



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

Phase Control Thyristor Type T173-1600-36

Mean on-state current		I_{TAV}		1600 A	
Repetitive peak off-state voltage		V_{DRM}		2800 ÷ 3600 V	
Repetitive peak reverse voltage		V_{RRM}			
Turn-off time		t_q		500, 630, 800 μ s	
V_{DRM}, V_{RRM}, V	2800	3000	3200	3400	3600
Voltage code	28	30	32	34	36
$T_j, ^\circ C$	- 60 ÷ 125				

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions
ON-STATE				
I_{TAV}	Mean on-state current	A	1600 2070	$T_c=98^\circ C$, Double side cooled $T_c=85^\circ C$, Double side cooled 180° half-sine wave; 50 Hz
I_{TRMS}	RMS on-state current	A	2512	$T_c=98^\circ C$, Double side cooled 180° half-sine wave; 50 Hz
I_{TSM}	Surge on-state current	kA	45.0 52.0	$T_j=T_{jmax}$ $T_j=25^\circ C$ 180° half-sine wave; $t_p=10$ ms; single pulse; $V_D=V_R=0$ V; Gate pulse: $I_G=2$ A; $t_{GP}=50$ μ s; $di_G/dt \geq 1$ A/ μ s
			47.0 54.0	$T_j=T_{jmax}$ $T_j=25^\circ C$ 180° half-sine wave; $t_p=8.3$ ms; single pulse; $V_D=V_R=0$ V; Gate pulse: $I_G=2$ A; $t_{GP}=50$ μ s; $di_G/dt \geq 1$ A/ μ s
I^2t	Safety factor	$A^2s \cdot 10^3$	10100 13500	$T_j=T_{jmax}$ $T_j=25^\circ C$ 180° half-sine wave; $t_p=10$ ms; single pulse; $V_D=V_R=0$ V; Gate pulse: $I_G=2$ A; $t_{GP}=50$ μ s; $di_G/dt \geq 1$ A/ μ s
			9100 12100	$T_j=T_{jmax}$ $T_j=25^\circ C$ 180° half-sine wave; $t_p=8.3$ ms; single pulse; $V_D=V_R=0$ V; Gate pulse: $I_G=2$ A; $t_{GP}=50$ μ s; $di_G/dt \geq 1$ A/ μ s
BLOCKING				
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	2800÷3600	$T_{jmin} < T_j < T_{jmax}$; 180° half-sine wave; $t_p=10$ ms; Gate open
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2900÷3700	$T_{jmin} < T_j < T_{jmax}$; 180° half-sine wave; single pulse; Gate open
V_D, V_R	Direct off-state and Direct reverse voltages	V	$0.6 \cdot V_{DRM}$ $0.6 \cdot V_{RRM}$	$T_j=T_{jmax}$; Gate open

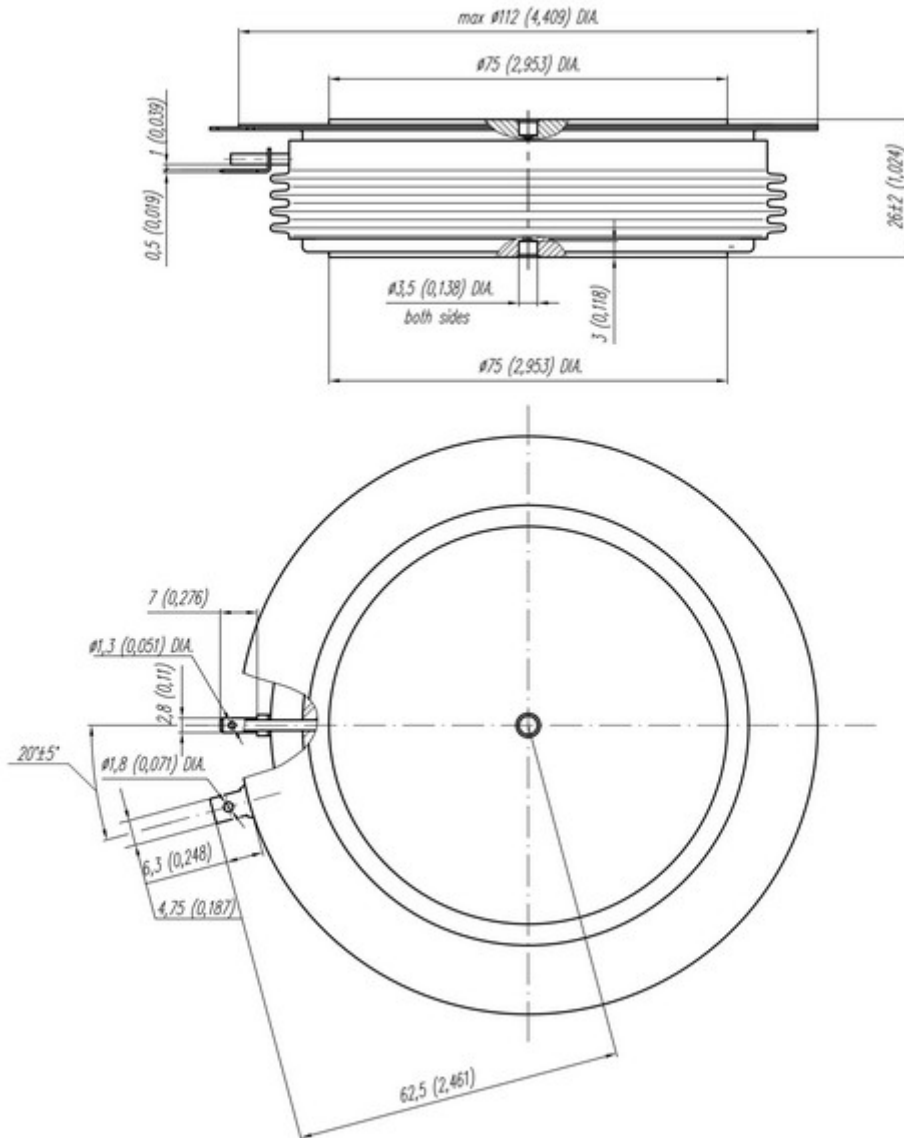
TRIGGERING				
I_{FGM}	Peak forward gate current	A	10	$T_j = T_{j\ max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	5	$T_j = T_{j\ max}$ for DC gate current
SWITCHING				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive ($f=1\ Hz$)	A/ μs	1600	$T_j = T_{j\ max}$; $V_D = 0.67 \cdot V_{DRM}$; $I_{TM} = 8000\ A$; Gate pulse: $I_G = 2\ A$; $t_{GP} = 50\ \mu s$; $di_G/dt \geq 2\ A/\mu s$
THERMAL				
T_{stg}	Storage temperature	$^{\circ}C$	-60 ÷ 50	
T_j	Operating junction temperature	$^{\circ}C$	-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	2.05	$T_j = 25\ ^{\circ}C$; $I_{TM} = 5024\ A$	
$V_{T(TO)}$	On-state threshold voltage, max	V	0.986	$T_j = T_{j\ max}$;	
r_T	On-state slope resistance, max	m Ω	0.254	$0.5\ \pi\ I_{TAV} < I_T < 1.5\ \pi\ I_{TAV}$	
I_L	Latching current, max	mA	1500	$T_j = 25\ ^{\circ}C$; $V_D = 12\ V$; Gate pulse: $I_G = 2\ A$; $t_{GP} = 50\ \mu s$; $di_G/dt \geq 1\ A/\mu s$	
I_H	Holding current, max	mA	300	$T_j = 25\ ^{\circ}C$; $V_D = 12\ V$; 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 2.50 1.50	$T_j = T_{j\ min}$ $T_j = 25\ ^{\circ}C$ $T_j = T_{j\ max}$	$V_D = 12\ V$; $I_D = 3\ A$; Direct gate current
I_{GT}	Gate trigger direct current, max	mA	400 250 150	$T_j = T_{j\ min}$ $T_j = 25\ ^{\circ}C$ $T_j = T_{j\ max}$	
V_{GD}	Gate non-trigger direct voltage, min	V	0.40	$T_j = T_{j\ max}$;	
I_{GD}	Gate non-trigger direct current, min	mA	65.0	$V_D = 0.67 \cdot V_{DRM}$; Direct gate current	
SWITCHING					
t_{gd}	Delay time, max	μs	2.35	$T_j = 25\ ^{\circ}C$; $V_D = 1500\ V$; $I_{TM} = I_{TAV}$; $di/dt = 200\ A/\mu s$;	
t_{gt}	Turn-on time, max	μs	14.00	Gate pulse: $I_G = 2\ A$; $V_G = 20\ V$; $t_{GP} = 50\ \mu s$; $di_G/dt = 2\ A/\mu s$	
t_q	Turn-off time ²⁾ , max	μs	500, 630, 800	$dv_D/dt = 50\ V/\mu s$; $T_j = T_{j\ max}$; $I_{TM} = I_{TAV}$; $di_R/dt = -5\ A/\mu s$; $V_R = 100V$; $V_D = 0.67 \cdot V_{DRM}$	
Q_{rr}	Total recovered charge, max	μC	5560	$T_j = T_{j\ max}$; $I_{TM} = 1600\ A$;	
t_{rr}	Reverse recovery time, max	μs	67	$di_R/dt = -5\ A/\mu s$;	
I_{rrM}	Peak reverse recovery current, max	A	166	$V_R = 100\ V$	

