



PROTON-ELECTROTEX RUSSIA

Electrically isolated base plate
Industrial standard package
Simplified mechanical design, rapid assembly
Pressure contact

Double Thyristor Module For Phase Control MTx-500-36-D

Mean on-state current			I _{TAV}		500 A	
Repetitive peak off-state voltage			V _{DRM}		3000...3600 V	
Repetitive peak reverse voltage			V _{RRM}			
Turn-off time			t _q		400 μs	
V _{DRM} , V _{RRM} , V	3000	3200		3400		3600
Voltage code	30	32		34		36
T _j , °C	−40...+125					

MT3		MT4		MT5	
Dimensions (mm / inches): - Top view: 5 (0,197), 15 (0,59), 60 (2,362), 60 (2,362), 74 (2,913), 25 (0,984), 20 (0,787), 84 (3,307), $\phi 8,5$ (0,335) DIA, 4 apertures, 40 (1,574), 132 (5,196), 150 (5,9), 180 (7,087), 58 (2,283), 77 (3,031). - Side view: 74 (2,913), 25 (0,984), 20 (0,787), 84 (3,307). - Front view: 132 (5,196), 150 (5,9), 180 (7,087), 58 (2,283), 77 (3,031).					
MT/D3	MD/T3	MT/D4	MD/T4	MT/D5	MD/T5

All dimensions in millimeters (inches)

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	500 520	$T_c=87\text{ }^{\circ}\text{C}$; $T_c=85\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	785	$T_c=87\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	20.0 23.0	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			21.0 24.0	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	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	$\text{A}^2\text{s}\cdot 10^3$	2000 2600	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			1800 2300	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	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	$T_{j\min} < T_j < T_{j\max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	3100...3700	$T_{j\min} < T_j < T_{j\max}$; 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	1250	$T_j=T_{j\max}$; $V_D=0.67\cdot V_{DRM}$; $I_{TM}=1800\text{ A}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 2\text{ A}/\mu\text{s}$	
THERMAL					
T_{stg}	Storage temperature	$^{\circ}\text{C}$	−40...+50		
T_j	Operating junction temperature	$^{\circ}\text{C}$	−40...+125		
$T_{c\text{ op}}$	Operating temperature	$^{\circ}\text{C}$	−40...+125		
MECHANICAL					
a	Acceleration under vibration	m/s ²	50		

CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
ON-STATE					
V _{TM}	Peak on-state voltage, max	V	1.70	T _j =25 °C; I _{TM} =1570 A	
V _{T(TO)}	On-state threshold voltage, max	V	0.968	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.447	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	250 4.00	T _j =T _{j max} T _j = 25 °C	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	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	0.35	T _j =T _{j max} ;	
I _{GD}	Gate non-trigger direct current, min	mA	70.00	V _D =0.67·V _{DRM} ; Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	2.05	T _j =25 °C; V _D =1500 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time, max	μs	8.0	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	400	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	3060	T _j =T _{j max} ; I _{TM} =I _{TAV} ;	
t _{rr}	Reverse recovery time, max	μs	54	di _R /dt=-5 A/μs;	
I _{rr}	Reverse recovery current, max	A	113	V _R =100 V	
THERMAL					
R _{thjc}	Thermal resistance, junction to case			180° half-sine wave, 50 Hz	
	per module	°C/W	0.0250		
	per arm	°C/W	0.0500		
R _{thch}	Thermal resistance, case to heatsink				
	per module	°C/W	0.0080		
	per arm	°C/W	0.0160		
INSULATION					
V _{ISOL}	Insulation test voltage	kV	3.00	Sine wave, 50 Hz; RMS	t=60 sec
			3.60		t=1 sec
MECHANICAL					
M ₁	Mounting torque (M8) ³⁾	Nm	9.00	Tolerance ± 15%	
M ₂	Terminal connection torque (M12) ³⁾	Nm	18.00	Tolerance ± 15%	
m	Weight, max	g	4170		

