



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

Phase Control Thyristor Type T643-320-65

Mean on-state current		I_{TAV}		320 A								
Repetitive peak off-state voltage		V_{DRM}		4600 ÷ 6500 V								
Repetitive peak reverse voltage		V_{RRM}										
Turn-off time		t_q		800 μ s								
V_{DRM}, V_{RRM}, V	4600	4800	5000	5200	5400	5600	5800	6000	6200	6400	6500	
Voltage code	46	48	50	52	54	56	58	60	62	64	65	
$T_j, ^\circ C$	-60 ÷ 125											

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Mean on-state current	A	320 419 344	$T_c=89^\circ C$; Double side cooled; $T_c=70^\circ C$; Double side cooled; $T_c=85^\circ C$; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	502	$T_c=92^\circ C$; Double side cooled; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	4.0 4.5	$T_j=T_{j\ max}$ $T_j=25^\circ C$	180° half-sine wave; $t_p=10\ ms$; single pulse; $V_D=V_R=0\ V$; Gate pulse: $I_G=2\ A$; $t_{GP}=50\ \mu s$; $di_G/dt \geq 1\ A/\mu s$
			4.0 4.5	$T_j=T_{j\ max}$ $T_j=25^\circ C$	180° half-sine wave; $t_p=8.3\ ms$; single pulse; $V_D=V_R=0\ V$; Gate pulse: $I_G=2\ A$; $t_{GP}=50\ \mu s$; $di_G/dt \geq 1\ A/\mu s$
I^2t	Safety factor	$A^2s \cdot 10^3$	80 100	$T_j=T_{j\ max}$ $T_j=25^\circ C$	180° half-sine wave; $t_p=10\ ms$; single pulse; $V_D=V_R=0\ V$; Gate pulse: $I_G=2\ A$; $t_{GP}=50\ \mu s$; $di_G/dt \geq 1\ A/\mu s$
			60 80	$T_j=T_{j\ max}$ $T_j=25^\circ C$	180° half-sine wave; $t_p=8.3\ ms$; single pulse; $V_D=V_R=0\ V$; Gate pulse: $I_G=2\ A$; $t_{GP}=50\ \mu s$; $di_G/dt \geq 1\ A/\mu s$
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	4600 ÷ 6500	$T_{j\ min} < T_j < T_{j\ max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	4700 ÷ 6600	$T_{j\ min} < T_j < T_{j\ max}$; 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	

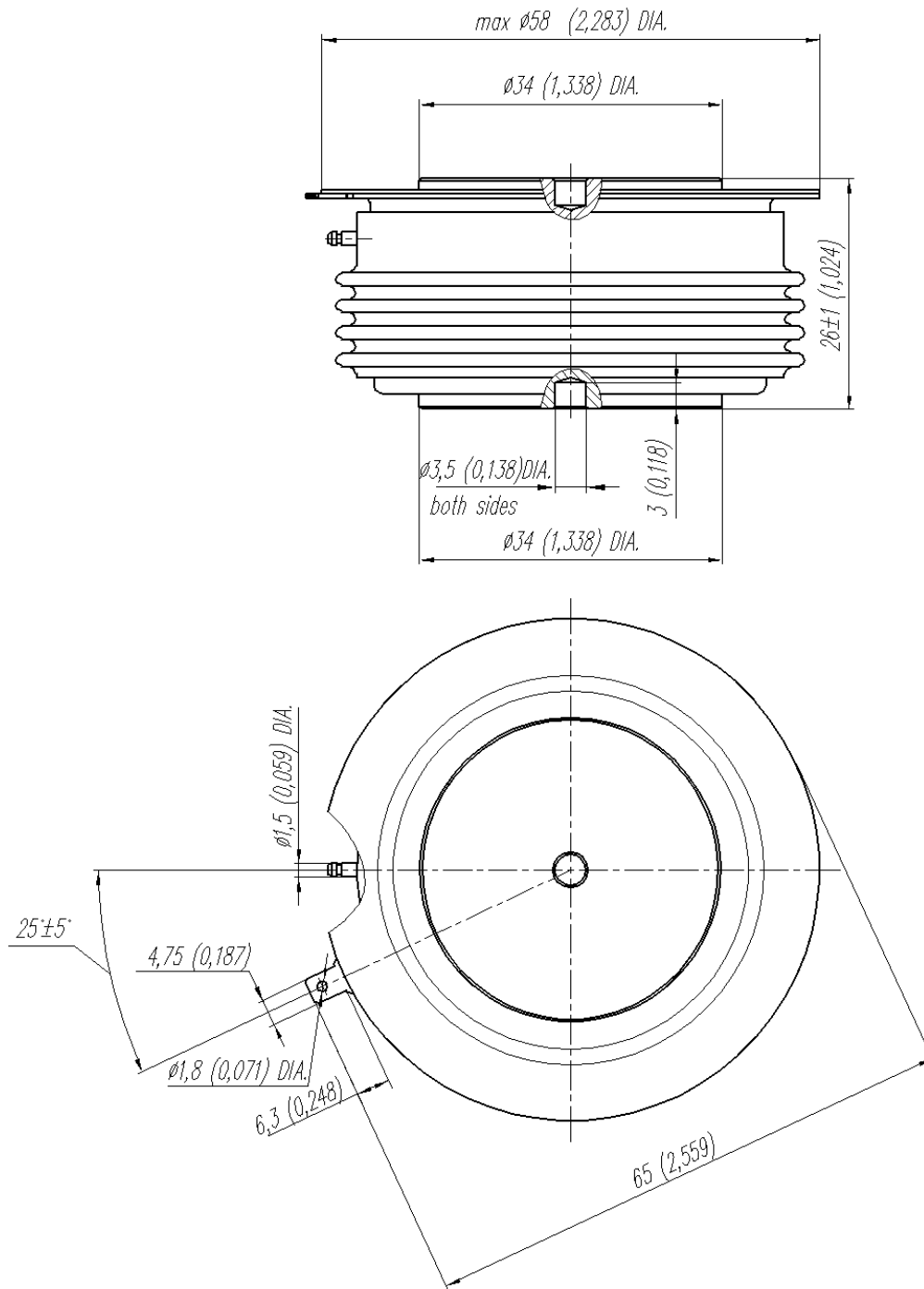
TRIGGERING				
I_{FGM}	Peak forward gate current	A	8	$T_j = T_{j\ max}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	4	$T_j = T_{j\ max}$ for DC gate current
SWITCHING				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive ($f=1\ Hz$)	A/ μs	500	$T_j = T_{j\ max}$; $V_D = 0.67 \cdot V_{DRM}$; $I_{TM} = 1400\ A$; Gate pulse: $I_G = 2\ A$; $t_{GP} = 50\ \mu s$; $di_G/dt \geq 2\ A/\mu s$
THERMAL				
T_{stg}	Storage temperature	$^{\circ}C$	$-60 \div 50$	
T_j	Operating junction temperature	$^{\circ}C$	$-60 \div 125$	
MECHANICAL				
F	Mounting force	kN	$14.0 \div 16.0$	
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	2.60	$T_j = 25\ ^{\circ}C$; $I_{TM} = 785\ A$	
$V_{T(TO)}$	On-state threshold voltage, max	V	1.338	$T_j = T_{j\ max}$;	
r_T	On-state slope resistance, max	$m\Omega$	2.351	$0.5\ \pi\ I_{TAV} < I_T < 1.5\ \pi\ I_{TAV}$	
I_L	Latching current, max	mA	700	$T_j = 25\ ^{\circ}C$; $V_D = 12\ V$; 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	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	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	400 300 150	$T_j = T_{j\ min}$ $T_j = 25\ ^{\circ}C$ $T_j = T_{j\ max}$	
V_{GD}	Gate non-trigger direct voltage, min	V	0.25	$T_j = T_{j\ max}$;	
I_{GD}	Gate non-trigger direct current, min	mA	35.00	$V_D = 0.67 \cdot V_{DRM}$; Direct gate current	
SWITCHING					
t_{gd}	Delay time, max	μs	3.00	$T_j = 25\ ^{\circ}C$; $V_D = 1500\ V$; $I_{TM} = I_{TAV}$; $di/dt = 200\ A/\mu s$;	
t_{gt}	Turn-on time, max	μs	10.00	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	800	$dv_D/dt = 50\ V/\mu s$; $T_j = T_{j\ max}$; $I_{TM} = I_{TAV}$; $di_R/dt = -10\ A/\mu s$; $V_R = 100V$; $V_D = 2000\ V$	
Q_{rr}	Total recovered charge, max	μC	2600	$T_j = T_{j\ max}$; $I_{TM} = 1000\ A$;	
t_{rr}	Reverse recovery time, typ	μs	52	$di_R/dt = -5\ A/\mu s$;	
I_{rrM}	Peak reverse recovery current, max	A	100	$V_R = 100\ V$	