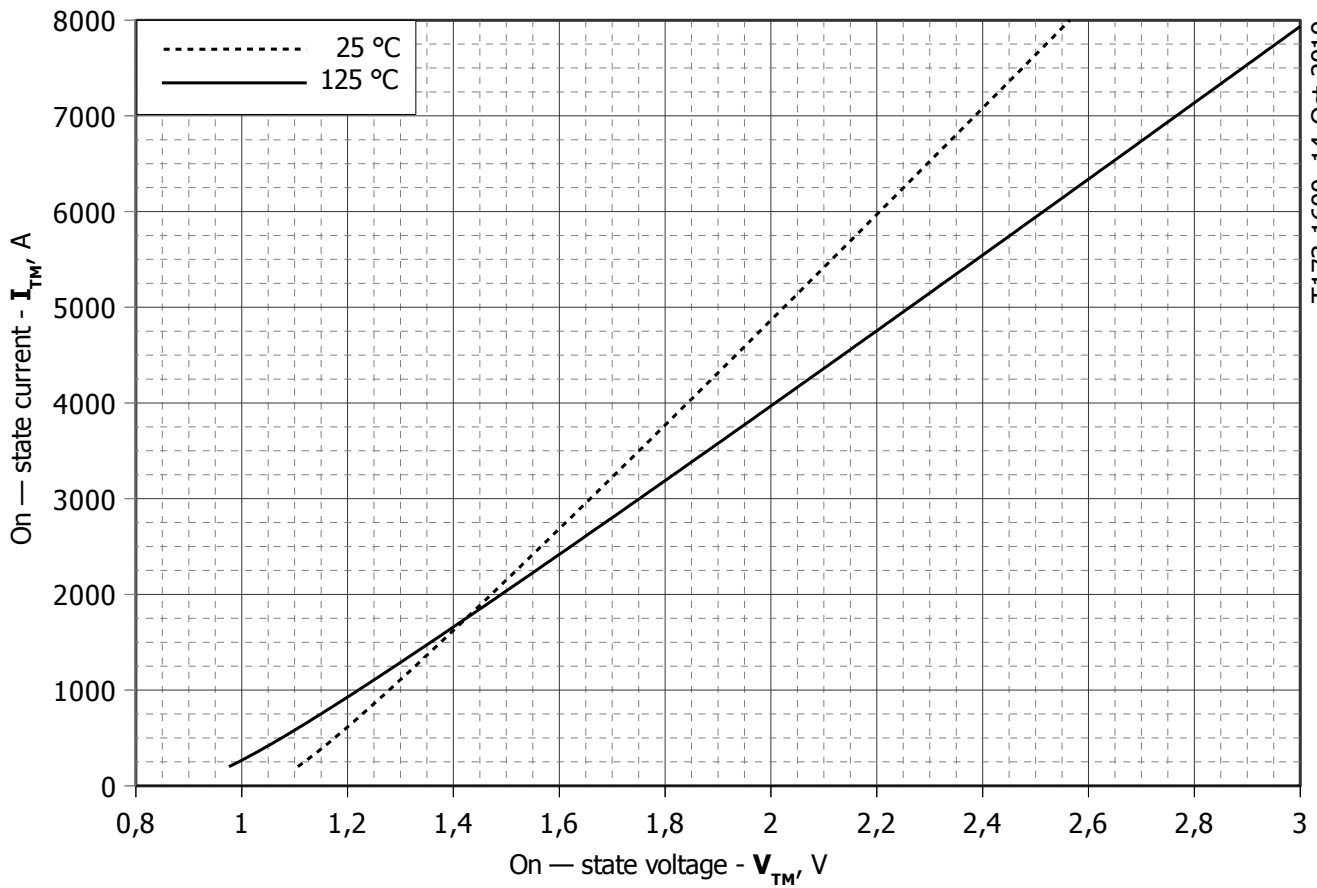
THERMAL					
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0085	Direct current	Double side cooled
R_{thjc-A}			0.0187		Anode side cooled
R_{thjc-K}			0.0153		Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0020	Direct current	
MECHANICAL					
w	Weight, max	g	1500		
D_s	Surface creepage distance	mm (inch)	36.60 (1.441)		
D_a	Air strike distance	mm (inch)	16.20 (0.638)		

PART NUMBERING GUIDE							NOTES																						
T	173	1600	36	A2	B2	N	1) Critical rate of rise of off-state voltage																						
1	2	3	4	5	6	7	<table border="1"> <thead> <tr> <th>Symbol of Group</th> <th>P2</th> <th>K2</th> <th>E2</th> <th>A2</th> <th>T1</th> <th>P1</th> <th>M1</th> </tr> </thead> <tbody> <tr> <td>$(dv_D/dt)_{crit}, V/\mu s$</td> <td>200</td> <td>320</td> <td>500</td> <td>1000</td> <td>1600</td> <td>2000</td> <td>2500</td> </tr> </tbody> </table>							Symbol of Group	P2	K2	E2	A2	T1	P1	M1	$(dv_D/dt)_{crit}, V/\mu s$	200	320	500	1000	1600	2000	2500
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$(dv_D/dt)_{crit}, V/\mu s$	200	320	500	1000	1600	2000	2500																						
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 ($dv_D/dt=50 V/\mu s$) 7. Ambient conditions: N – normal; T – tropical							2) Turn-off time ($dv_D/dt=50 V/\mu s$) <table border="1"> <thead> <tr> <th>Symbol of Group</th> <th>E2</th> <th>C2</th> <th>B2</th> </tr> </thead> <tbody> <tr> <td>$t_{gr}, \mu s$</td> <td>500</td> <td>630</td> <td>800</td> </tr> </tbody> </table>							Symbol of Group	E2	C2	B2	$t_{gr}, \mu s$	500	630	800								
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All dimensions in millimeters (inches)