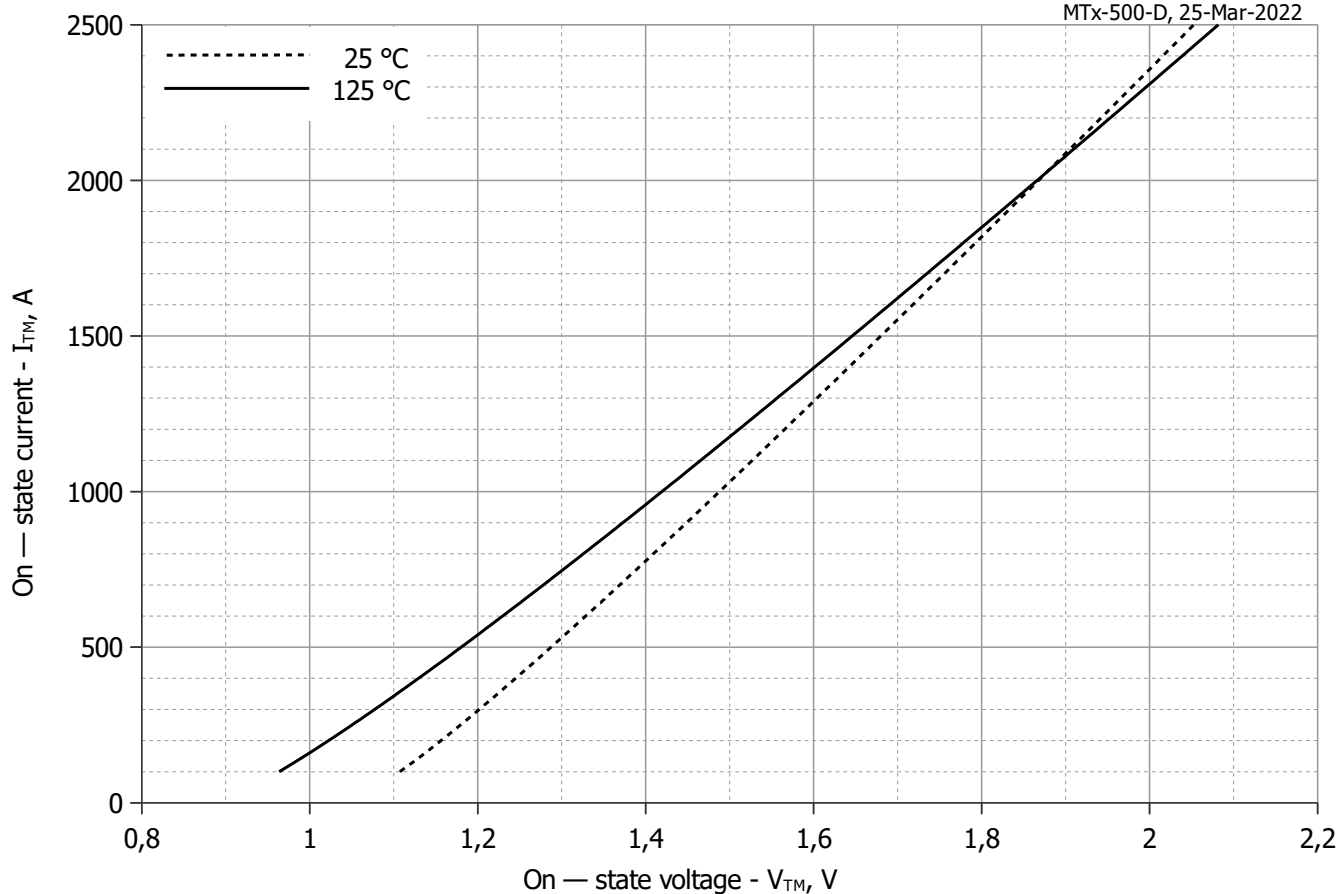


Fig 1 – On-state characteristics of Limit device

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	1.03572086	0.89576529
B	0.00032788	0.00036310
C	-0.00022020	-0.00794325
D	0.00398027	0.00680993

On-state characteristic model (see Fig. 1)