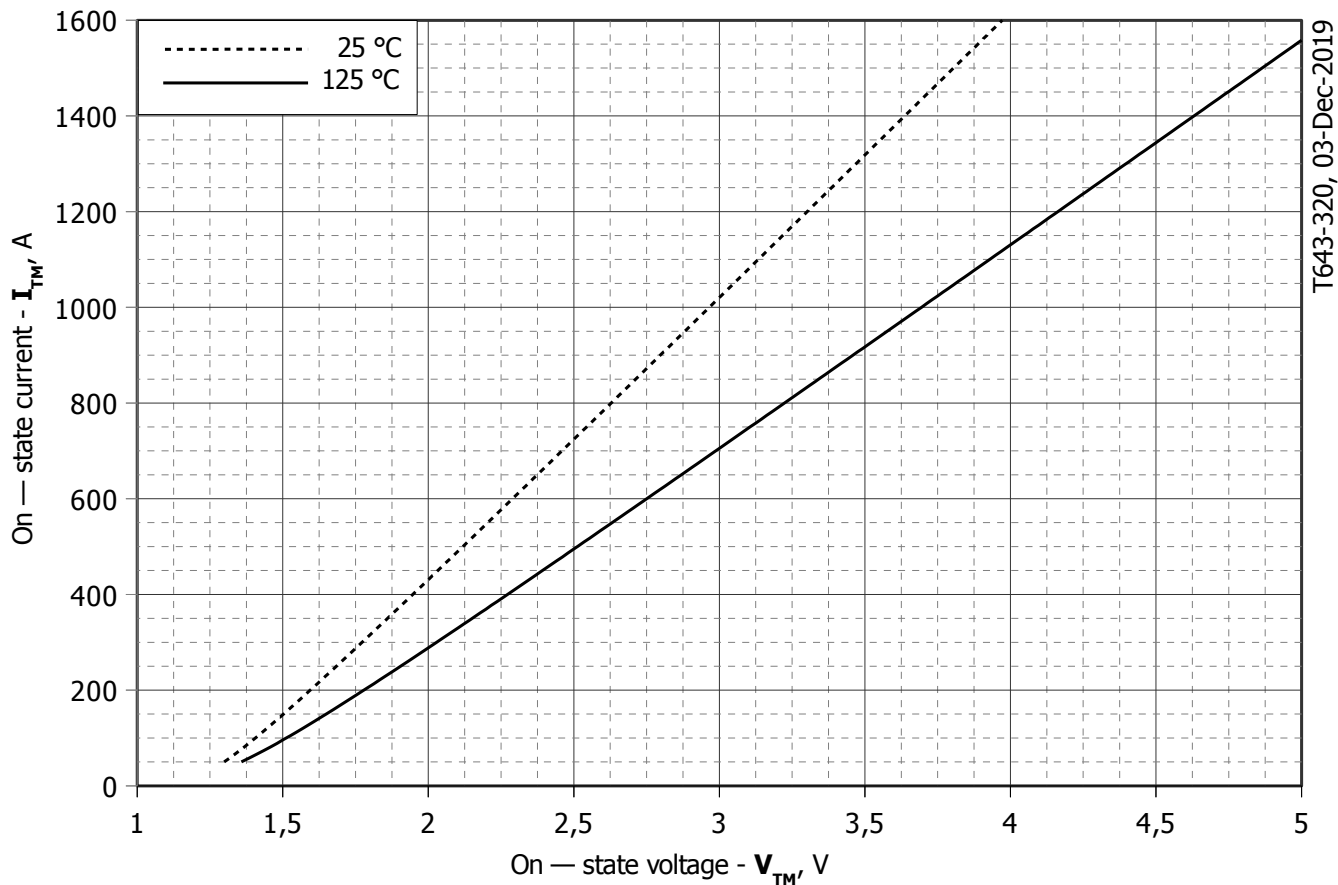
THERMAL					
R_{thjc}	Thermal resistance, junction to case, max	°C/W	0.0350	Direct current	Double side cooled
R_{thjc-A}			0.0770		Anode side cooled
R_{thjc-K}			0.0630		Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	°C/W	0.0060	Direct current	
MECHANICAL					
w	Weight, max	g	280		
D_s	Surface creepage distance	mm (inch)	29.60 (1.165)		
D_a	Air strike distance	mm (inch)	18.25 (0.716)		

PART NUMBERING GUIDE							NOTES																		
T	643	320	65	A2	B2	N	¹⁾ Critical rate of rise of off-state voltage <table border="1"> <thead> <tr> <th>Symbol of Group</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>1000</td> <td>1600</td> <td>2000</td> <td>2500</td> </tr> </tbody> </table> ²⁾ Turn-off time ($dv_D/dt=50 V/\mu s$) <table border="1"> <thead> <tr> <th>Symbol of Group</th> <th>B2</th> </tr> </thead> <tbody> <tr> <td>$t_q, \mu s$</td> <td>800</td> </tr> </tbody> </table>					Symbol of Group	A2	T1	P1	M1	$(dv_D/dt)_{crit}, V/\mu s$	1000	1600	2000	2500	Symbol of Group	B2	$t_q, \mu s$	800
Symbol of Group	A2	T1	P1	M1																					
$(dv_D/dt)_{crit}, V/\mu s$	1000	1600	2000	2500																					
Symbol of Group	B2																								
$t_q, \mu s$	800																								
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 ($dv_D/dt=50 V/\mu s$) 7. Ambient conditions: N – normal; T – tropical																									



All dimensions in millimeters (inches)

The information contained herein is confidential and protected by Copyright. In the interest of product improvement, Proton-Electrotex reserves the right to change data sheet without notice.