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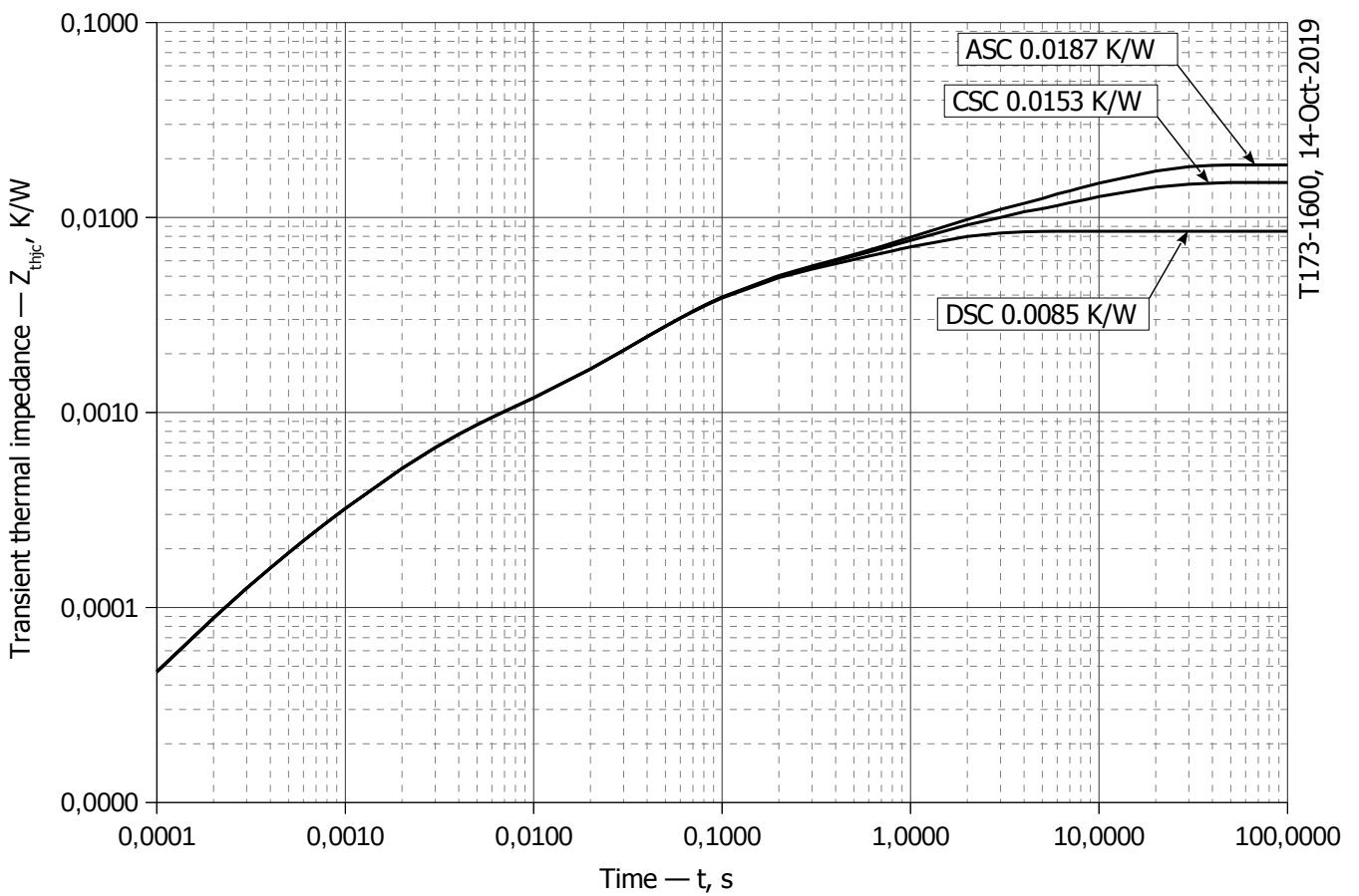
Fig 1 – On-state characteristics of Limit device

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	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\text{max}}$
A	1.00530000	0.81297000
B	0.00017132	0.00024035
C	0.00939300	0.01819700
D	0.00116920	0.00130860

On-state characteristic model (see Fig. 1)



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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	0.00007989	0.002973	0.0005936	0.000846	0.00005975	0.003948
τ_i , s	1.688	0.06219	0.002329	0.138	0.0003243	0.9533

DC Anode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.01013	0.004062	0.0009401	0.002853	0.0005963	0.00005641
τ_i , s	9.747	1.058	0.1304	0.06179	0.002313	0.0003013

DC Cathode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.006619	0.004034	0.0008595	0.002956	0.0005965	0.00005689
τ_i , s	9.744	1.025	0.1394	0.06237	0.002318	0.0003037

