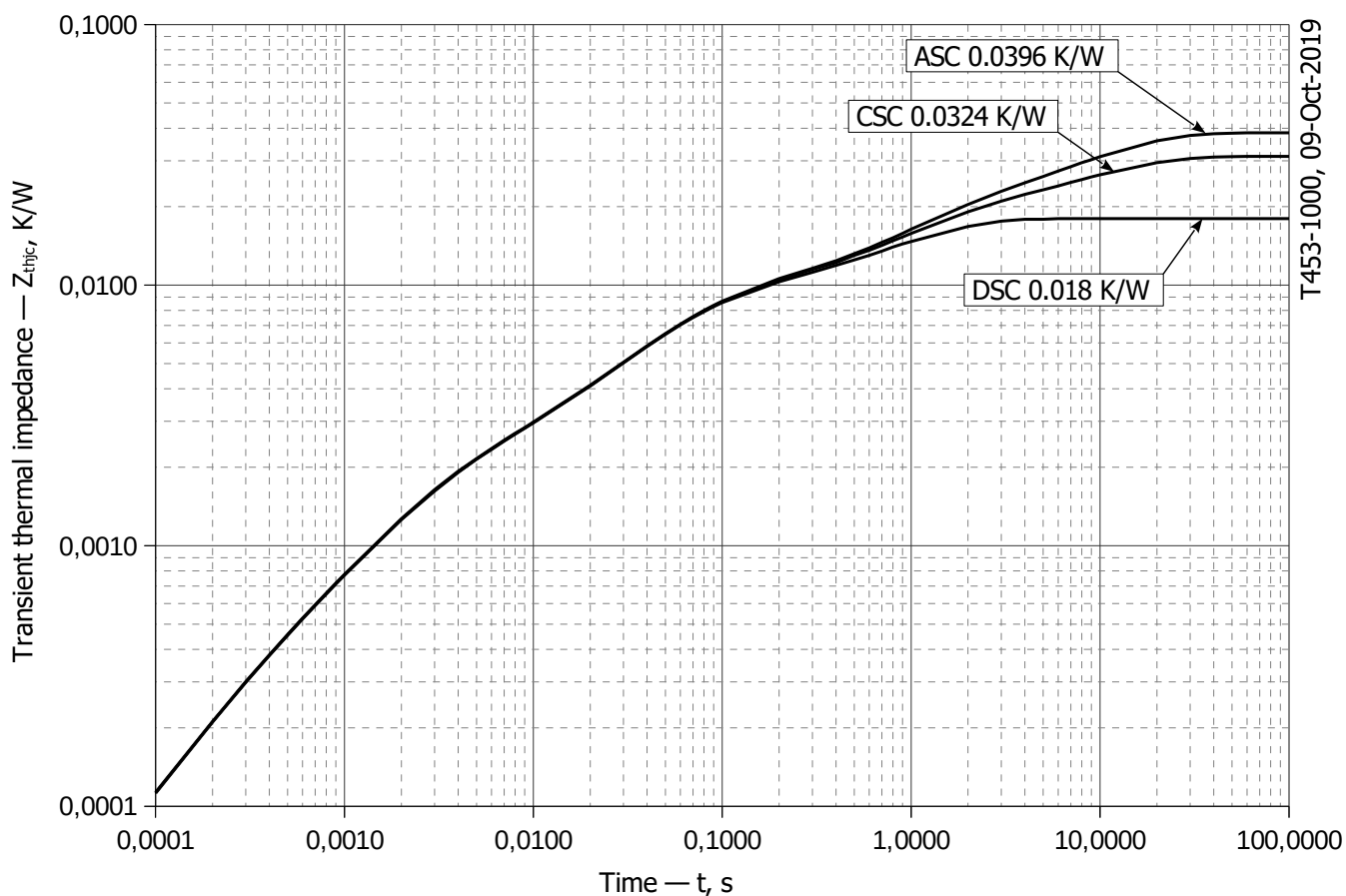


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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	0.009241	0.006037	0.001231	0.001054	0.0003396	0.00009575
τ_i , s	0.9673	0.04967	0.002733	0.07734	0.001638	0.0002248

DC Anode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.01318	0.009281	0.006055	0.001018	0.001535	0.0001182
τ_i , s	9.745	1.028	0.05591	0.03732	0.002468	0.0002687

DC Cathode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.02041	0.009325	0.006949	0.0001252	0.001516	0.0001119
τ_i , s	9.752	1.065	0.05344	0.01407	0.002421	0.0002554