T643-320, 03-Dec-2019

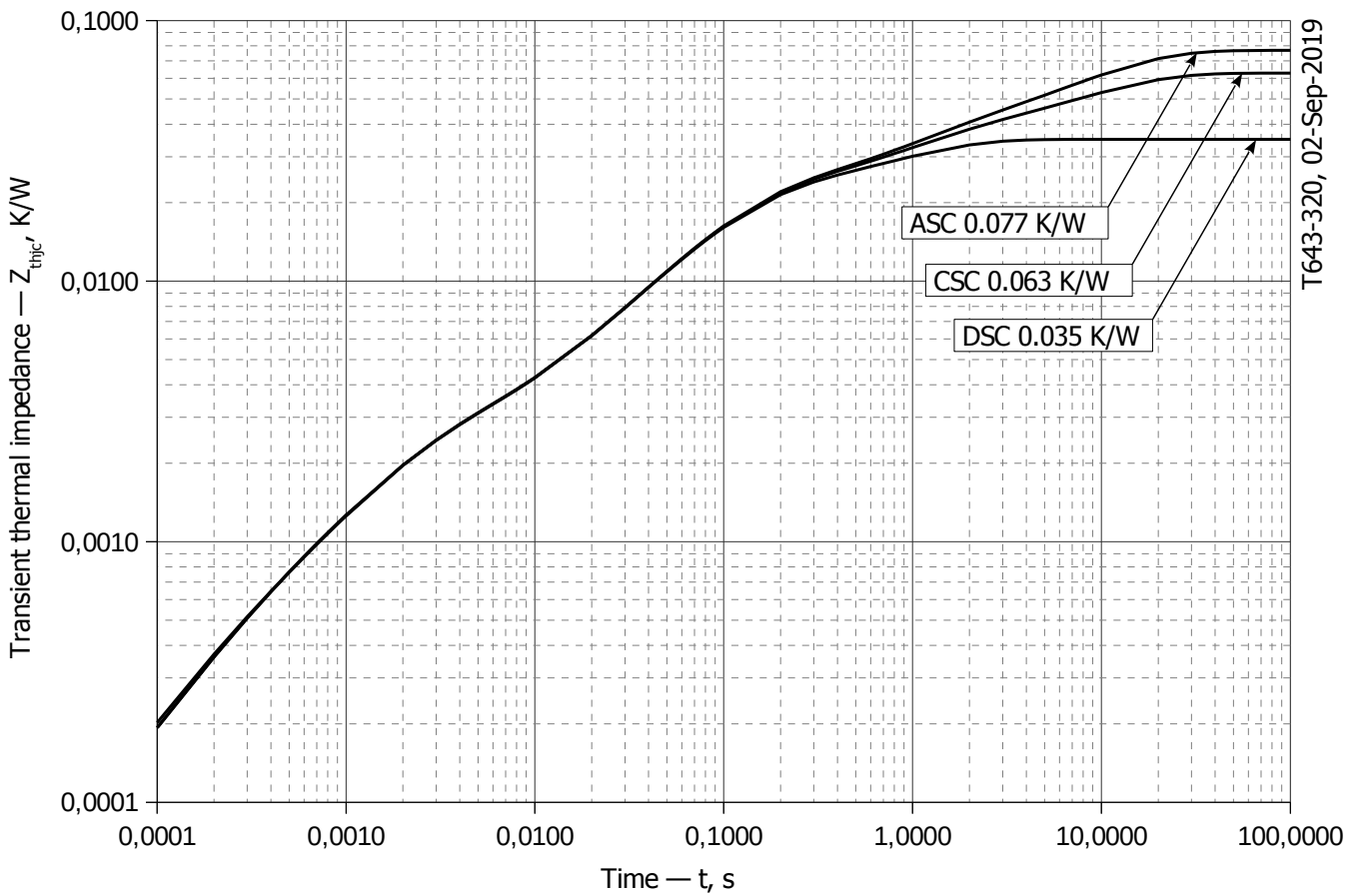
Fig 1 – On-state characteristics of Limit device

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	1.0573210	0.9806394
B	0.0016740	0.0023475
C	0.0441791	0.0745885
D	-0.0022481	-0.0047270

On-state characteristic model (see Fig. 1)



T643-320, 02-Sep-2019

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	2.007e-005	0.01412	0.01797	0.0007764	0.00193	0.0001844
τ_i , s	4.957	0.9362	0.09335	0.04227	0.001702	0.0002492

DC Anode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.04173	0.01173	0.01847	0.001981	0.0001722	0.002719
τ_i , s	9.751	1.085	0.09044	0.00175	0.0001916	0.791

DC Cathode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.02781	0.0007698	0.01797	0.001931	0.000209	0.01416
τ_i , s	9.752	0.186	0.08881	0.001757	0.0002747	1.004