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

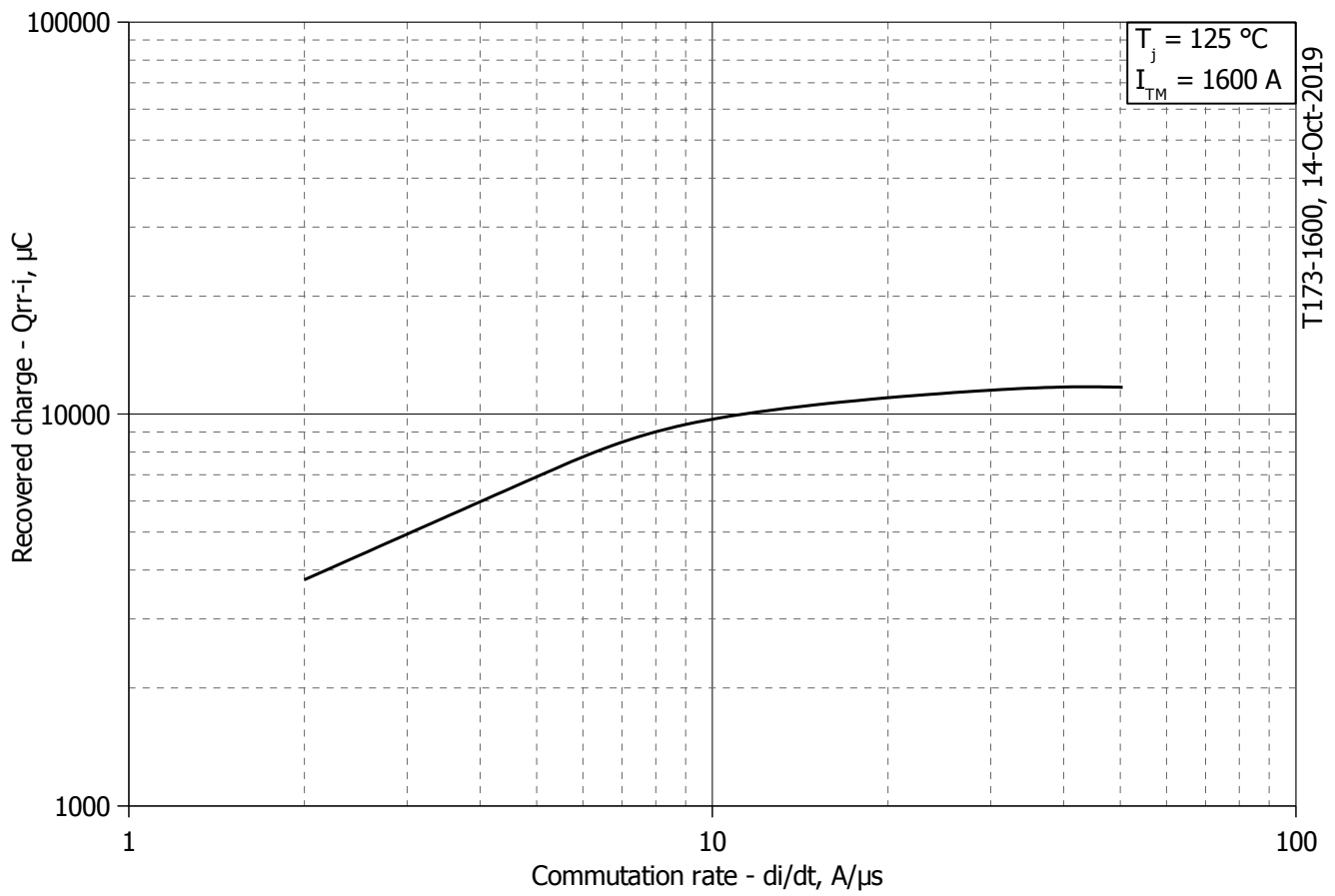


Fig 3 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

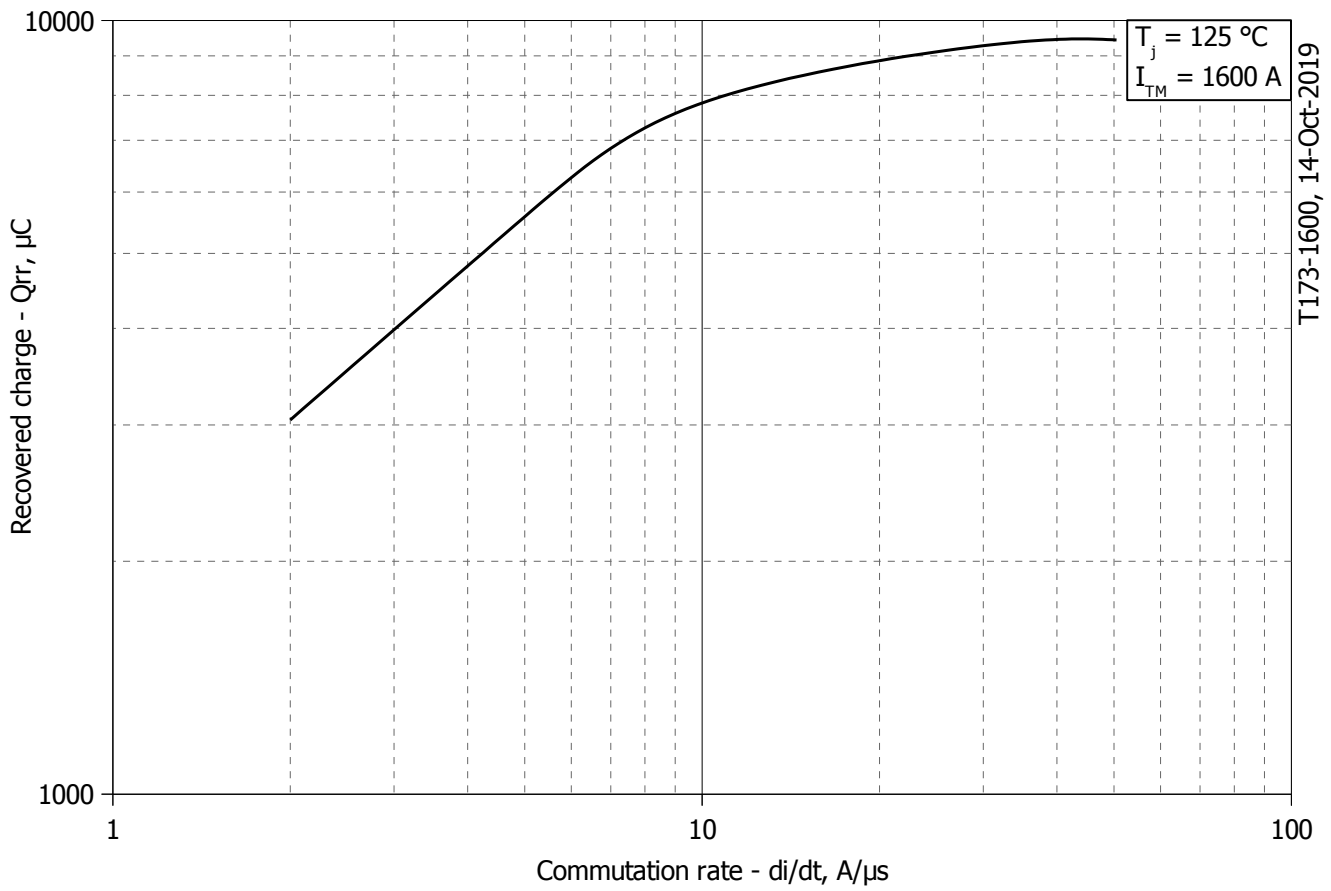


Fig 4 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