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

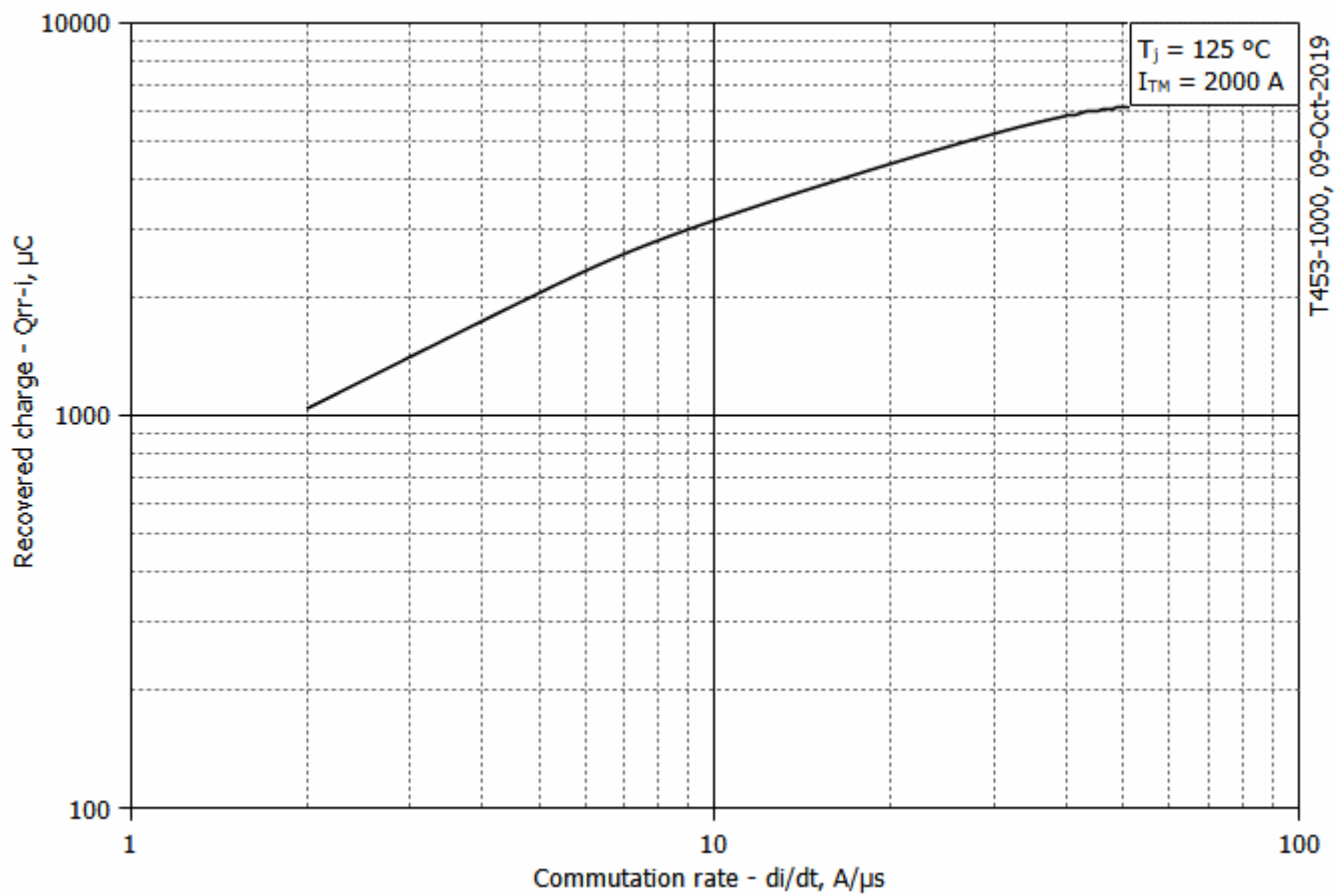


Fig 3 