



PROTON-ELECTROTEX RUSSIA

Optimum power handling
Low on-state and switching losses
Designed for traction and industrial applications

Phase Control Stud Thyristor Type T161-200-18

Mean on-state current							I_{TAV}			200 A								
Repetitive peak off-state voltage							V_{DRM}			100...1800 V								
Repetitive peak reverse voltage																		
Turn-off time							t_q			125, 160, 200, 250, 320, 400, 500 μs								
V_{DRM}, V_{RRM}, V	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1800	
Voltage code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	
$T_j, ^\circ C$	-60...+125																	

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I _{TAV}	Maximum allowable mean on-state current	A	200	T _c = 83 °C; 180° half-sine wave; 50 Hz	
I _{TRMS}	RMS on-state current	A	314	T _c = 83 °C; 180° half-sine wave; 50 Hz	
I _{TSM}	Surge on-state current	kA	5.2 6.0	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
			5.5 6.5	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	130 180	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
			120 170	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	100...1800	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	200...1900	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	

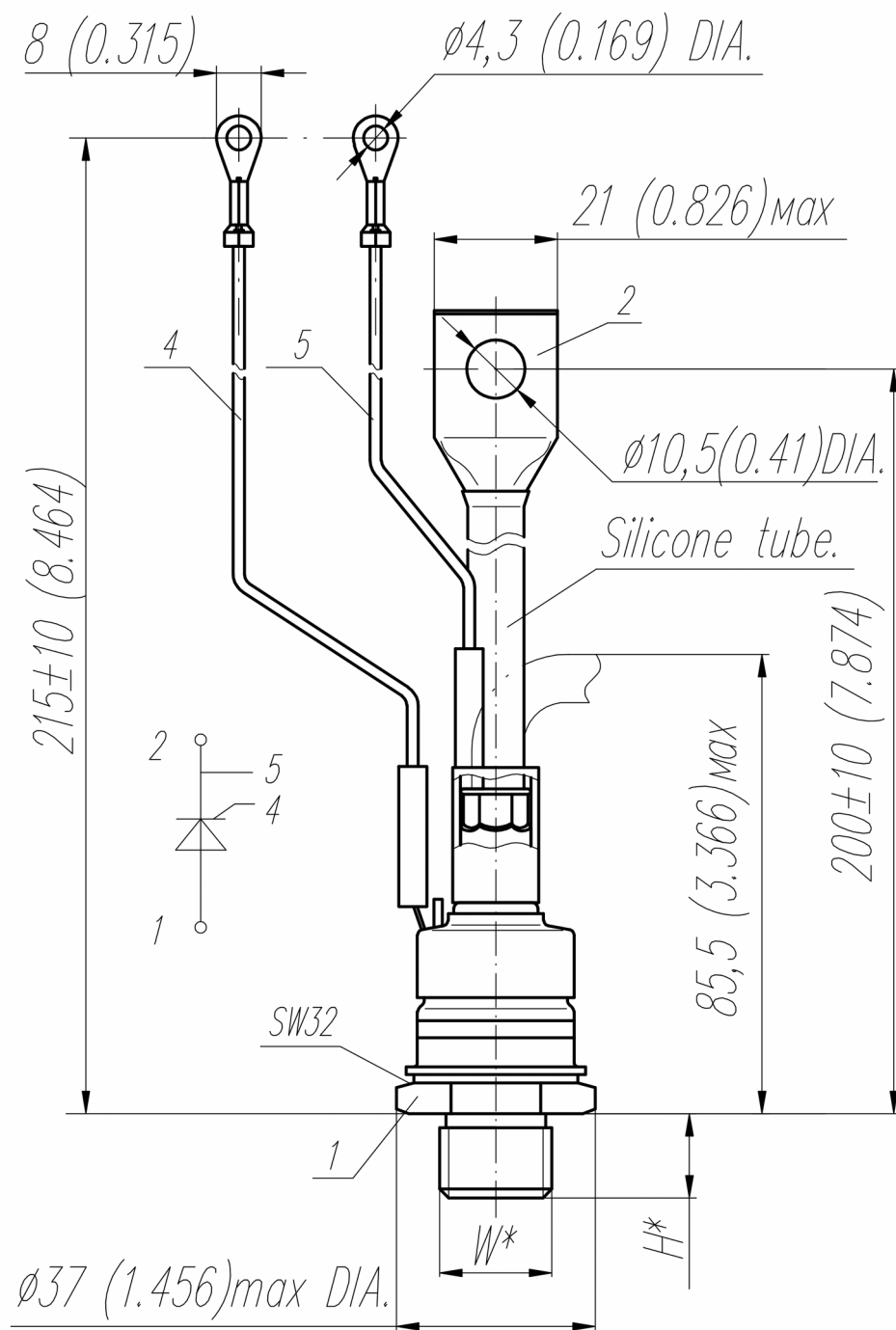
TRIGGERING				
I_{FGM}	Peak forward gate current	A	5	$T_j = T_{j\max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	3	$T_j = T_{j\max}$ for DC gate current
SWITCHING				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive ($f=1$ Hz)	A/ μ s	800	$T_j = T_{j\max}$; $V_D = 0.67 \cdot V_{DRM}$; $I_{TM} = 640$ 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				
M	Tightening torque	Nm	20...30	
a	Acceleration	m/s ²	100	

CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V _{TM}	Peak on-state voltage, max	V	1.60	T _j =25 °C; I _{TM} = 628 A	
V _{T(TO)}	On-state threshold voltage, max	V	0.84	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	1.129	0.5 π I _{TAV} < I _T < 1.5 π I _{TAV}	
I _L	Latching current, max	mA	500	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	250	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	50	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	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	400 250 150	T _j = T _{j min} T _j = 25 °C T _j = T _{j max}	
V _{GD}	Gate non-trigger direct voltage, min	V	0.70	T _j =T _{j max} ; V _D =0.67·V _{DRM} ;	
I _{GD}	Gate non-trigger direct current, min	mA	65.00	Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	1.10	T _j =25 °C; V _D =1000 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time, max	μs	3.00	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	125, 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	725	T _j =T _{j max} ; I _{TM} =200 A;	
t _{rr}	Reverse recovery time, max	μs	17	di _R /dt=-10 A/μs;	
I _{rr}	Reverse recovery current, max	A	85	V _R =100 V	

THERMAL				
R_{thjc}	Thermal resistance, junction to case, max	$^{\circ}\text{C}/\text{W}$	0.1500	Direct current
MECHANICAL				
m	Weight, max	g	280	
D_s	Surface creepage distance	mm (inch)	12.40 (4.882)	
D_a	Air strike distance	mm (inch)	12.40 (4.882)	