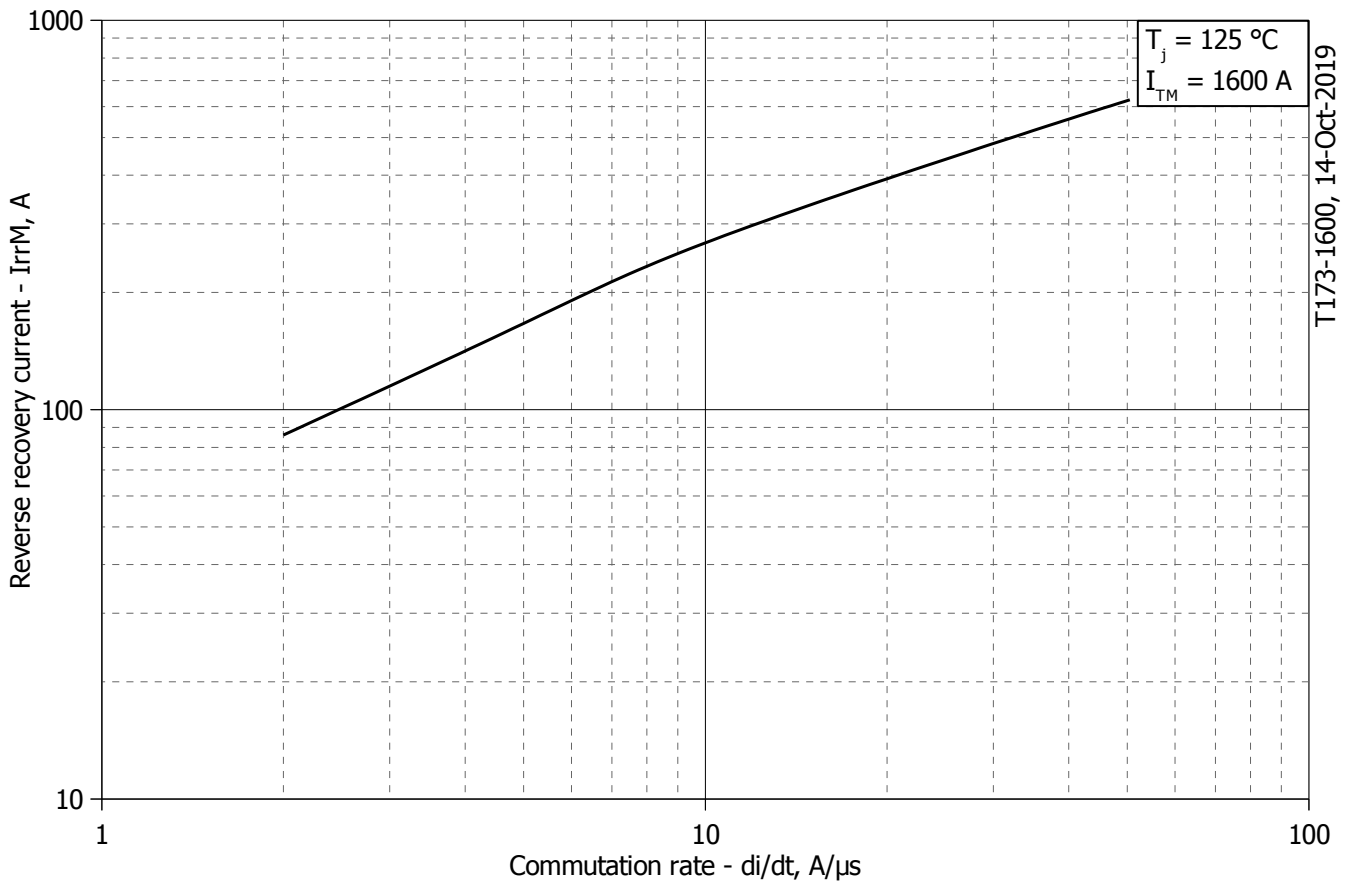


Fig 5 – Maximum reverse recovery current I_{rrM} vs. commutation rate di_R/dt

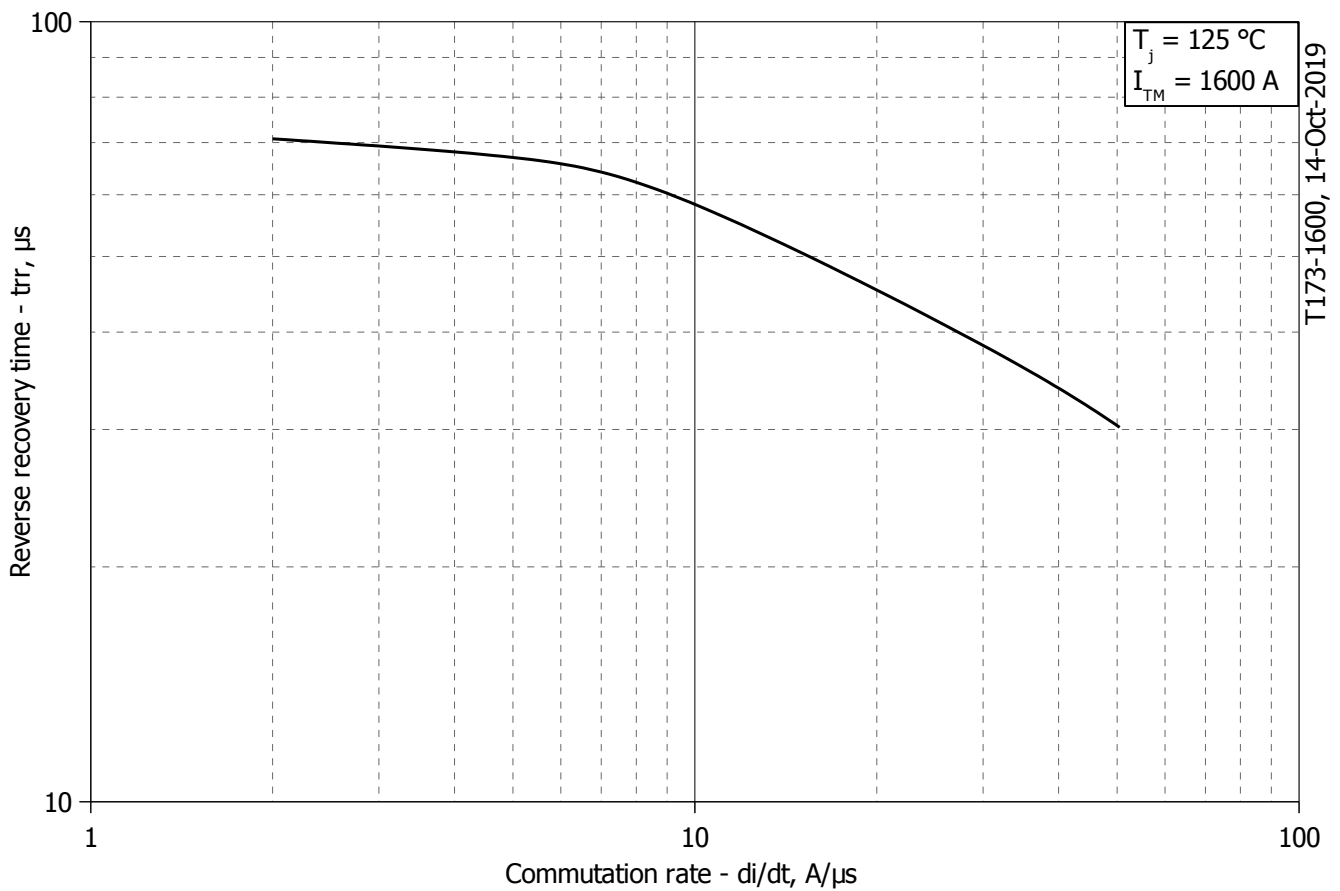
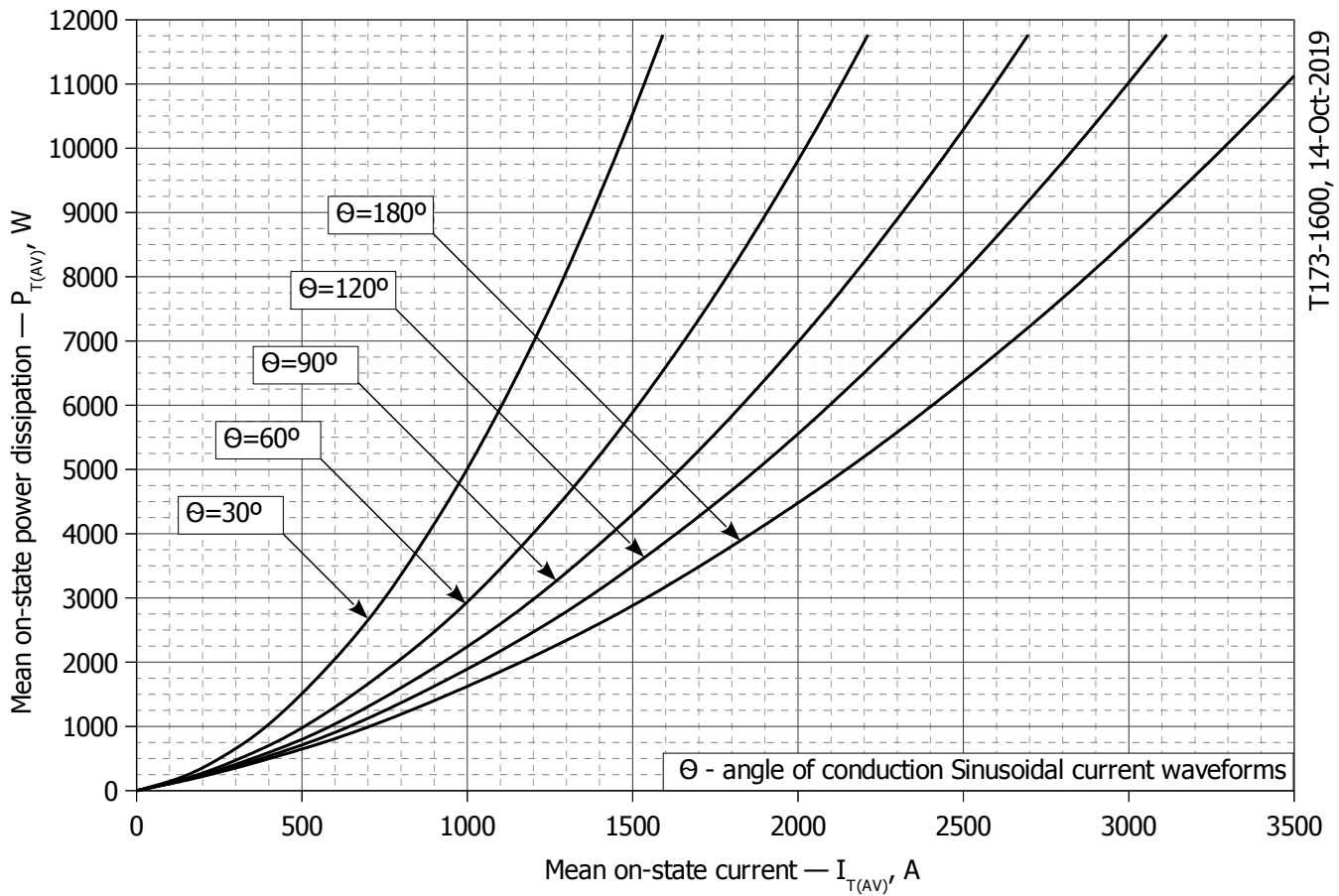
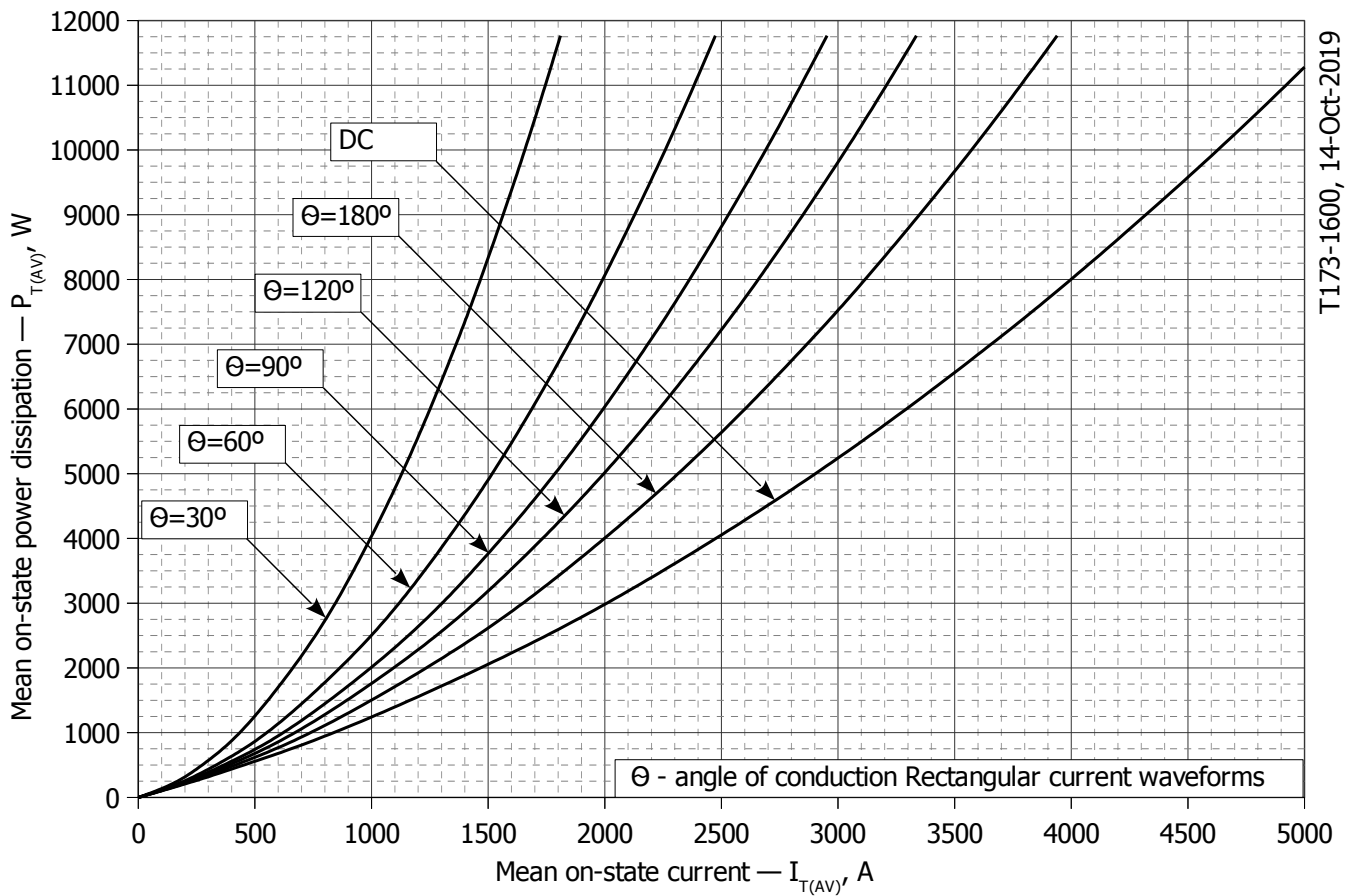


Fig 6 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)



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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)



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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)