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

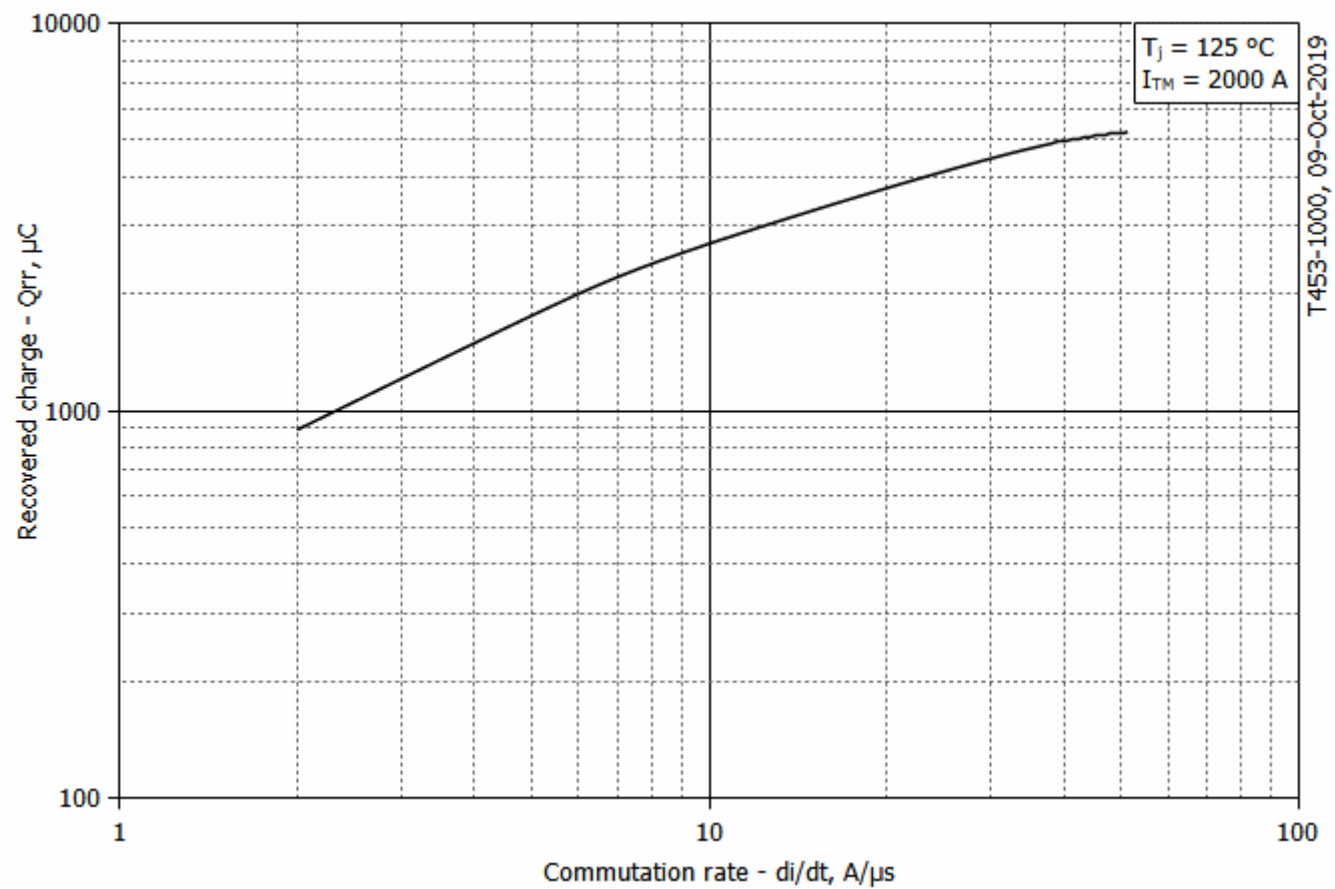


Fig 4 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