PART NUMBERING GUIDE							NOTES																
T	161	200	18	A2	E2	N	1) Critical rate of rise of off-state voltage <table><tr><td>Symbol of Group</td><td>P2</td><td>K2</td><td>E2</td><td>A2</td></tr><tr><td>(dv_D/dt)_{crit}, V/μs</td><td>200</td><td>320</td><td>500</td><td>1000</td></tr></table>	Symbol of Group	P2	K2	E2	A2	(dv _D /dt) _{crit} , V/μs	200	320	500	1000						
Symbol of Group	P2	K2	E2	A2																			
(dv _D /dt) _{crit} , V/μs	200	320	500	1000																			
1	2	3	4	5	6	7																	
1. Phase Control Thyristor							2) Turn-off time (dv _D /dt=50 V/μs) <table><tr><td>Symbol of Group</td><td>X2</td><td>T2</td><td>P2</td><td>M2</td><td>K2</td><td>H2</td><td>E2</td></tr><tr><td>t_{gr}, μs</td><td>125</td><td>160</td><td>200</td><td>250</td><td>320</td><td>400</td><td>500</td></tr></table>	Symbol of Group	X2	T2	P2	M2	K2	H2	E2	t _{gr} , μs	125	160	200	250	320	400	500
Symbol of Group	X2	T2	P2	M2	K2	H2		E2															
t _{gr} , μs	125	160	200	250	320	400		500															
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																							



Type of screw	W	H
Metric Screw Type A (upon request)	M16x1,5 – 8g	13
Metric Screw Type B	M20x1,5 – 8g	15

Polarity	Example of code designation	Reference designation	Colors		
			Anode	Cathode	Gate
Anode to stud	T161-200-18		-	Red tube	White

All dimensions in millimeters (inches)

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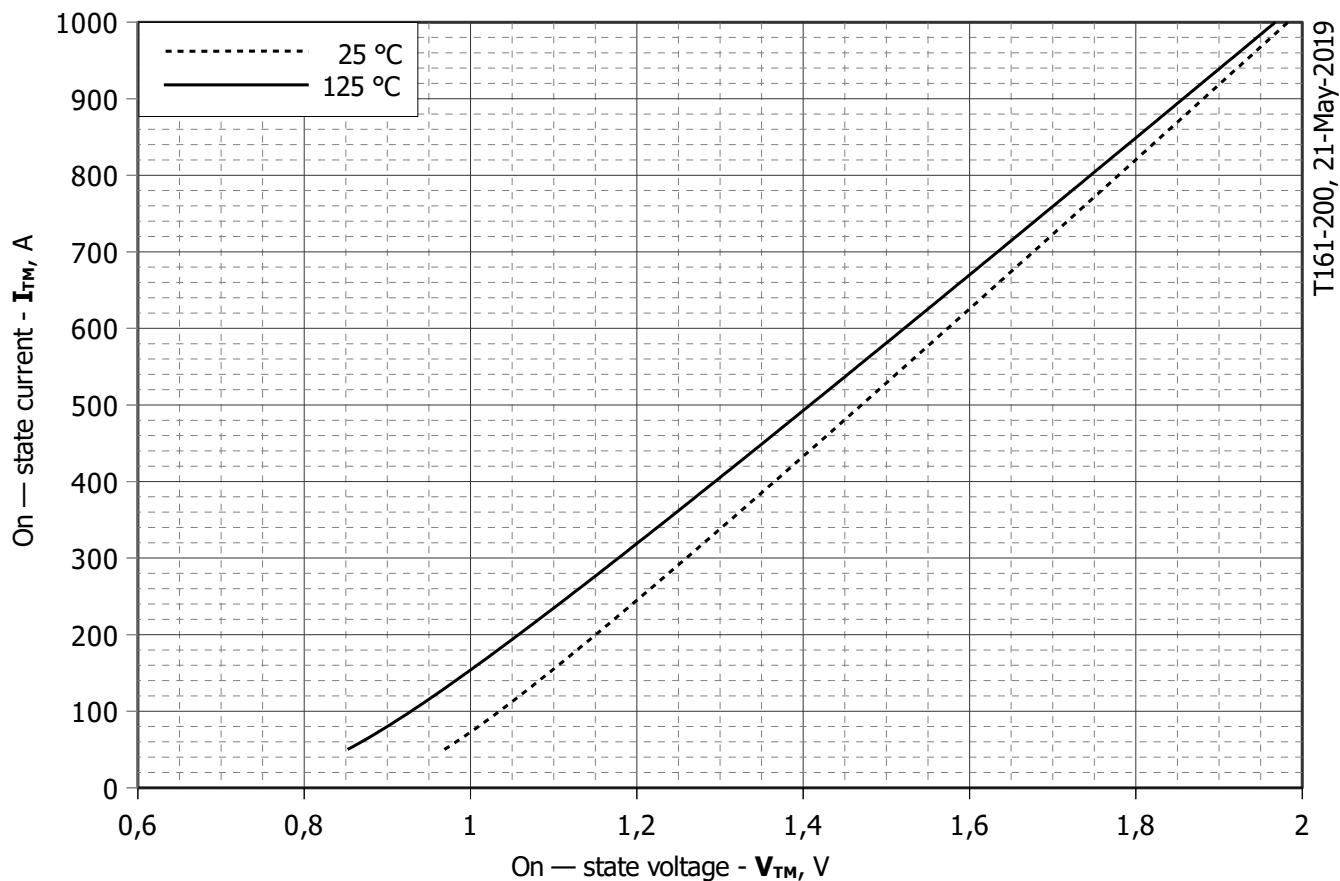


Fig 1 – On-state characteristics of Limit device

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	0.82048000	0.6596823
B	0.00099742	0.0010940
C	0.02565100	0.0010940
D	-0.00038346	-0.0014744

On-state characteristic model (see Fig. 1)