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

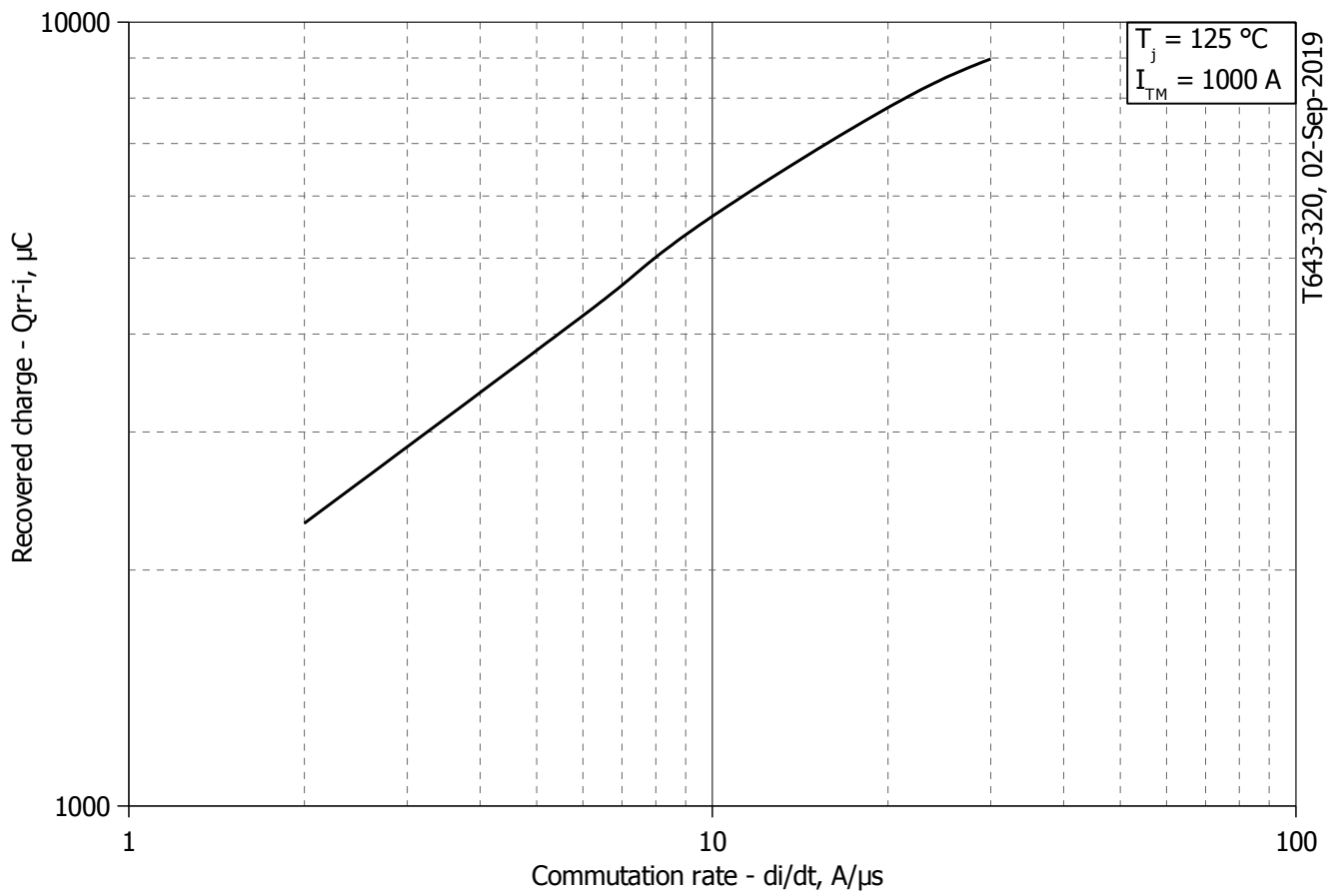


Fig 3 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

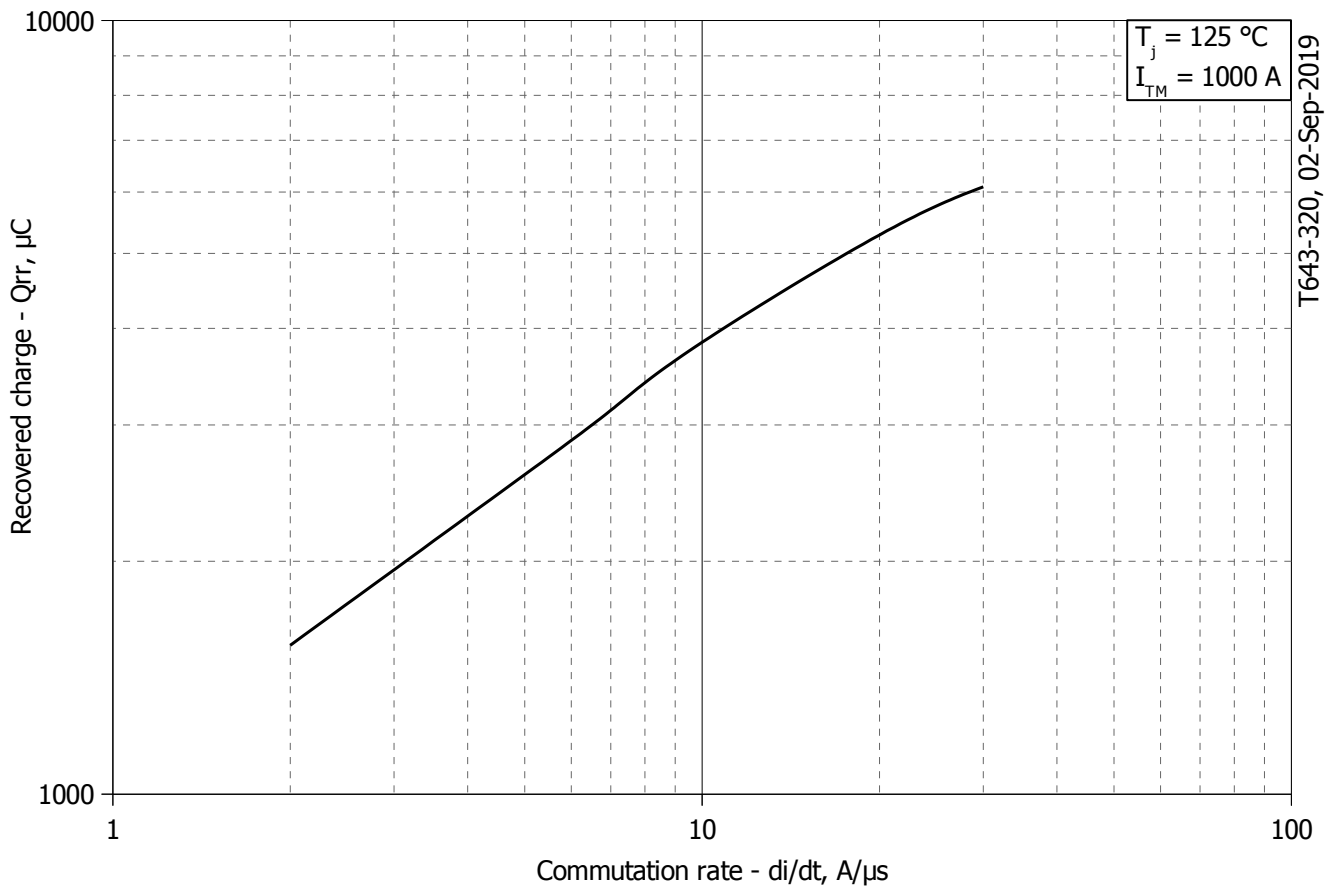


Fig 4 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