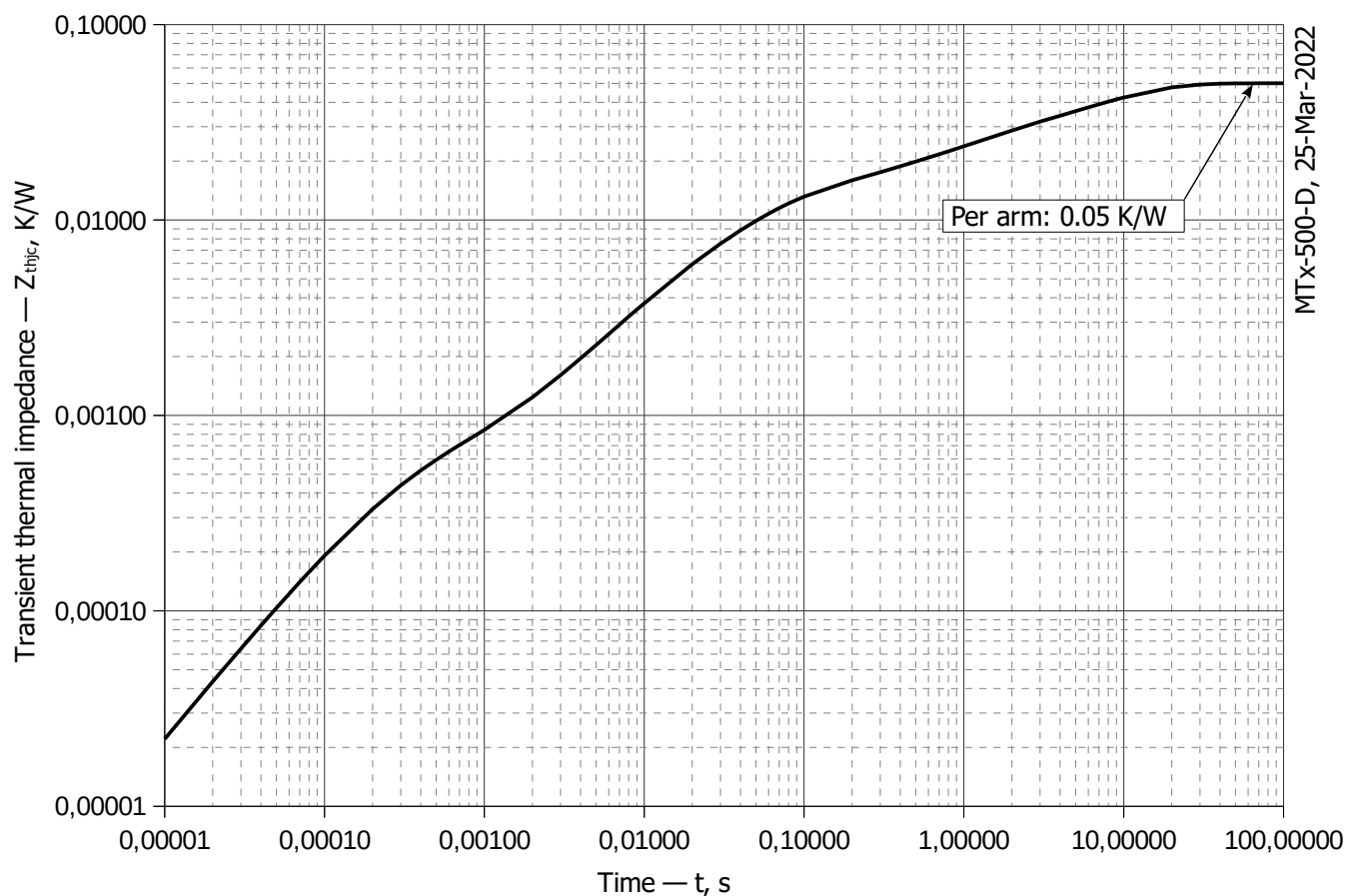


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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.

i	1	2	3	4	5	6
R_i , K/W	0.02506	0.009643	0.00348	0.009712	0.001719	0.0004399
τ_i , s	8.474	1.11	0.2289	0.04529	0.009524	0.0002414