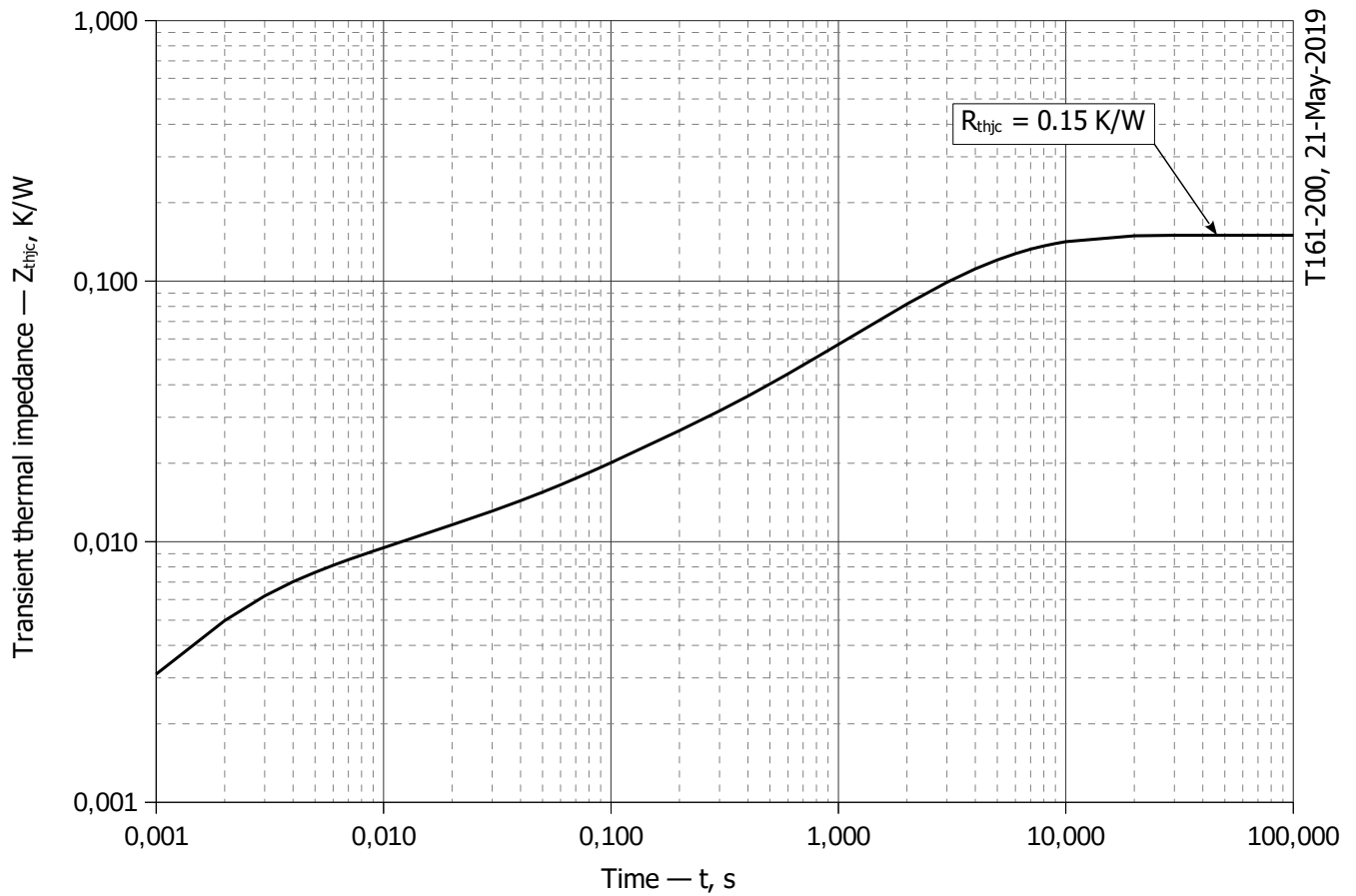


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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

i	1	2	3	4	5	6
$R_i, \text{K/W}$	0.07504	0.0516	0.007369	0.006977	0.003512	0.005502
τ_i, s	4.409	2.183	0.3382	0.07307	0.008189	0.001615