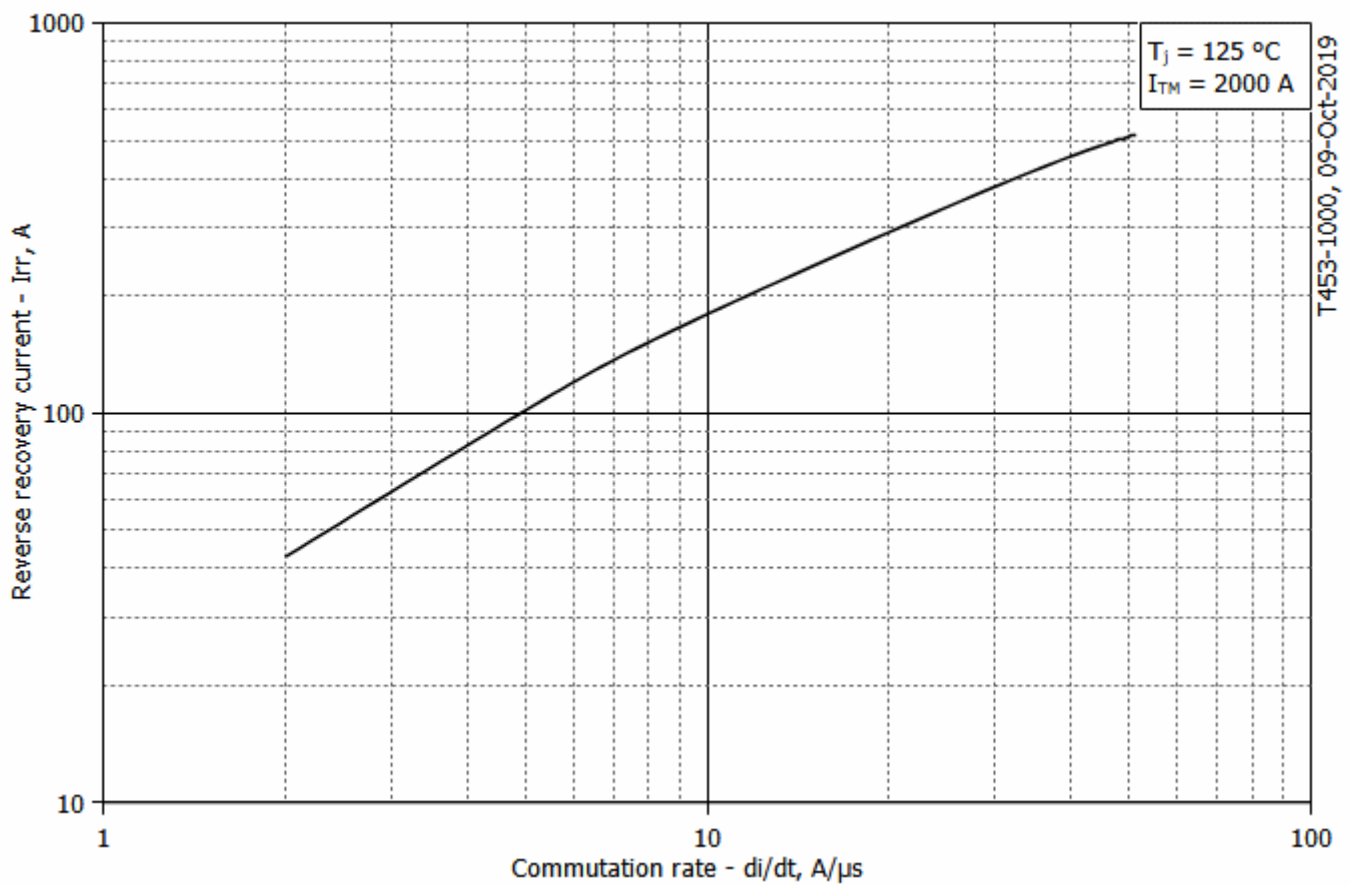


Fig 5 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