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

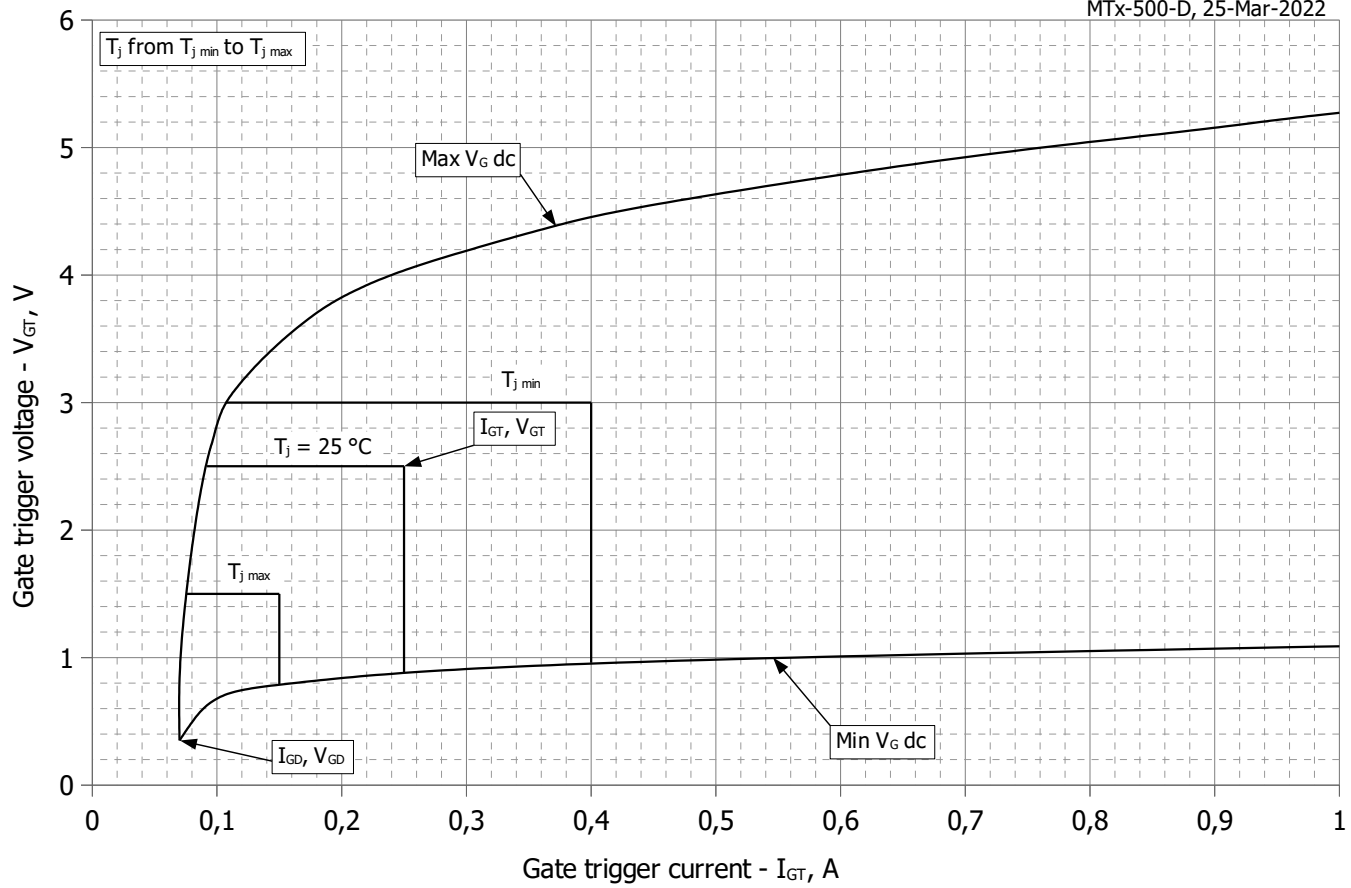


Fig 3 – Gate characteristics – Trigger limits

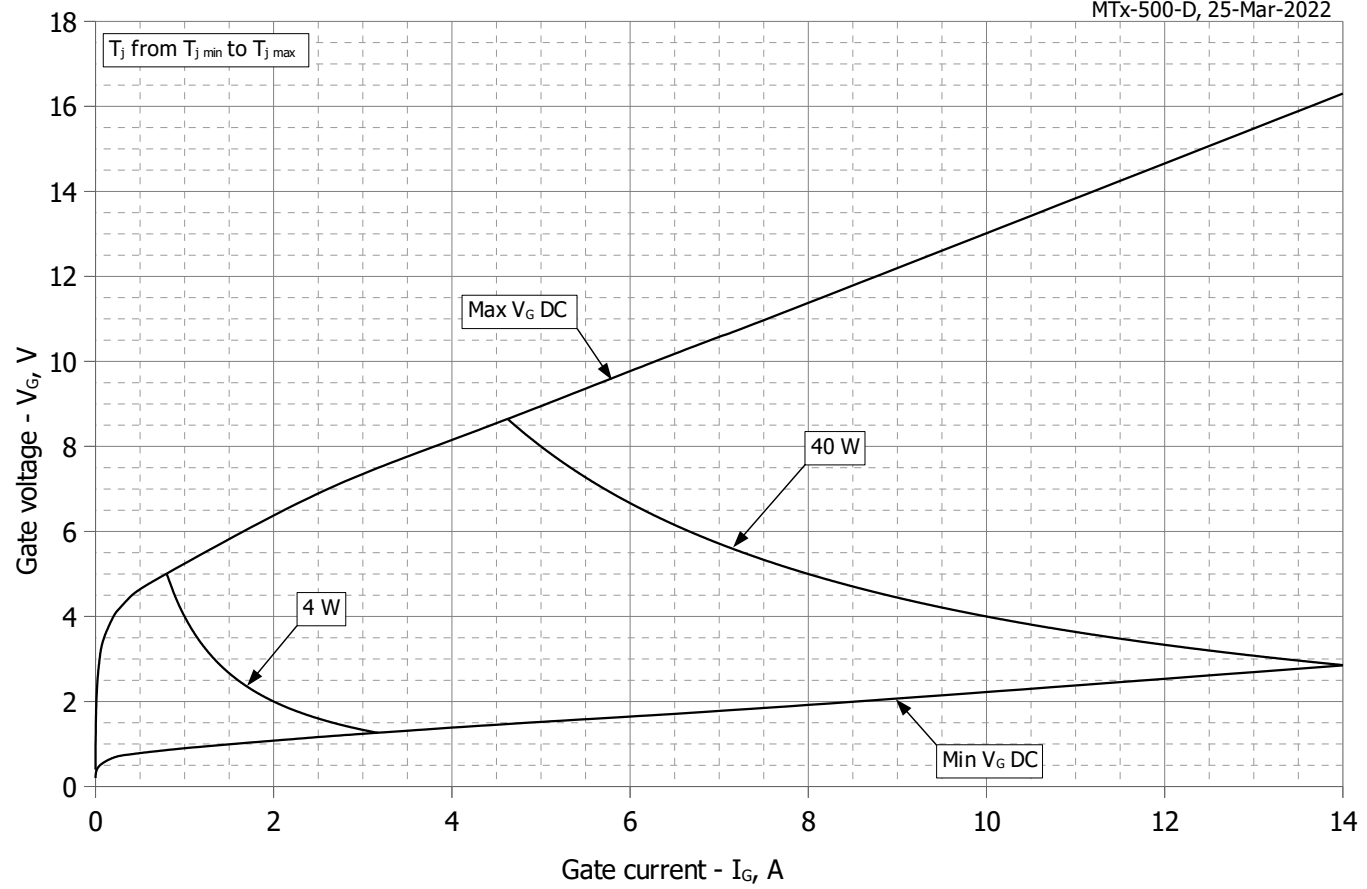