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

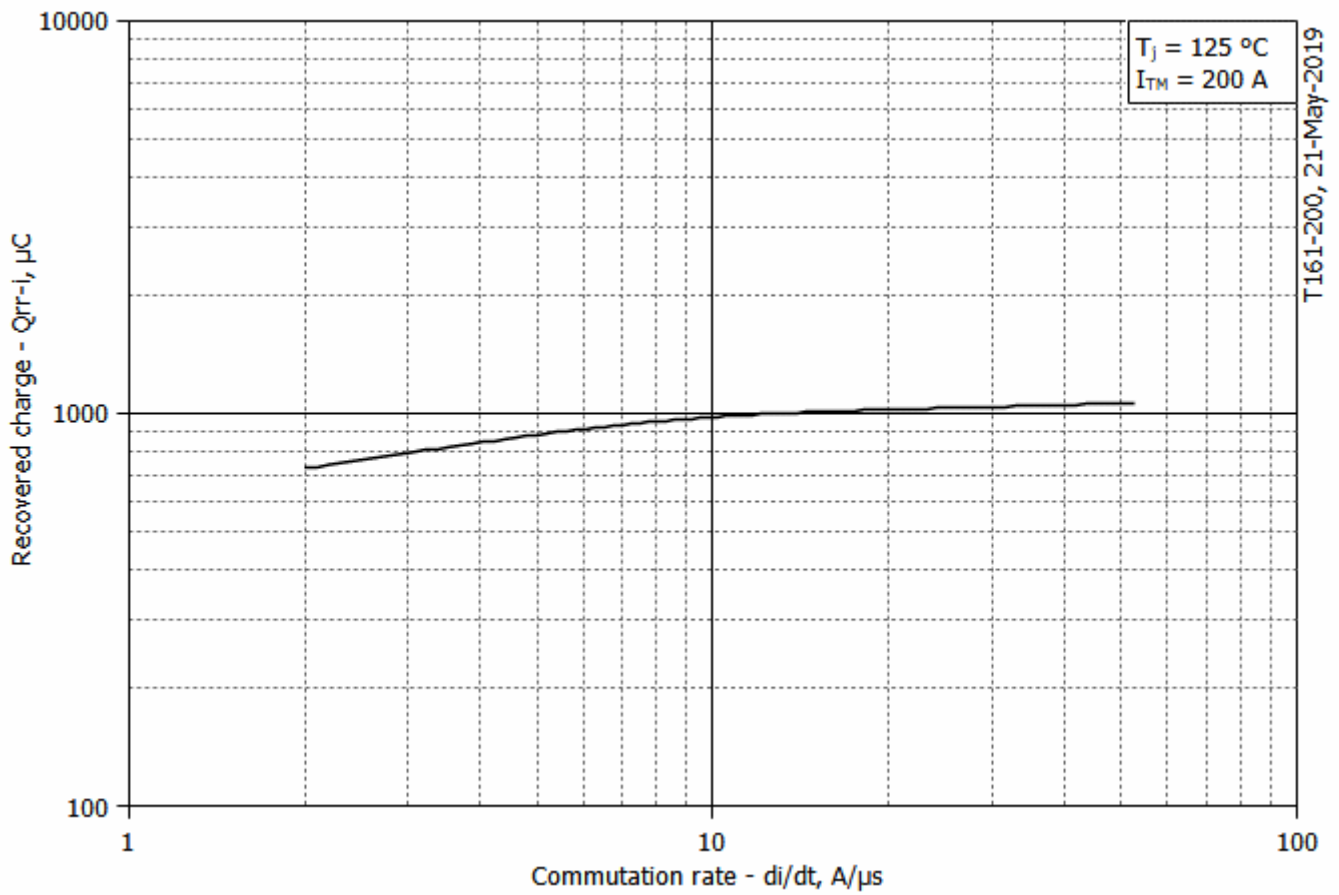


Fig 3 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

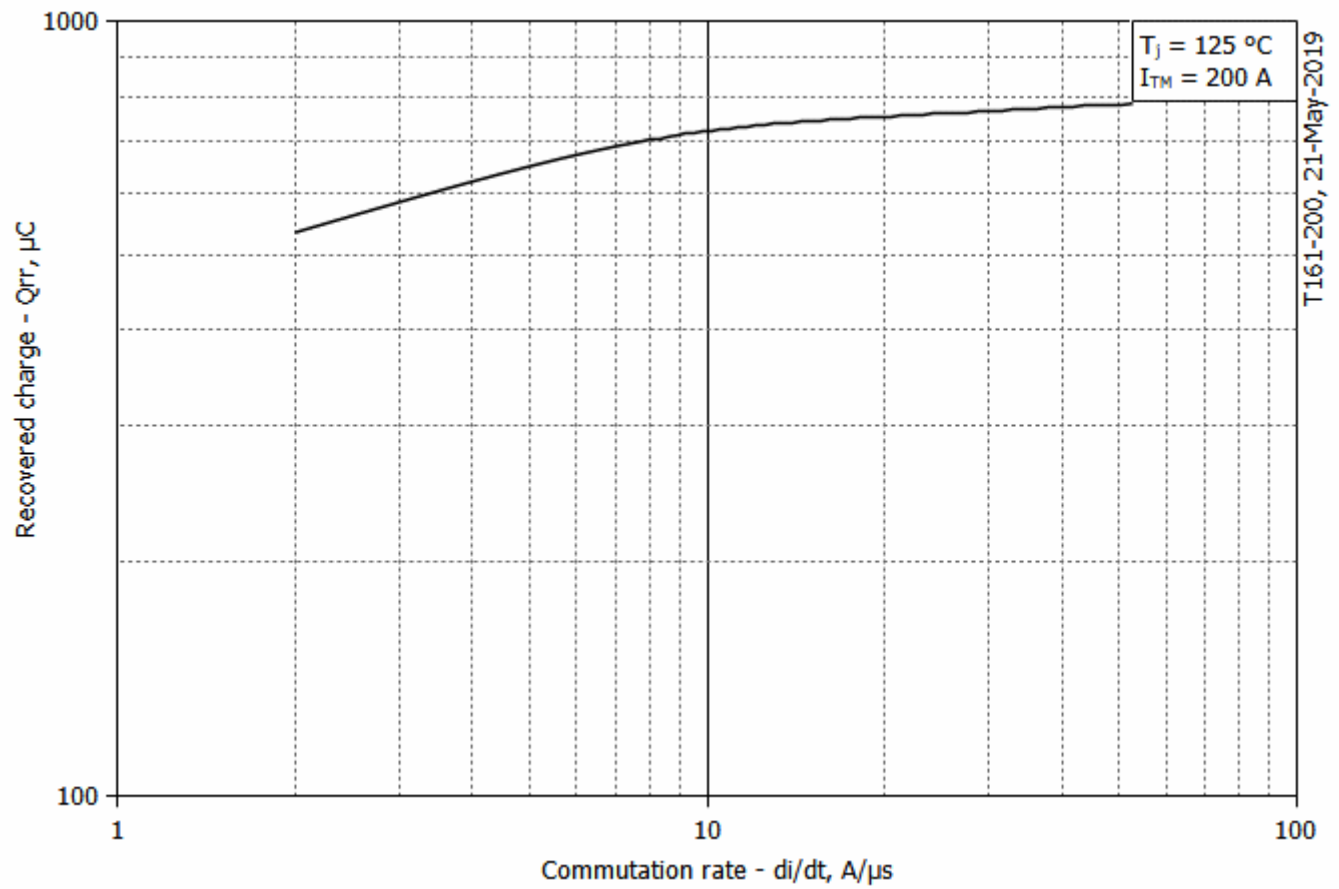