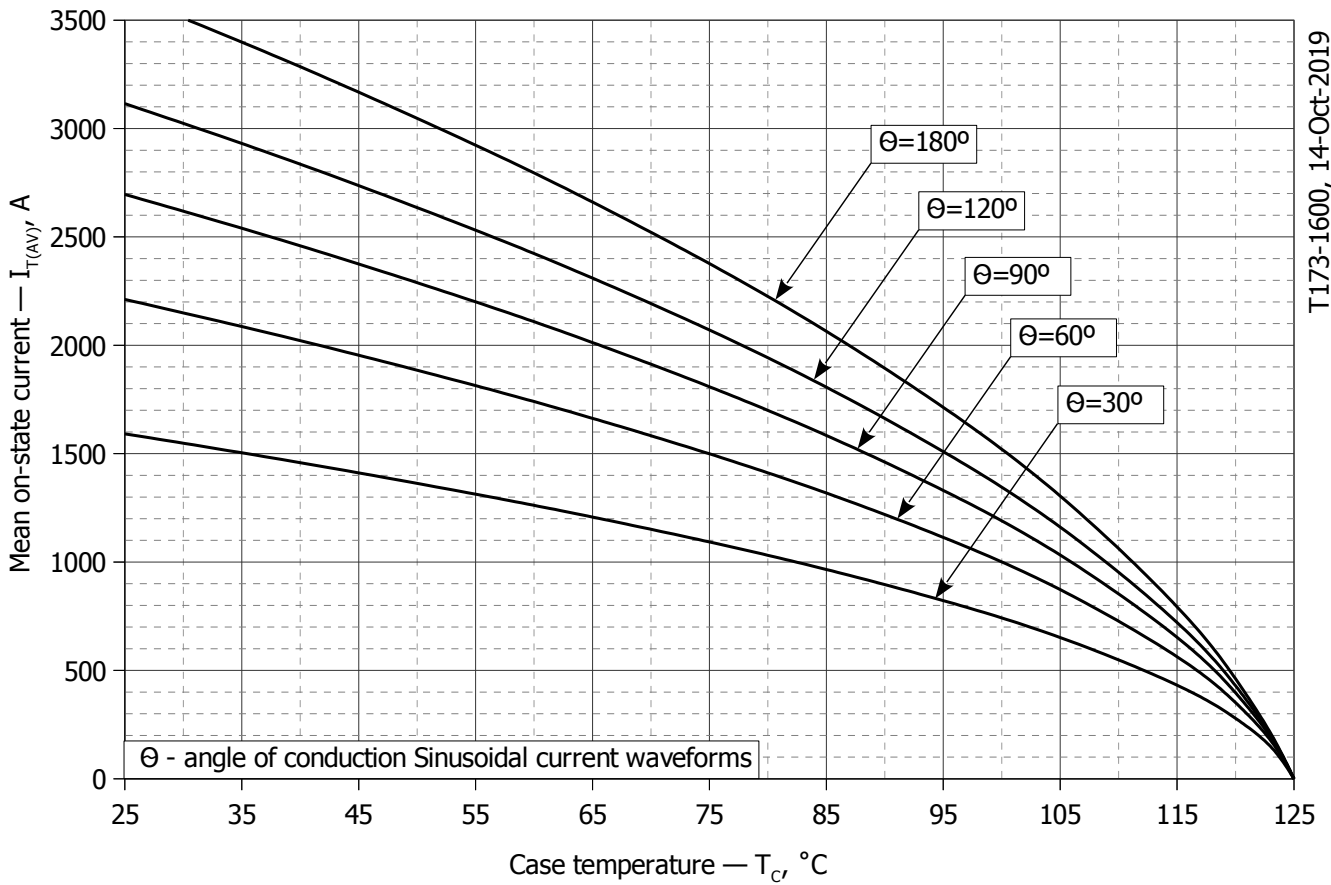


Fig. 9 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

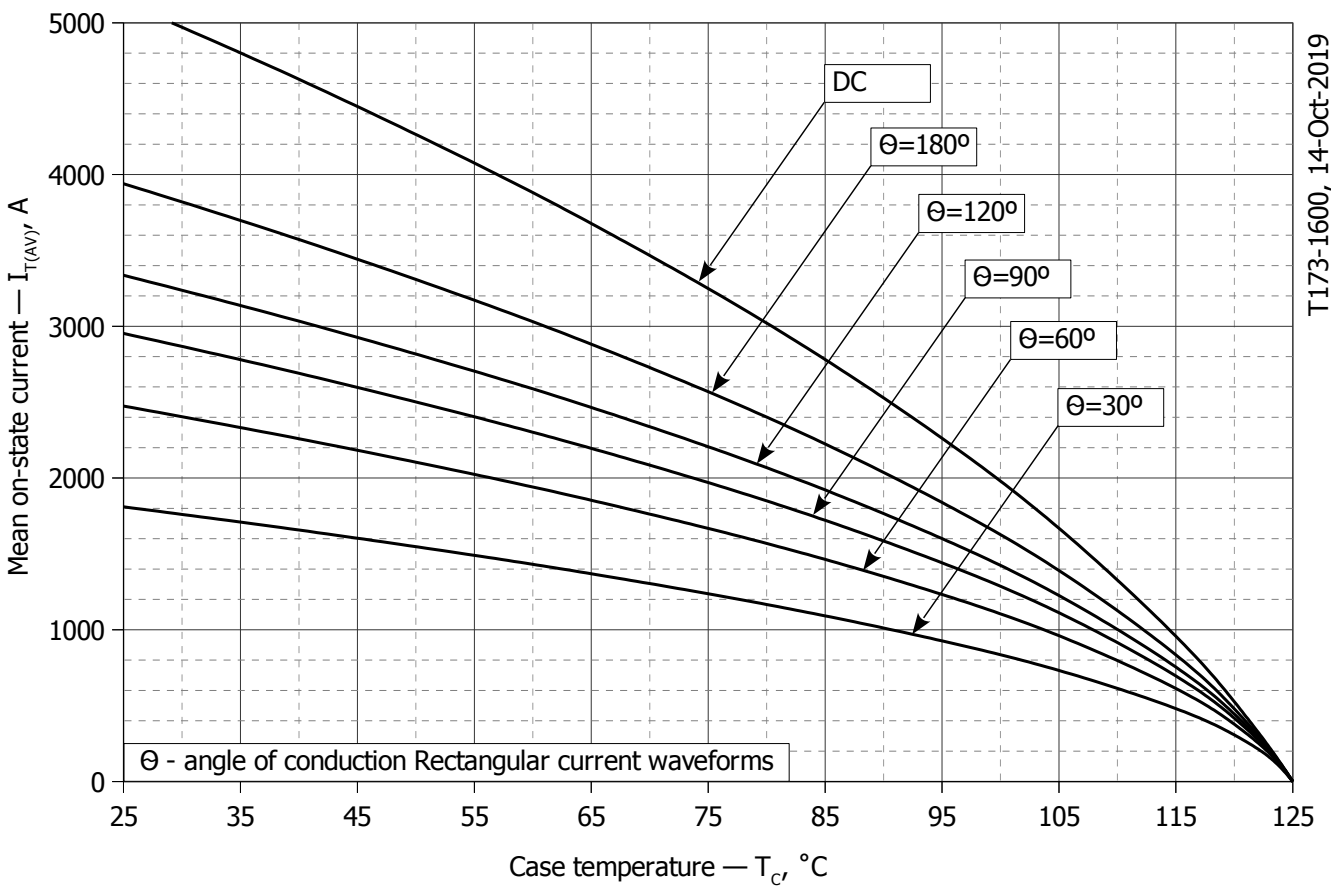


Fig. 10 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