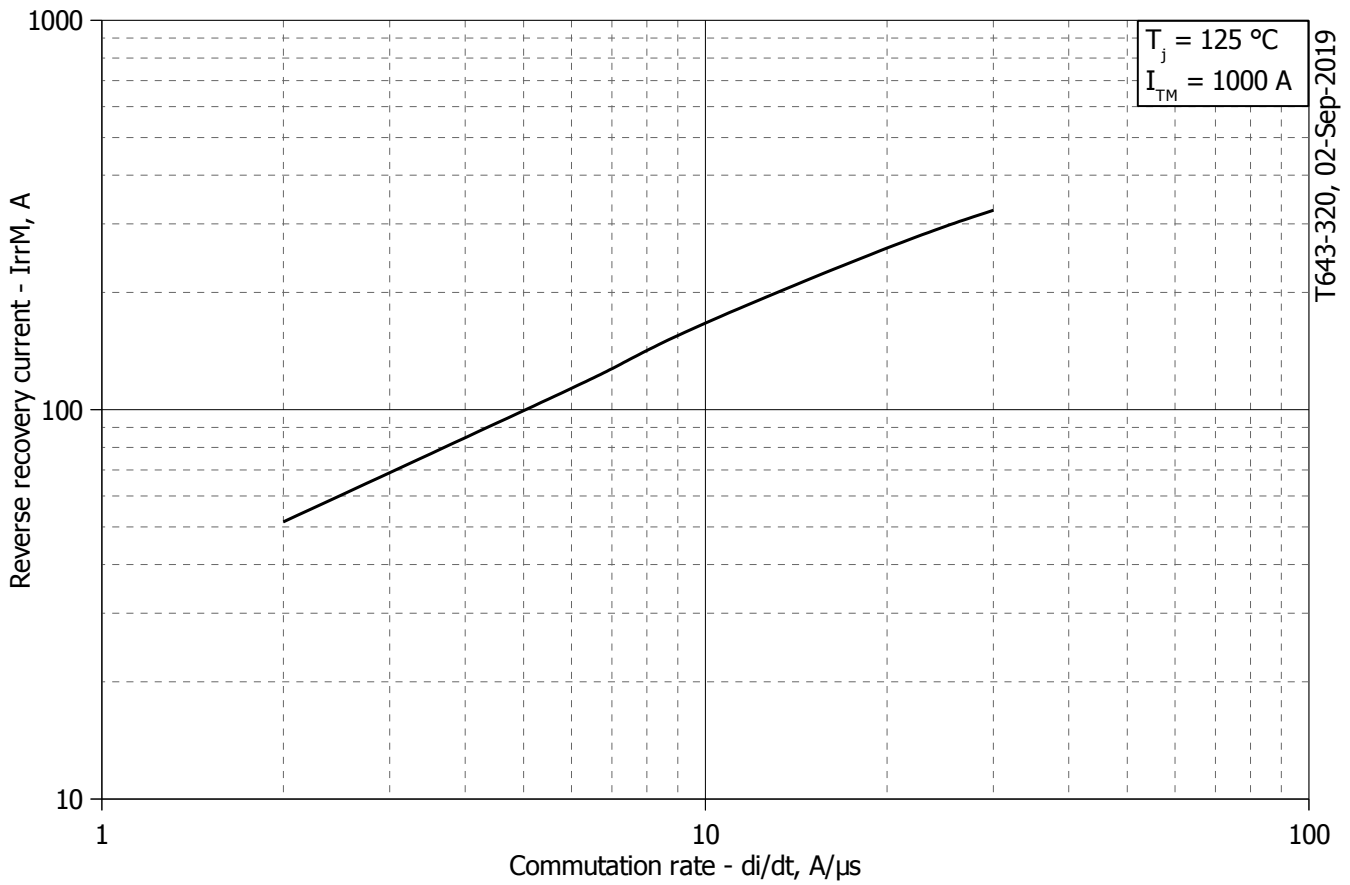


Fig 5 – Maximum reverse recovery current I_{rrM} vs. commutation rate di_R/dt

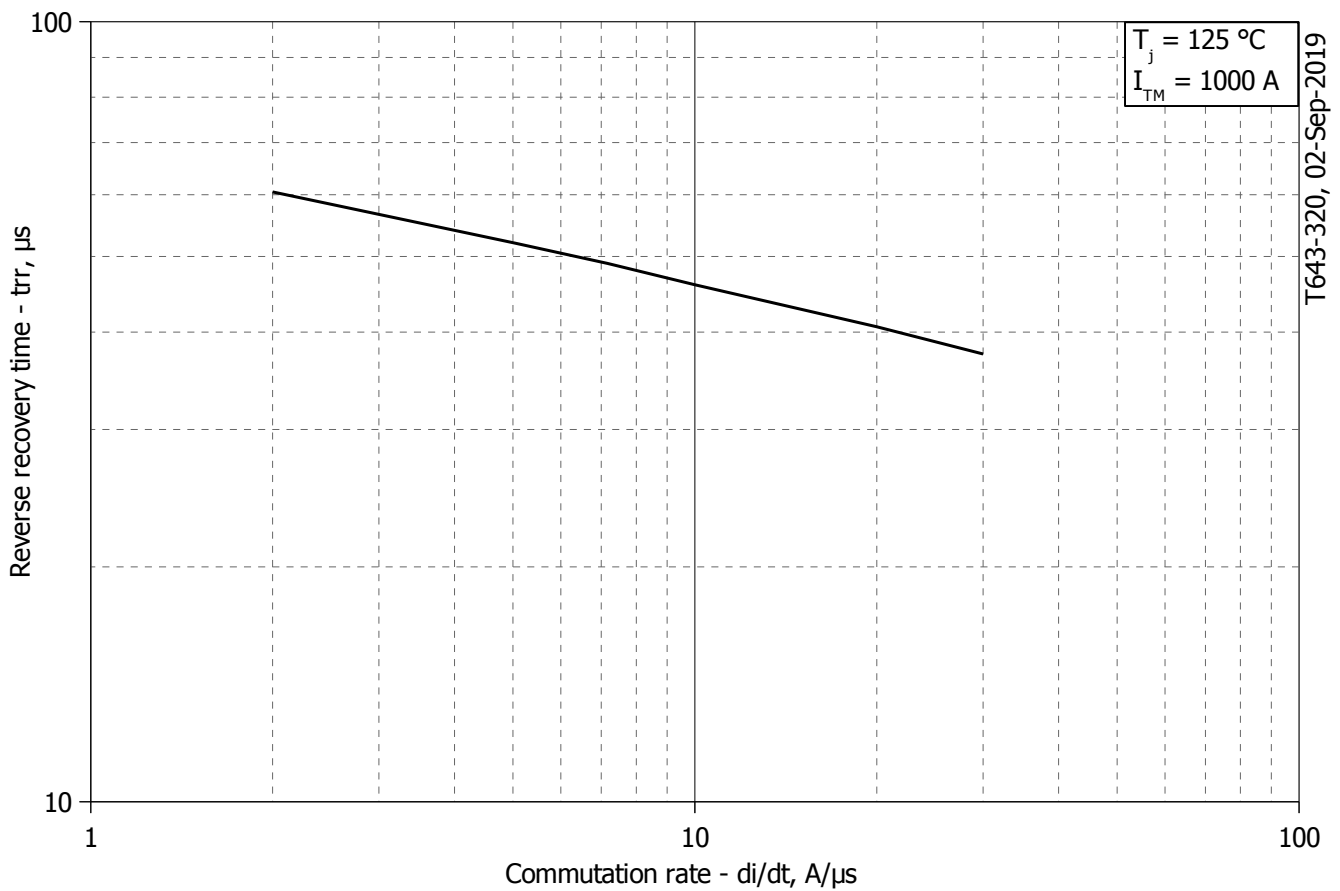
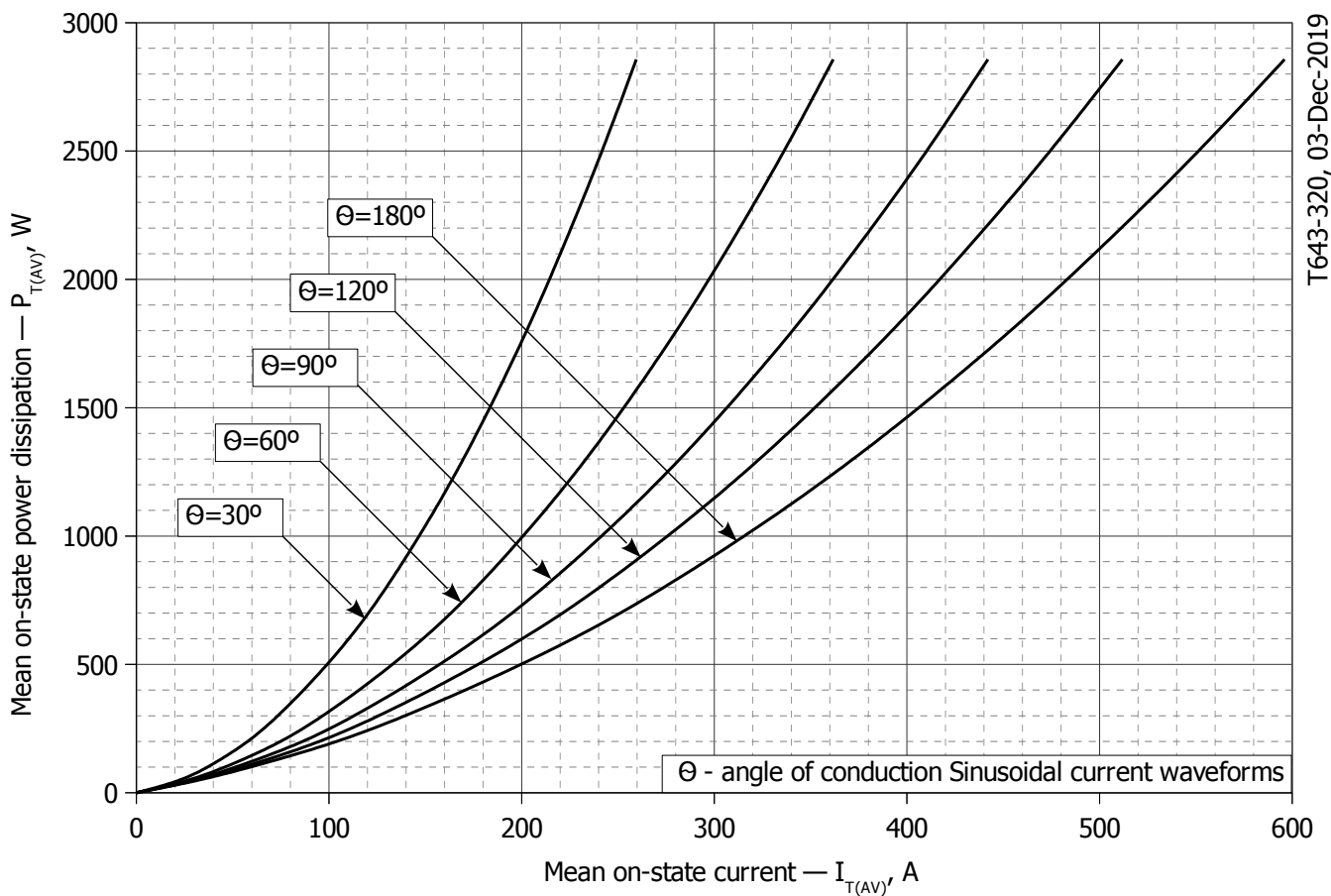