Fig 4 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

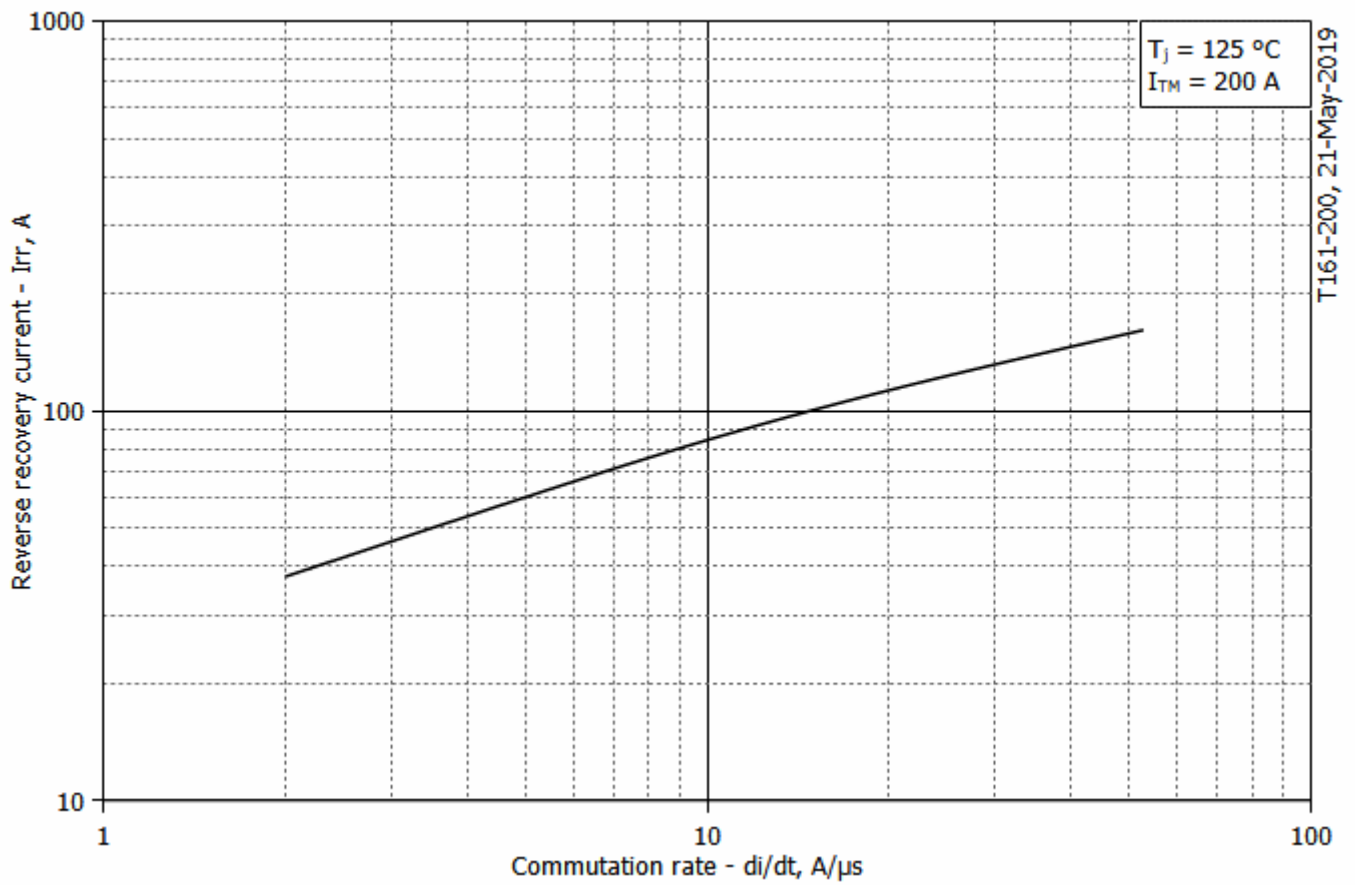


Fig 5 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