Fig 4 - Gate characteristics – Power curves

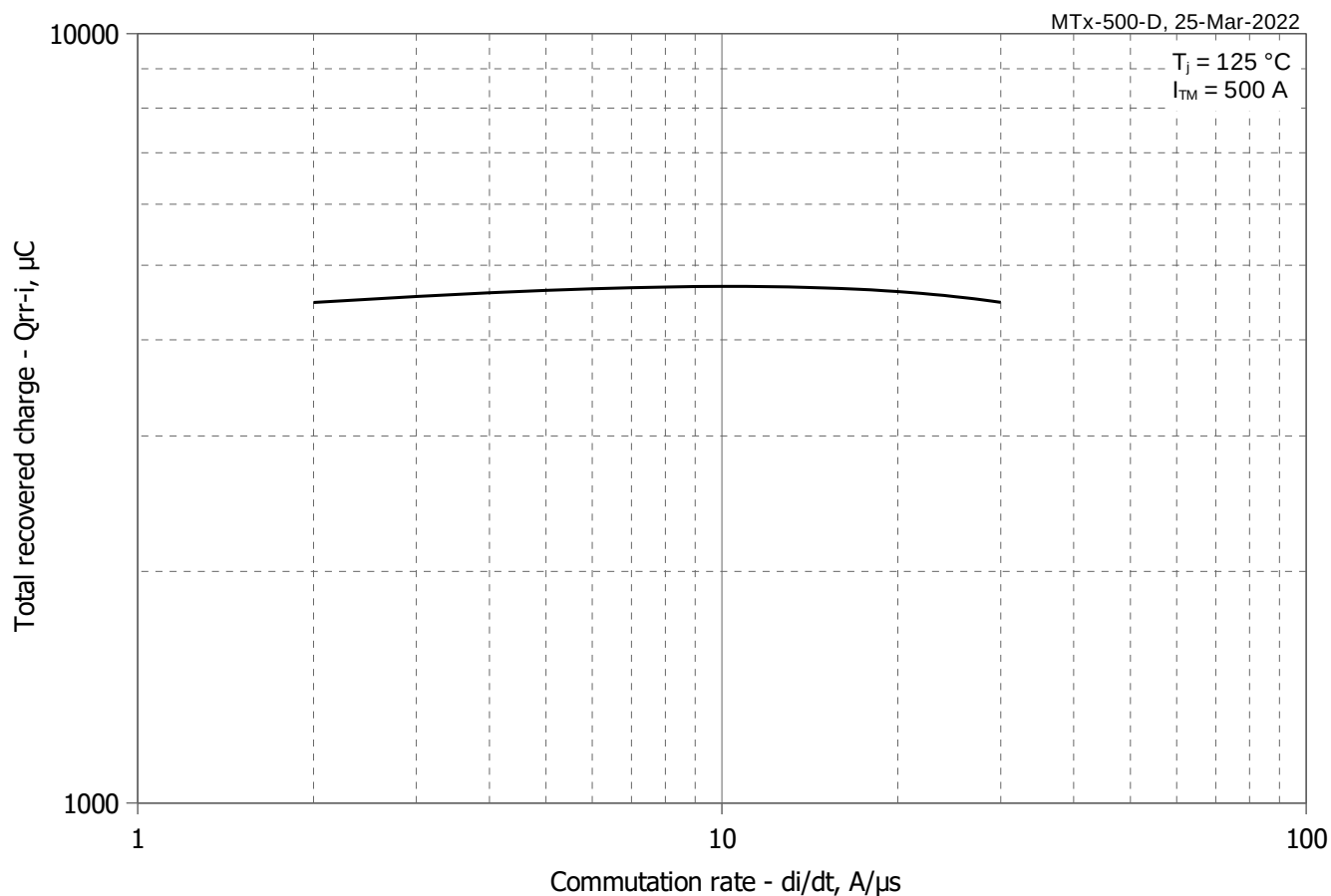


Fig 5 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