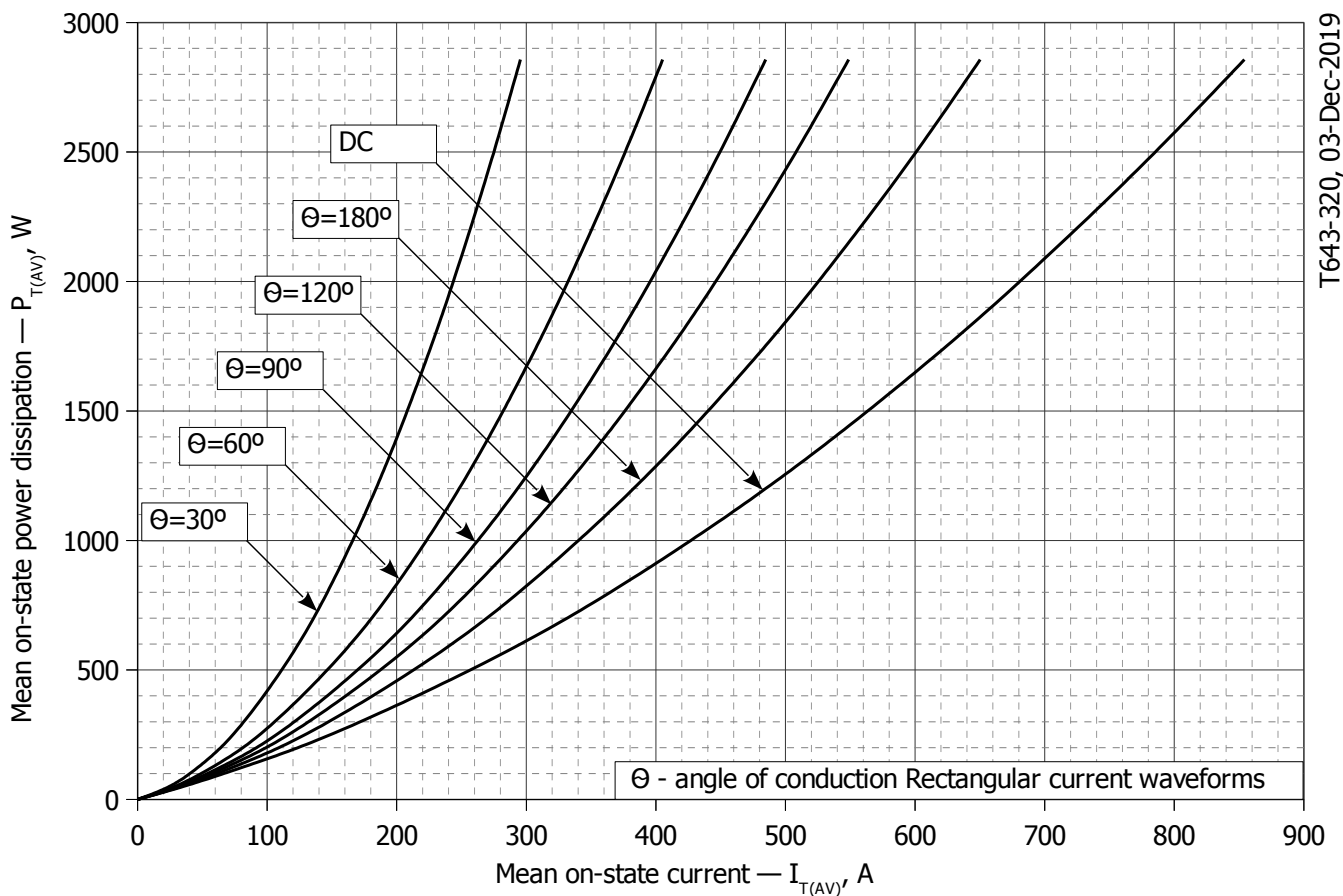


Fig 6 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)



T643-320, 03-Dec-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)



T643-320, 03-Dec-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)