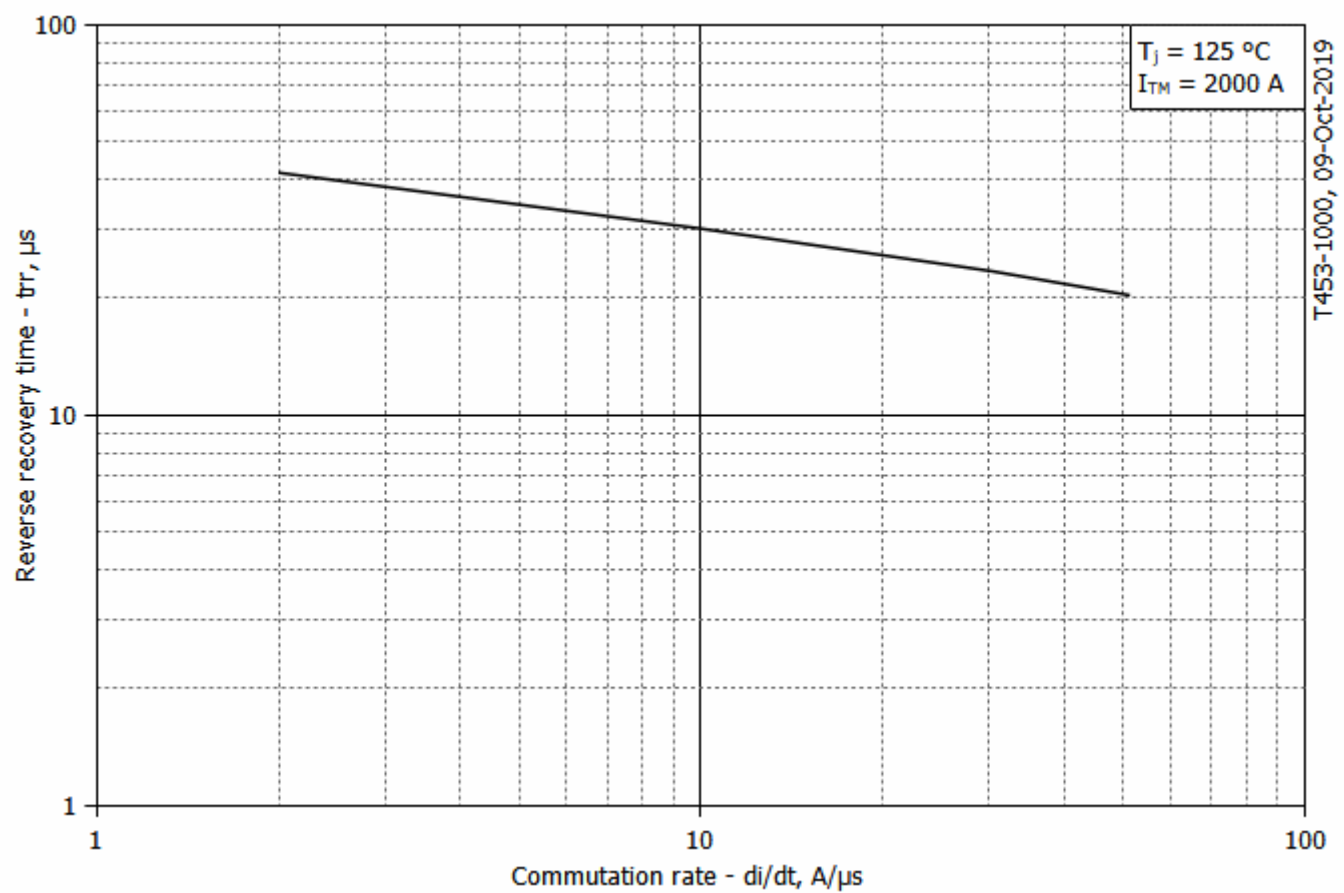
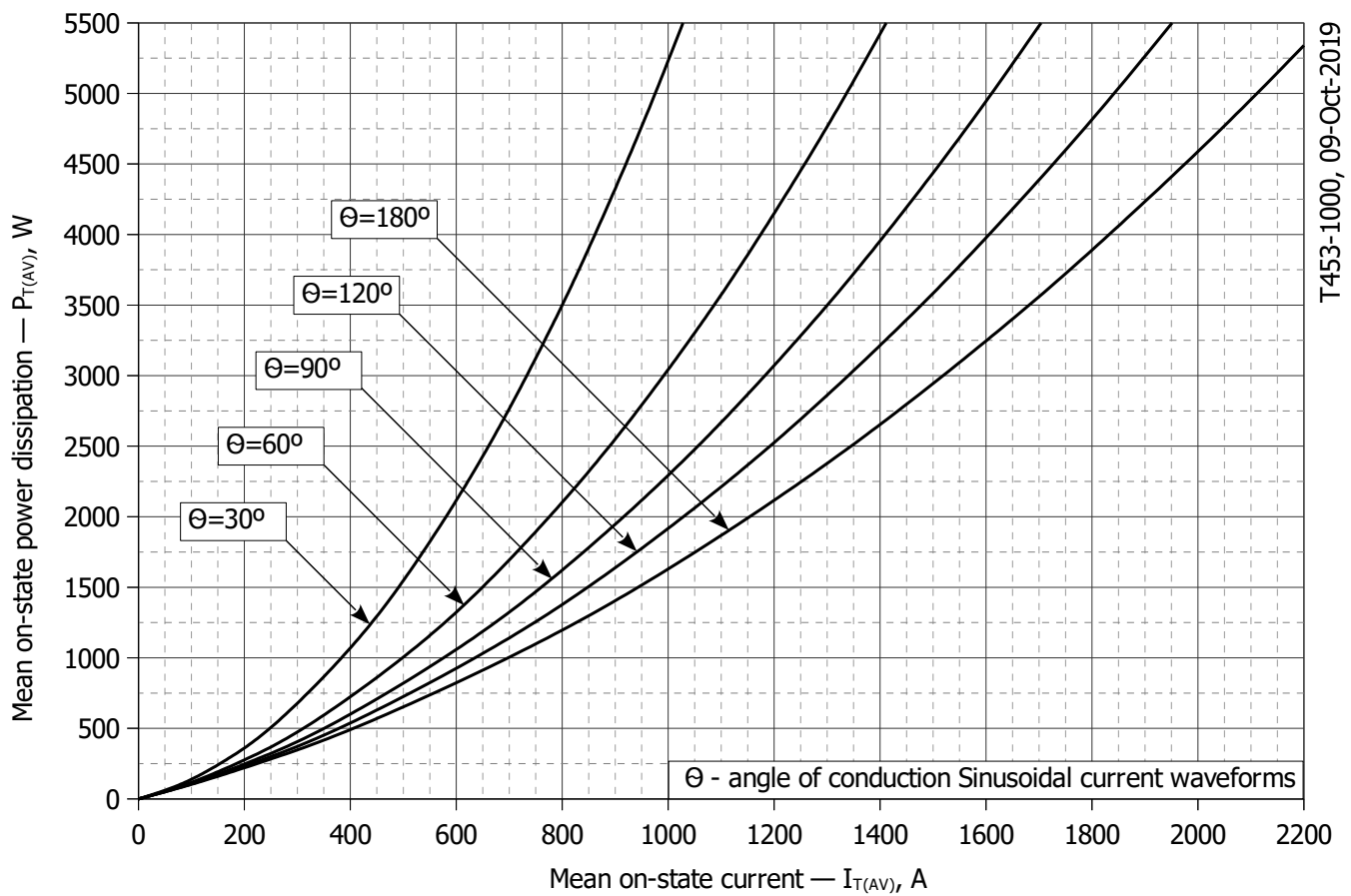
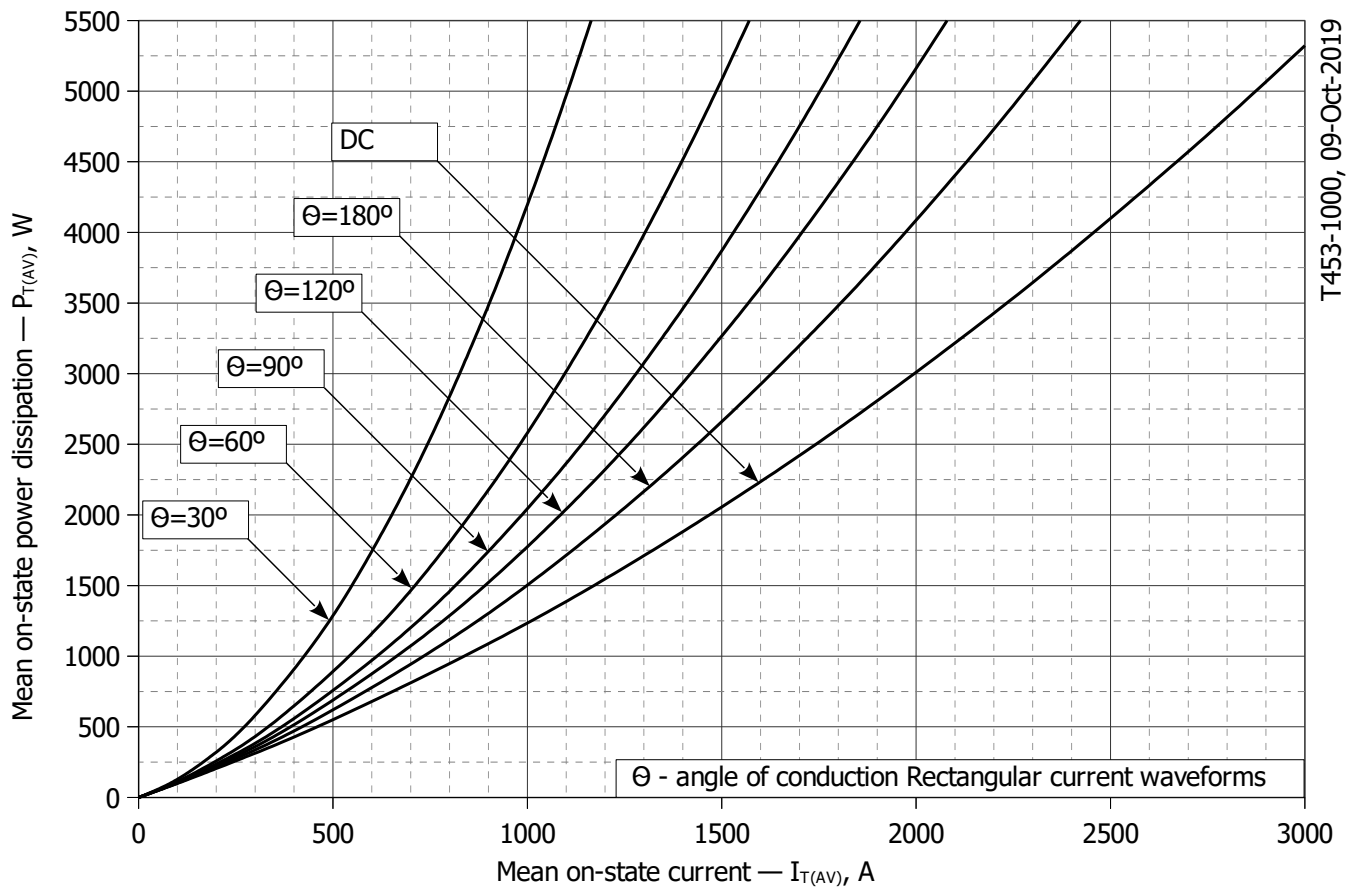