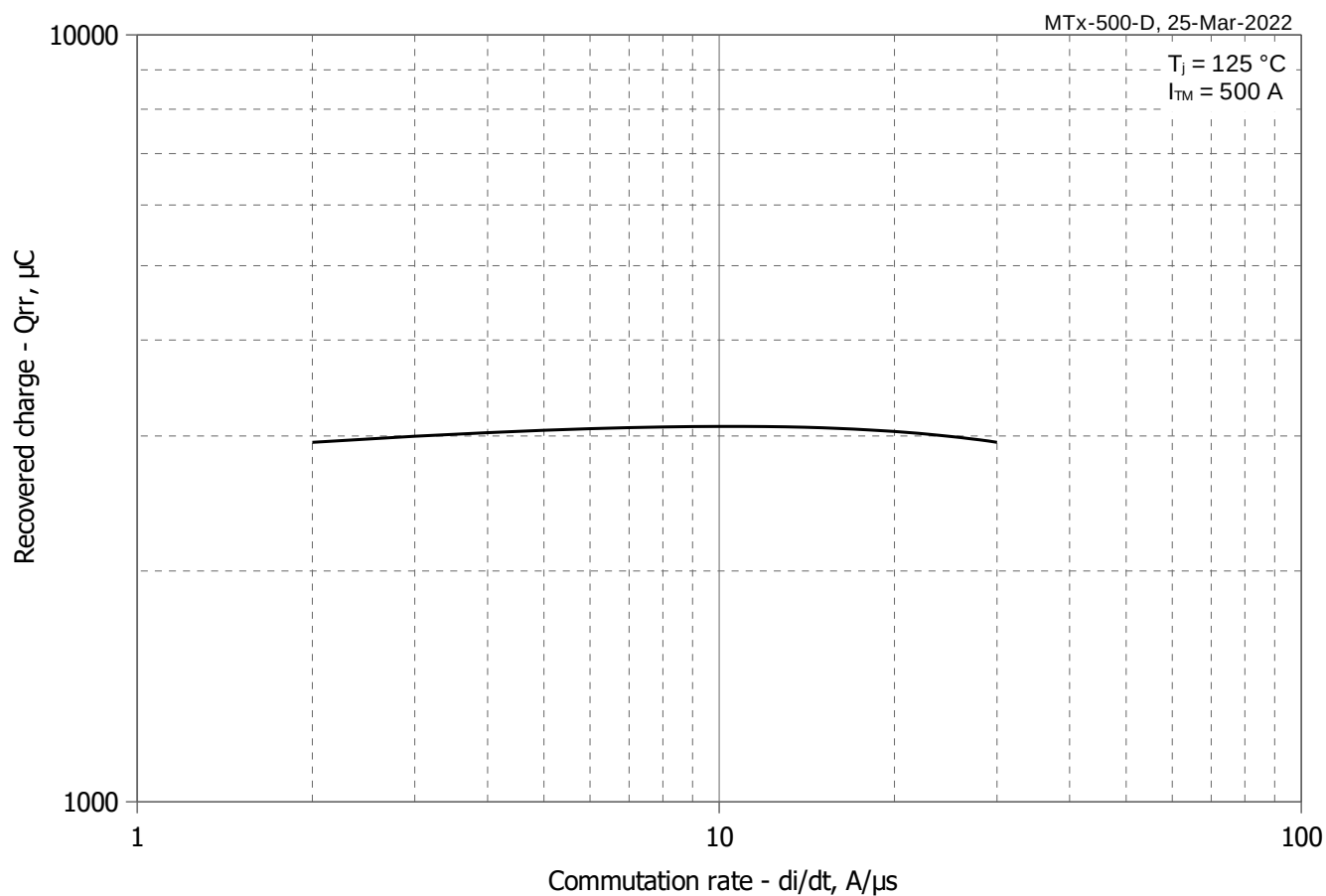


Fig 6 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

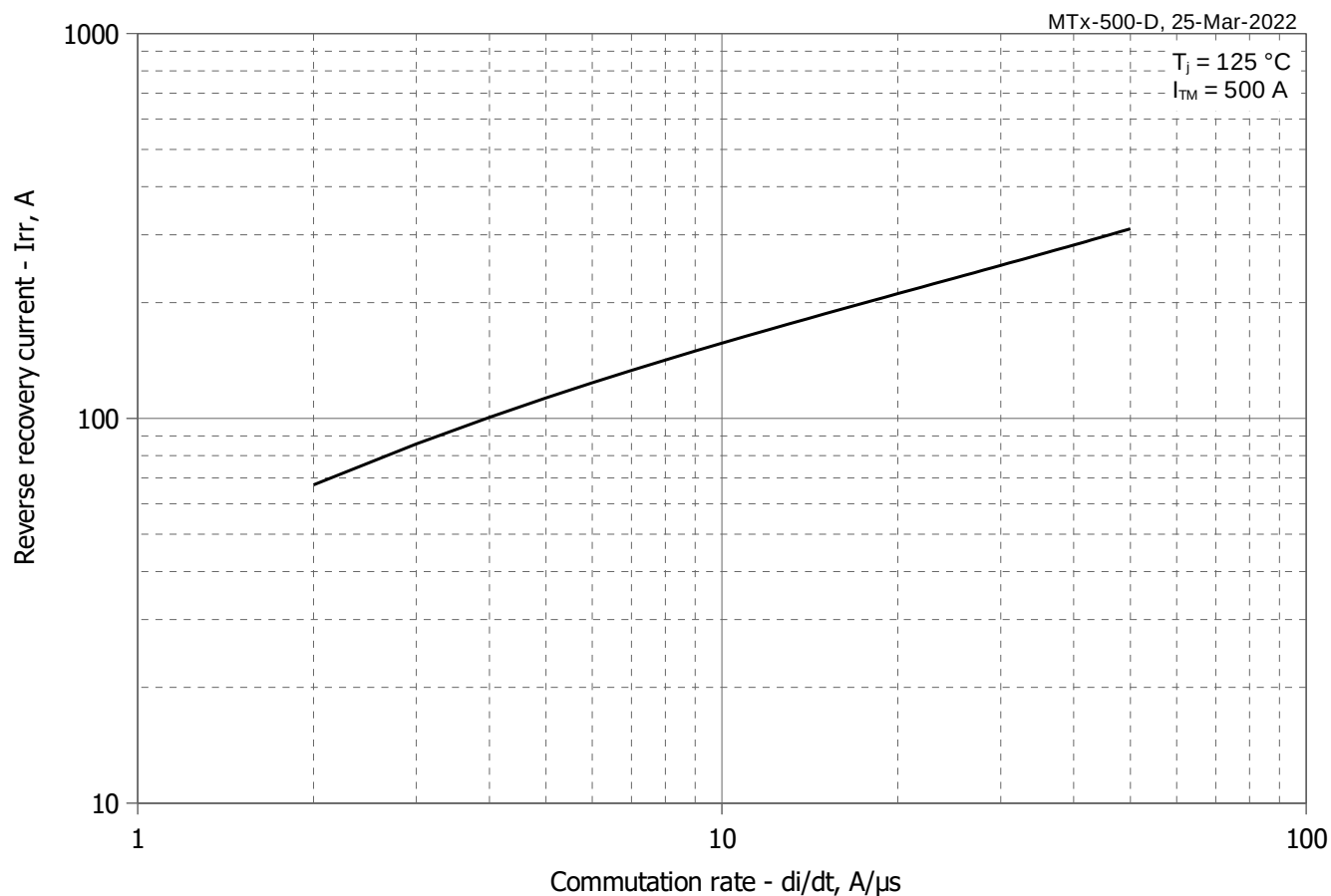


Fig 7 