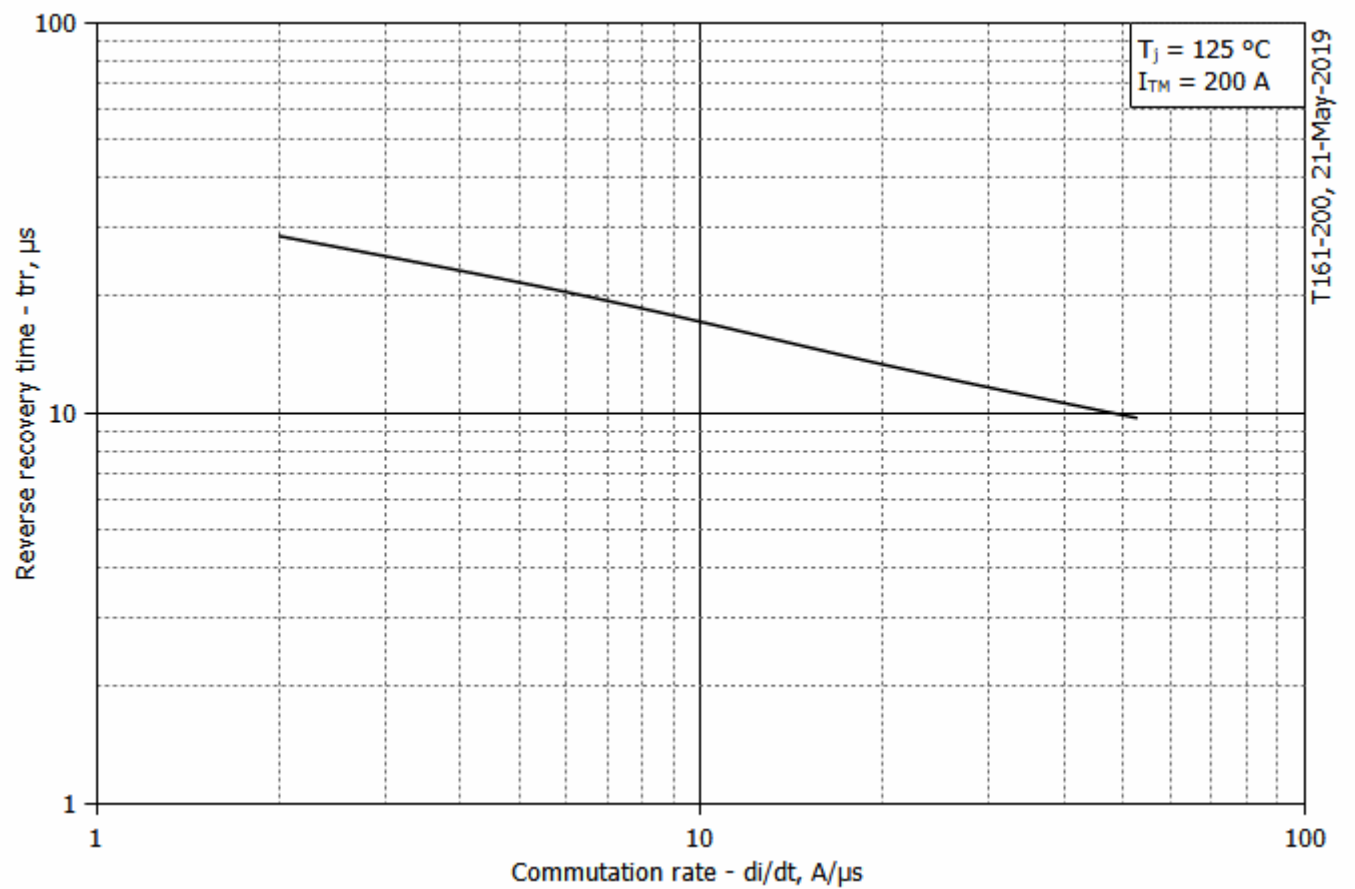


Fig 6 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

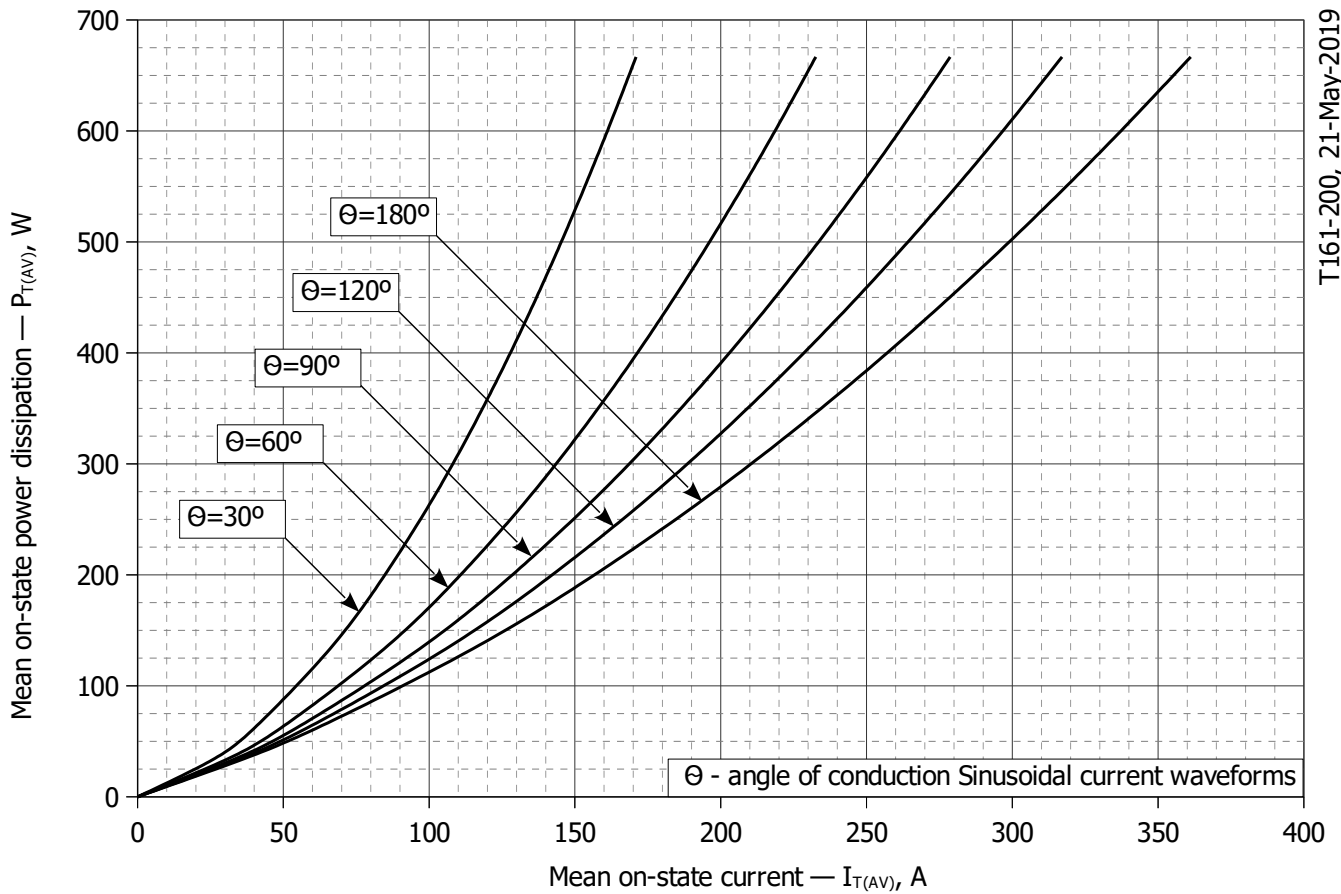


Fig. 7 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