Fig 6 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)



T453-1000, 09-Oct-2019

Fig. 7 - 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)



T453-1000, 09-Oct-2019

Fig. 8 - 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)

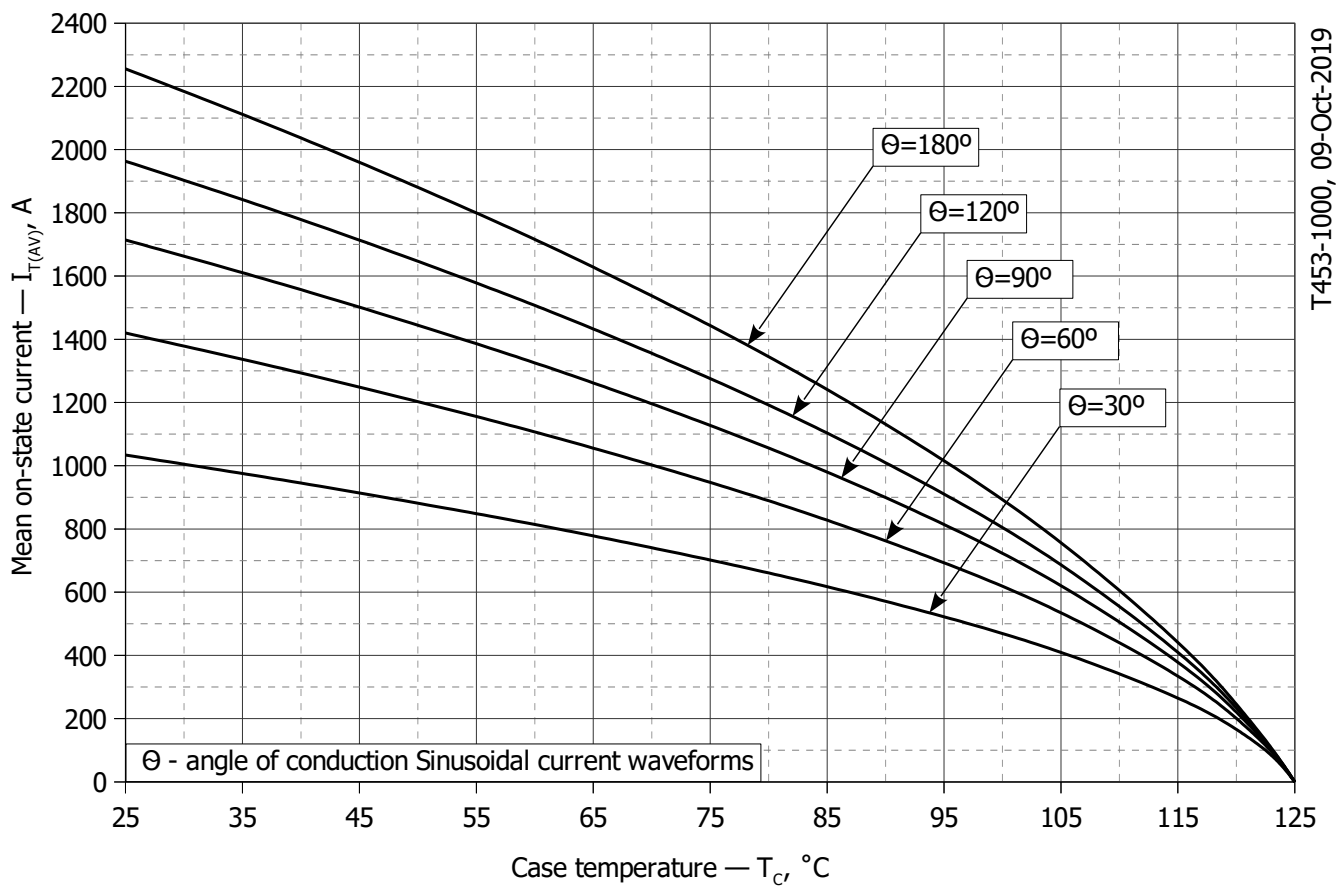


Fig. 9 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

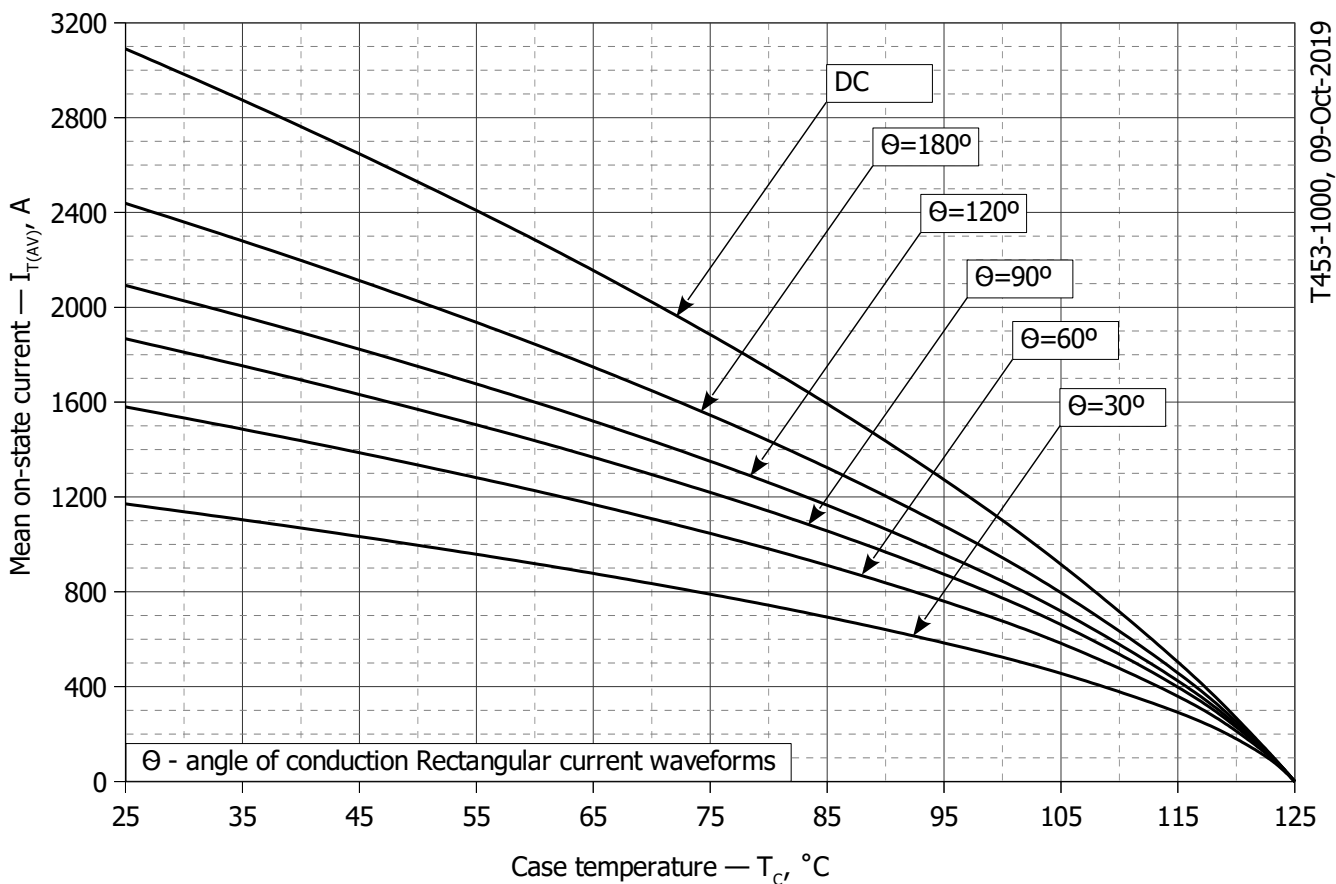


Fig. 10 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