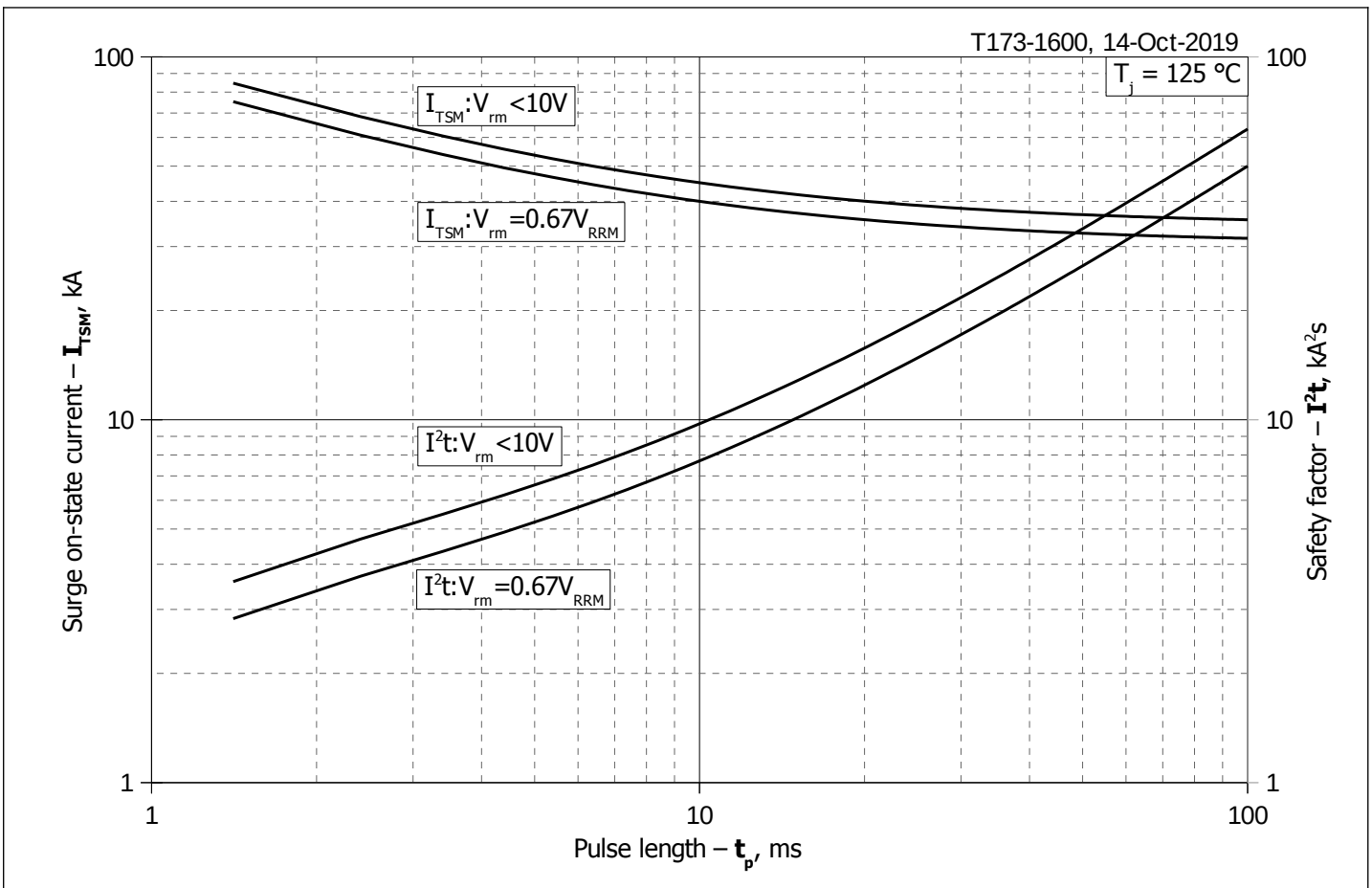


Fig. 11 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

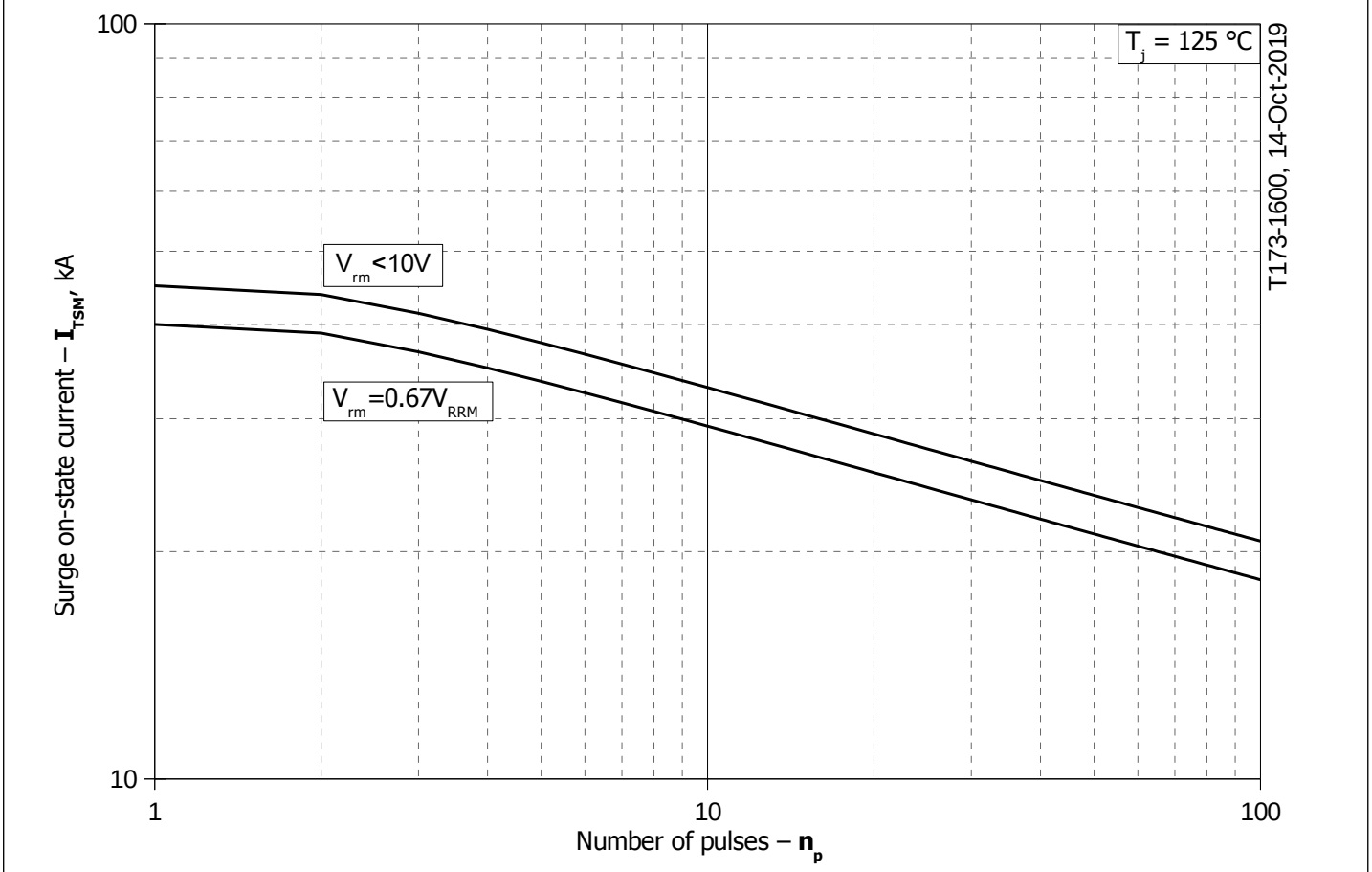


Fig. 12 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p