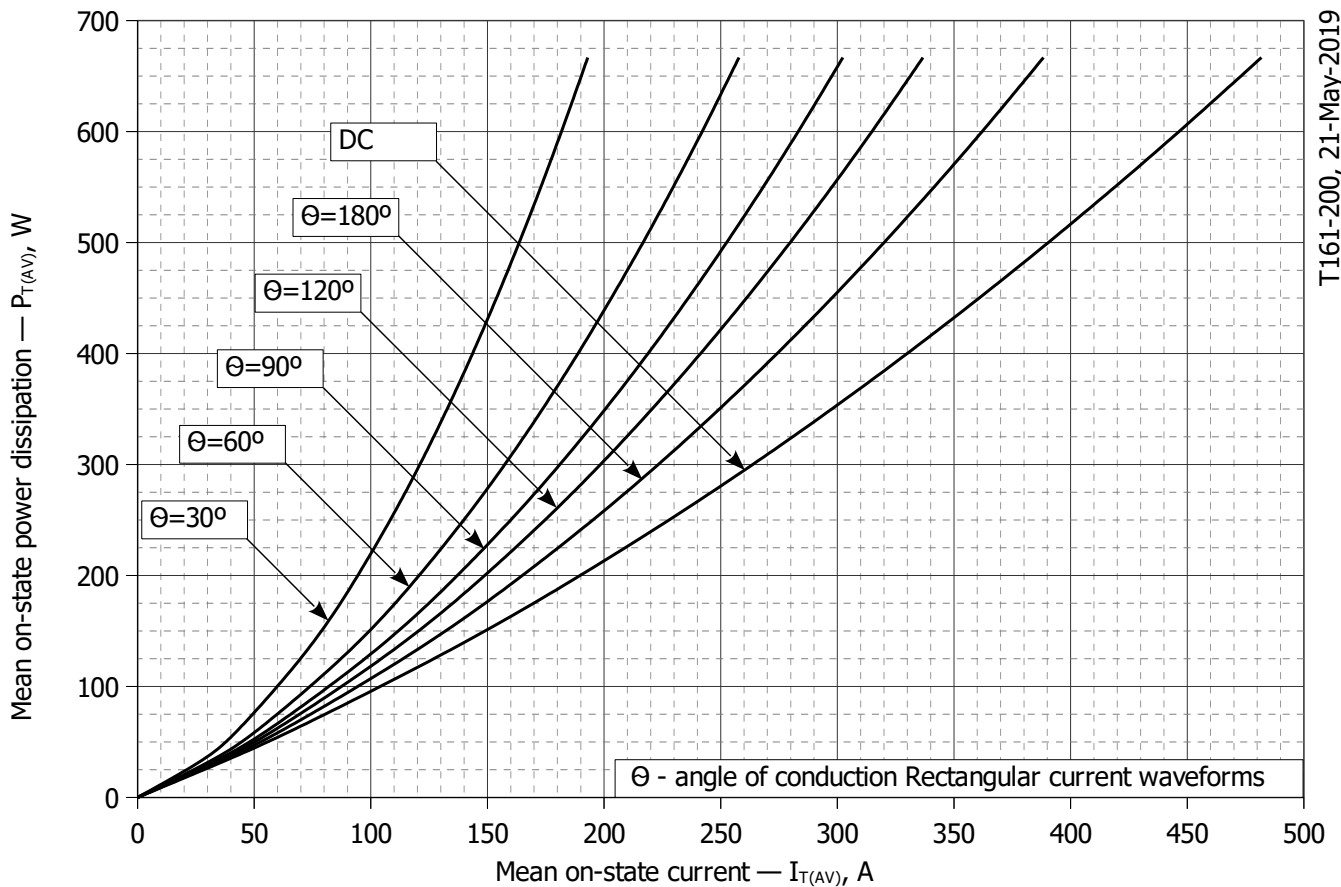
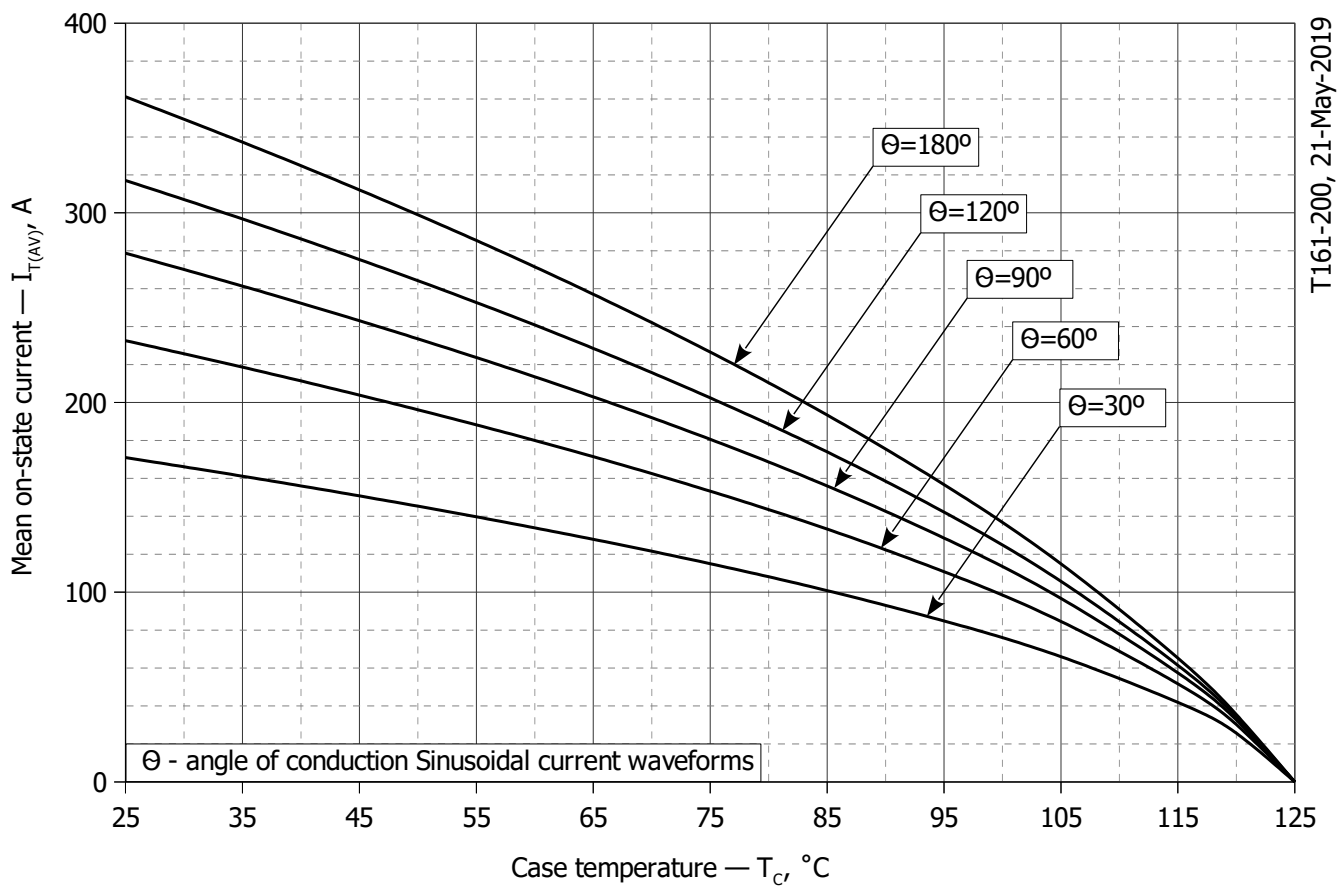
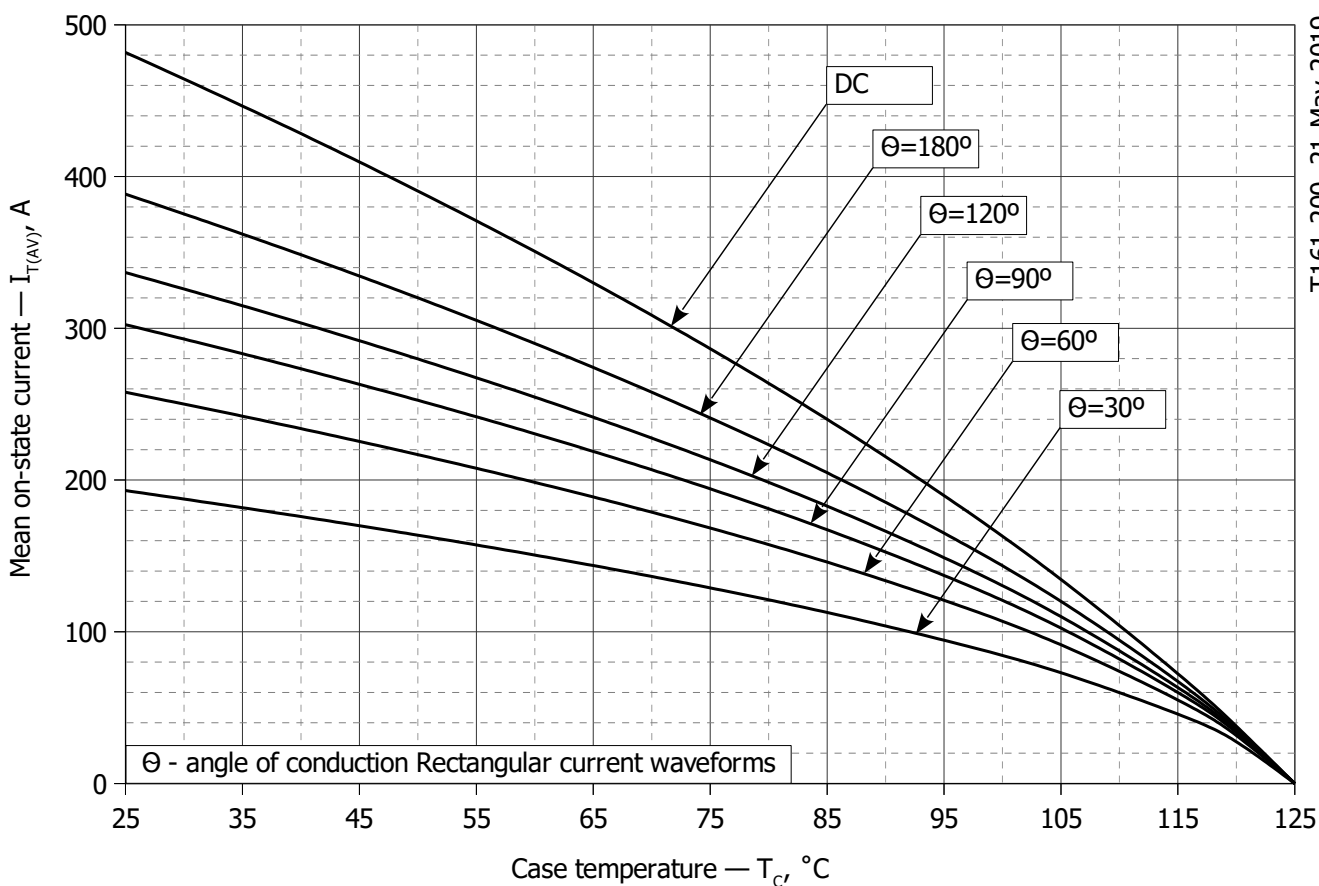


Fig. 8 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)