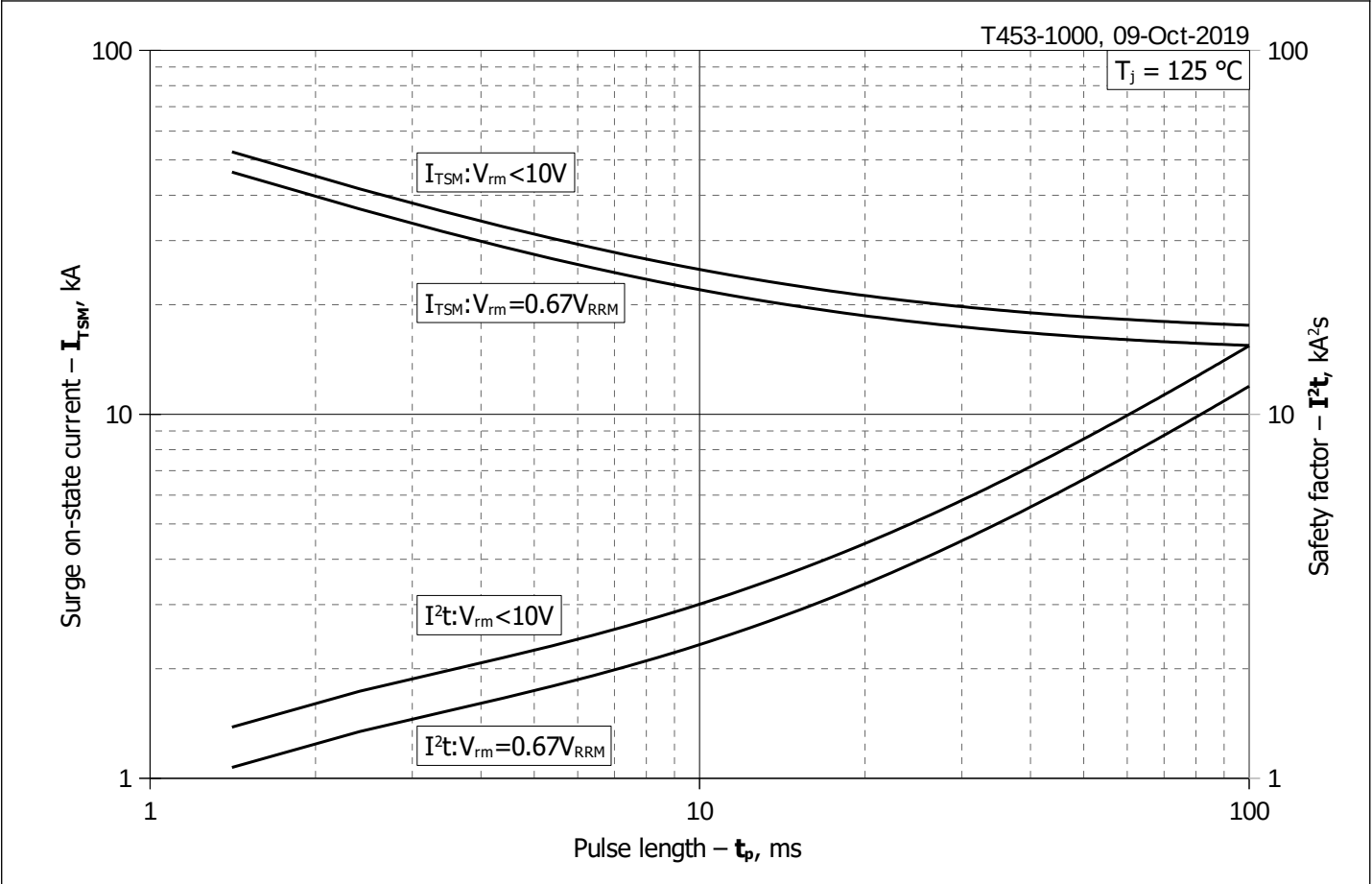


Fig. 11 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

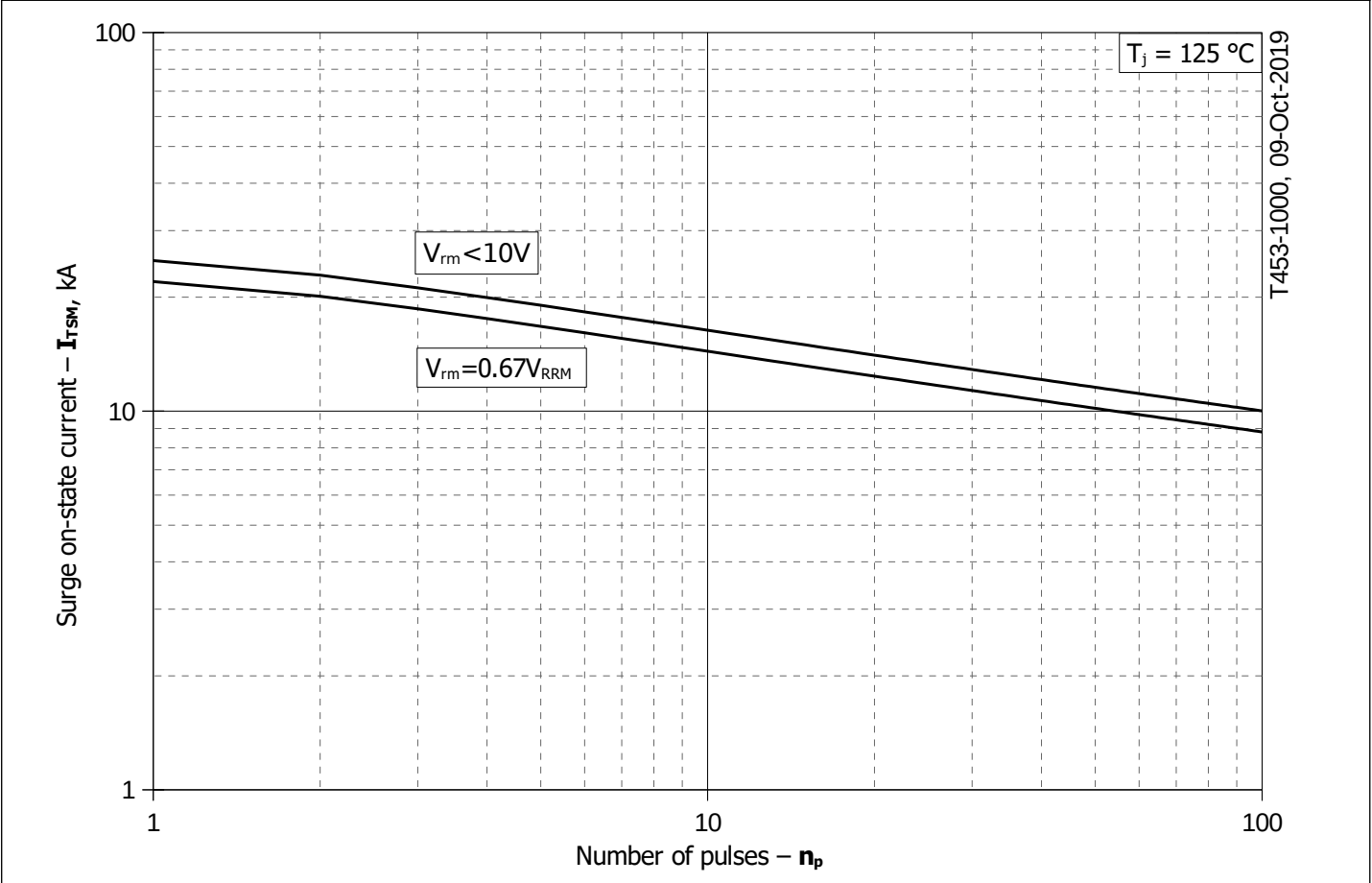


Fig. 12 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p