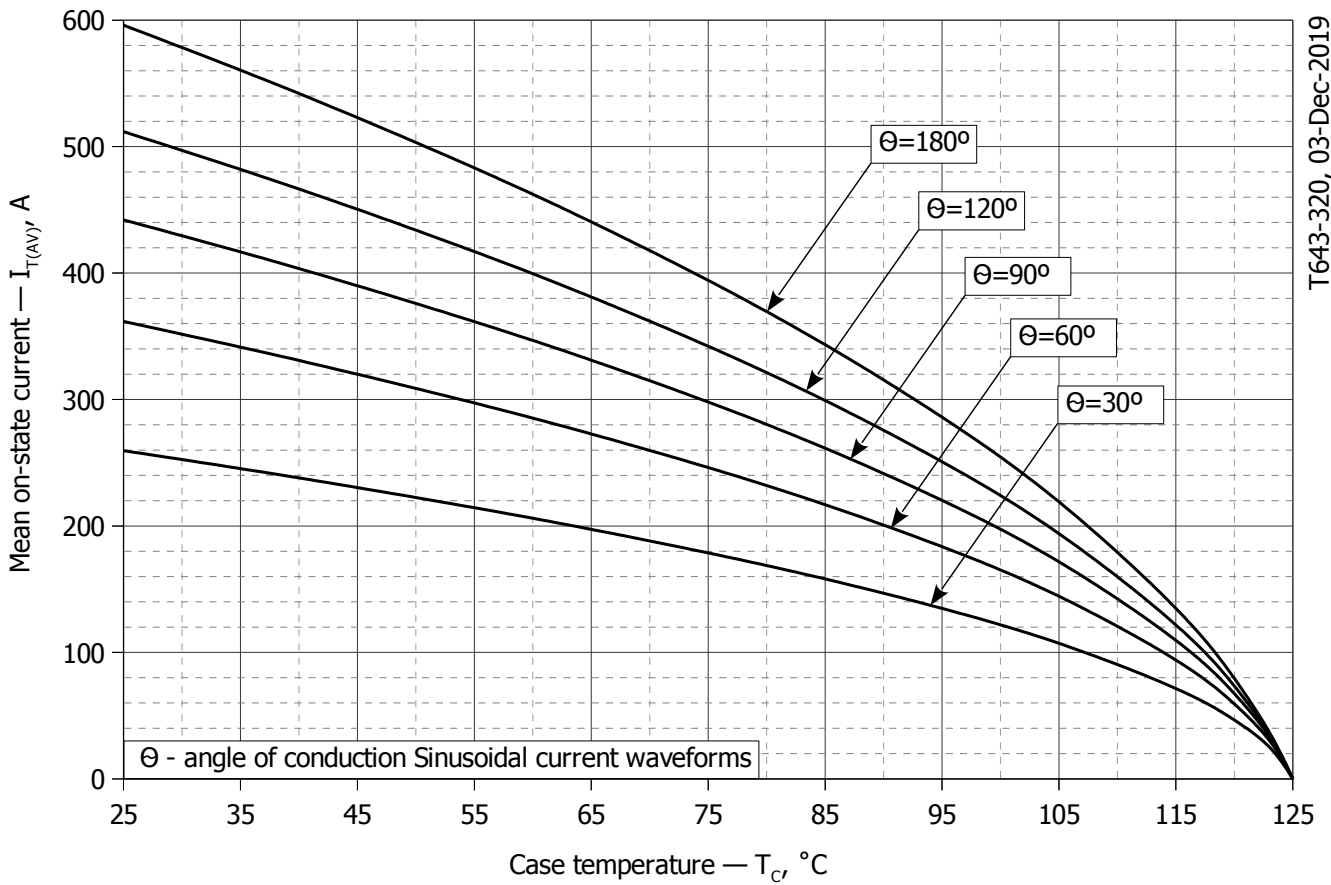


Fig. 9 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

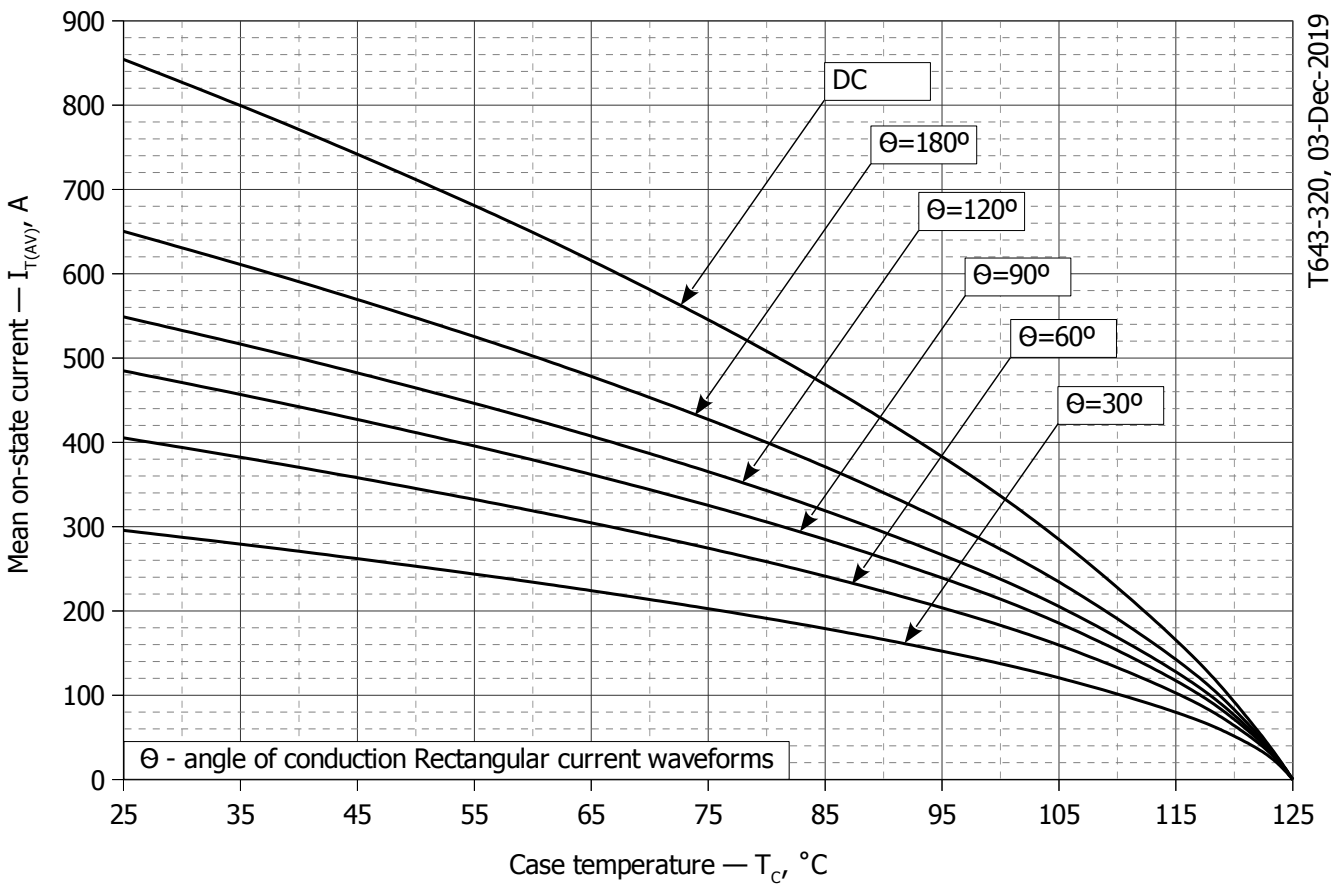


Fig. 10 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