T161-200, 21-May-2019

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



T161-200, 21-May-2019

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

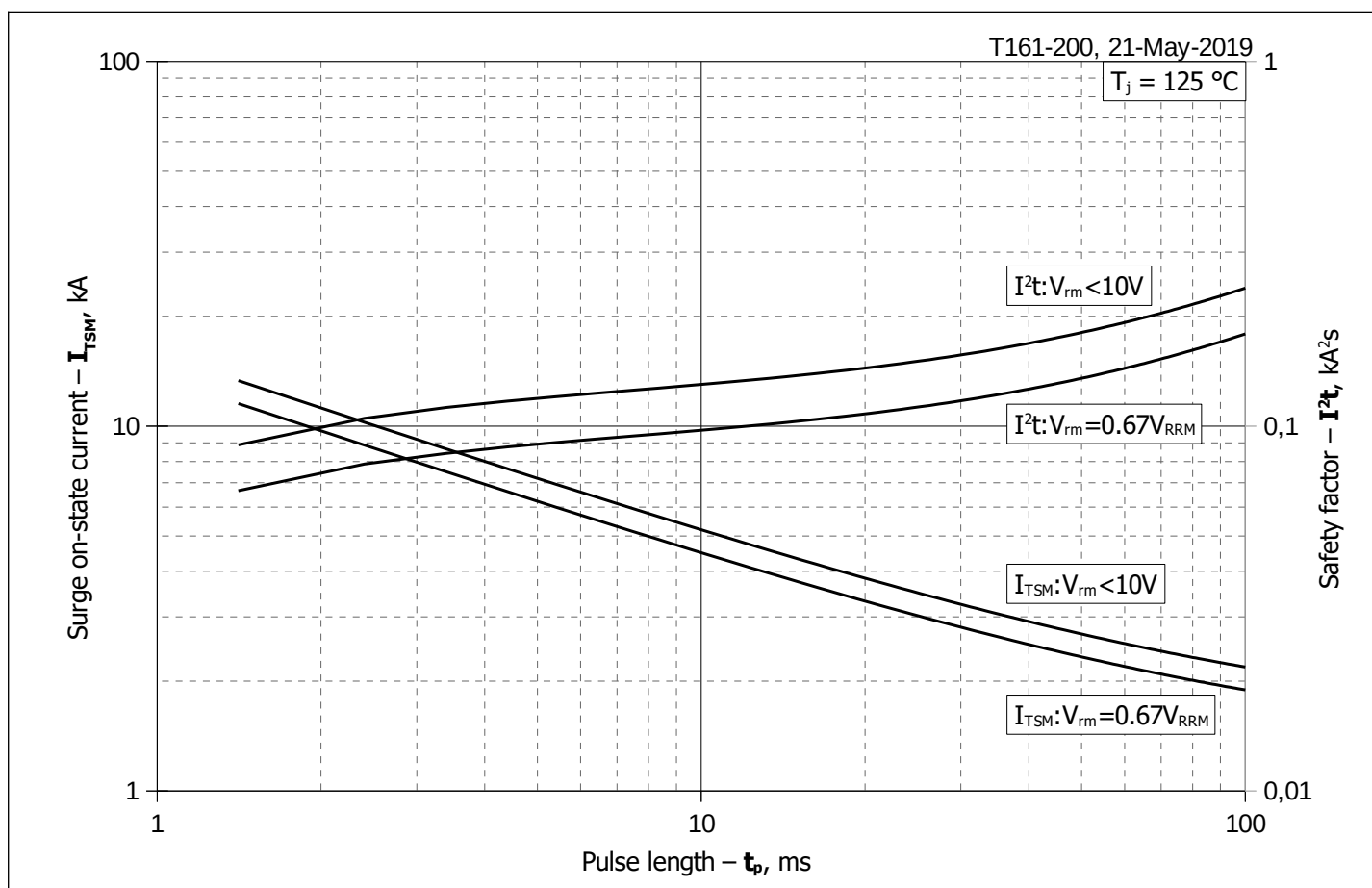


Fig. 11 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

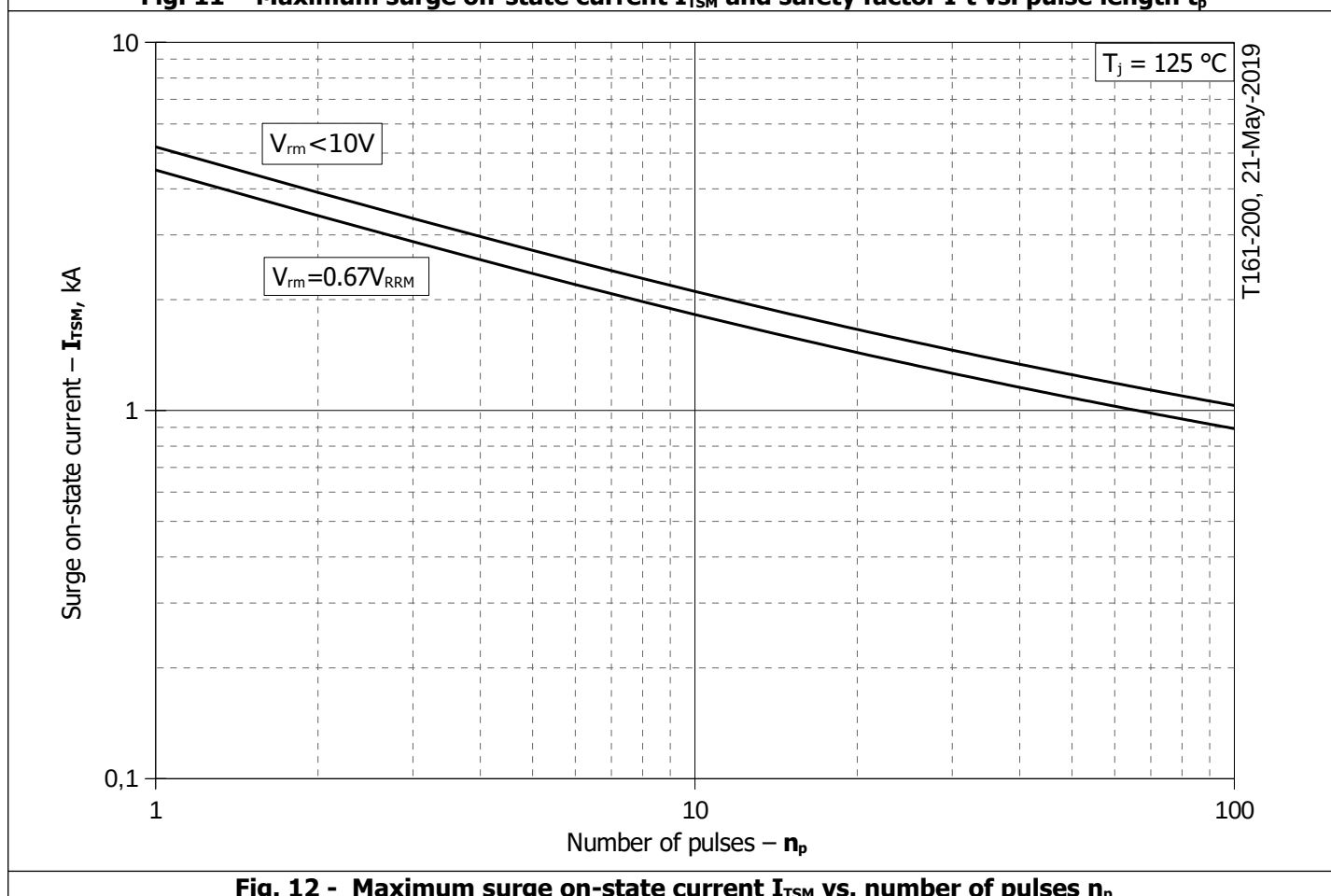


Fig. 12 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p