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

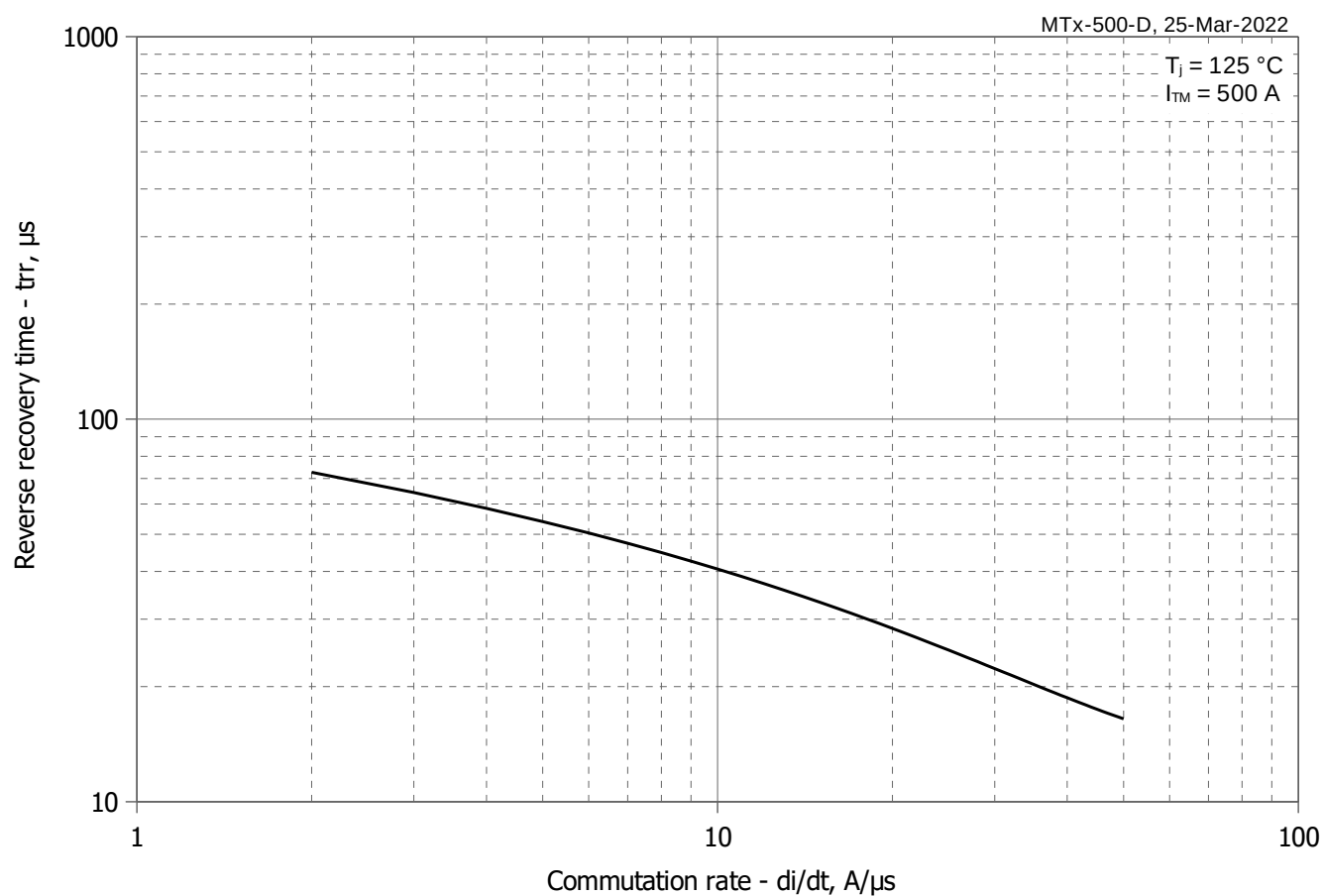


Fig 8 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

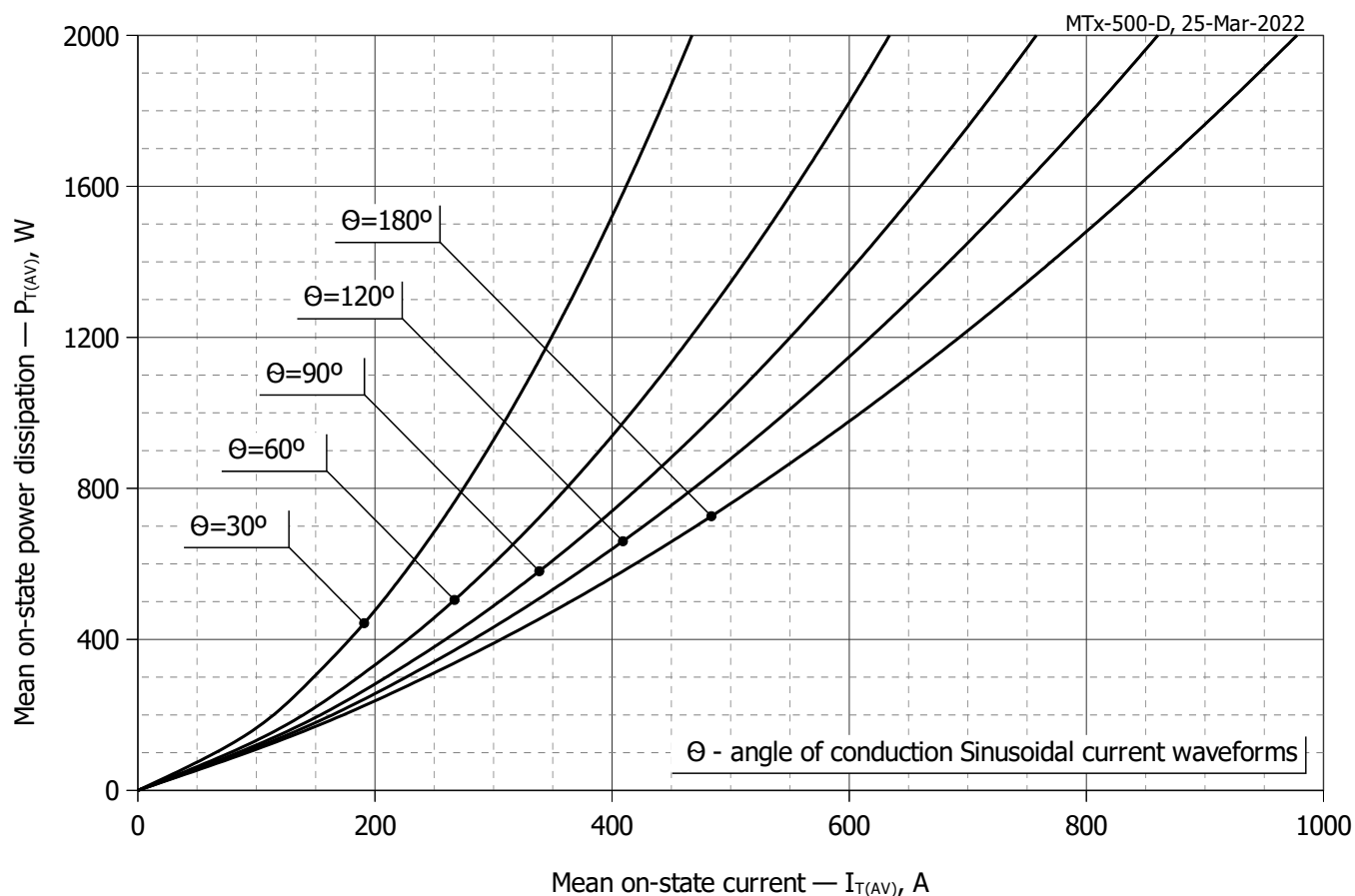