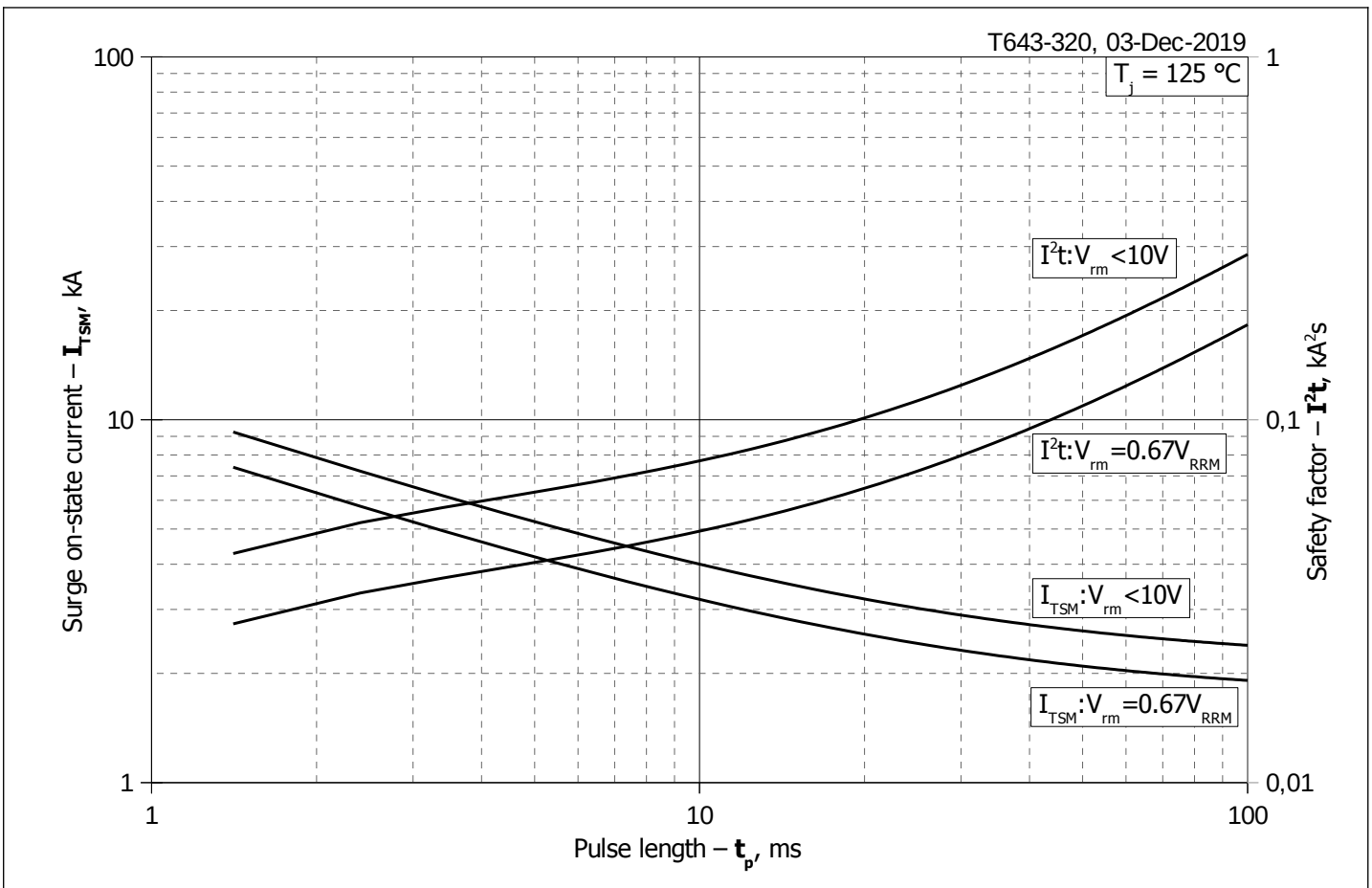


Fig. 11 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

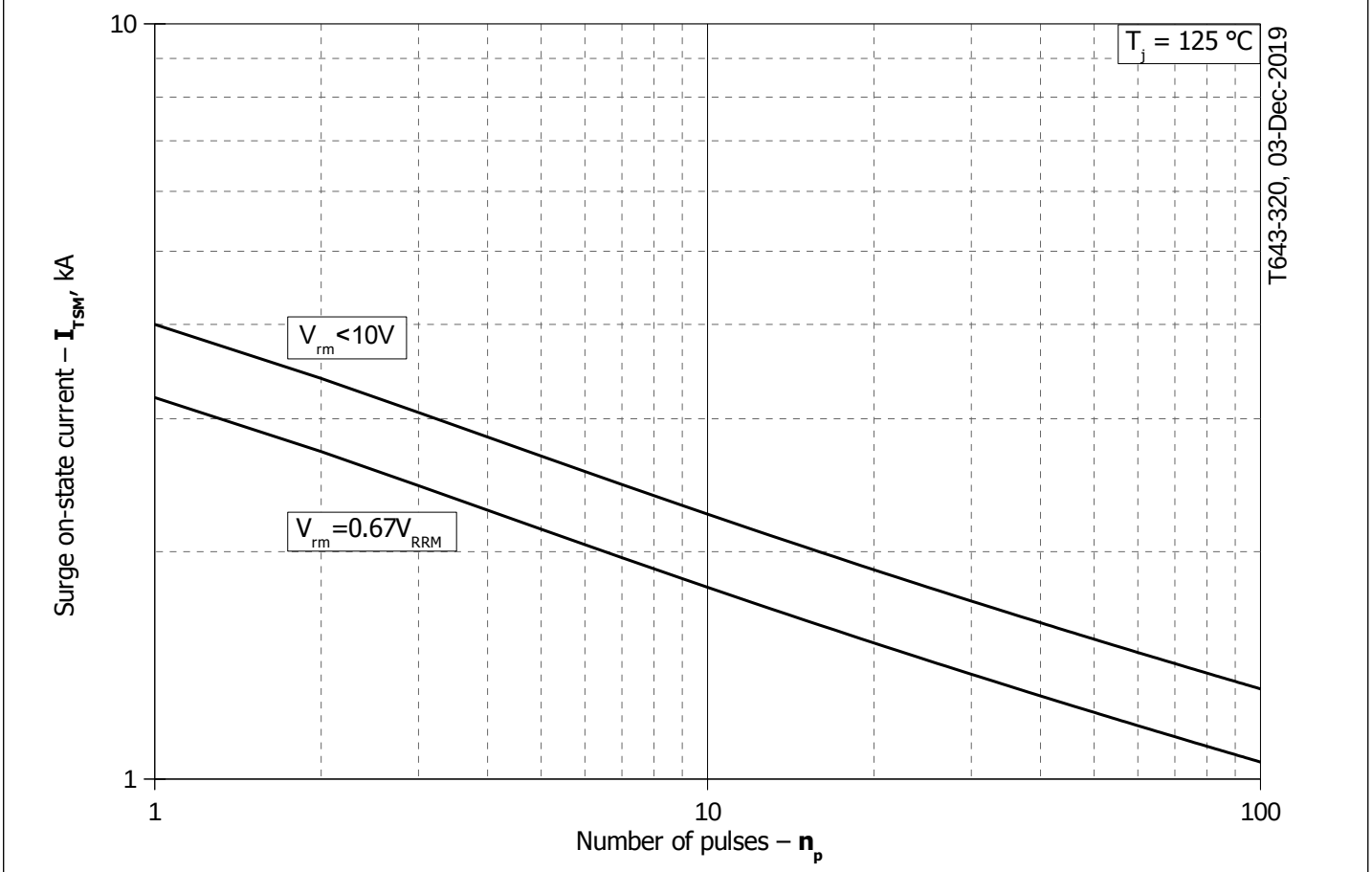


Fig. 12 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p