Fig. 9 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

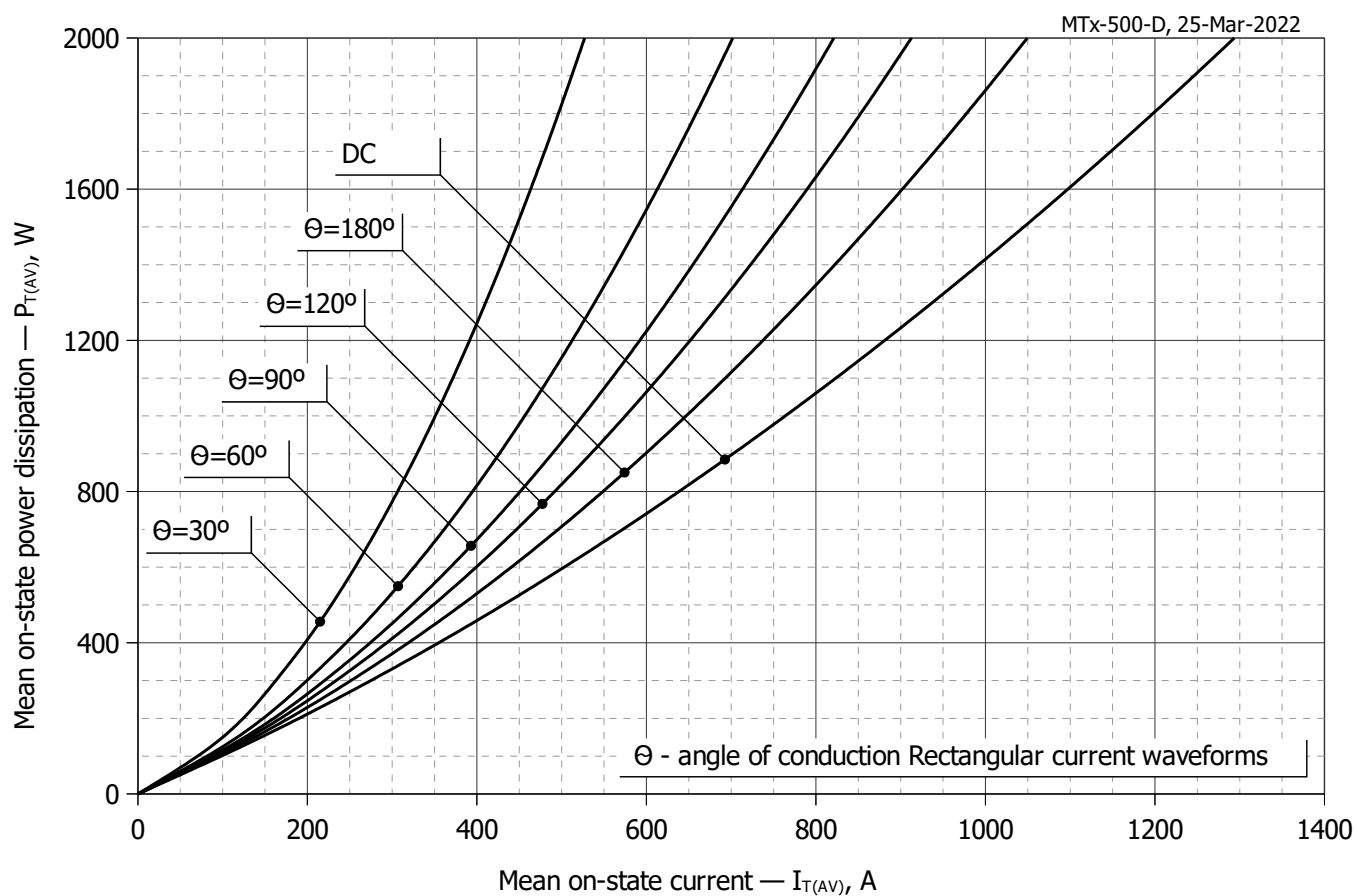


Fig. 10 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

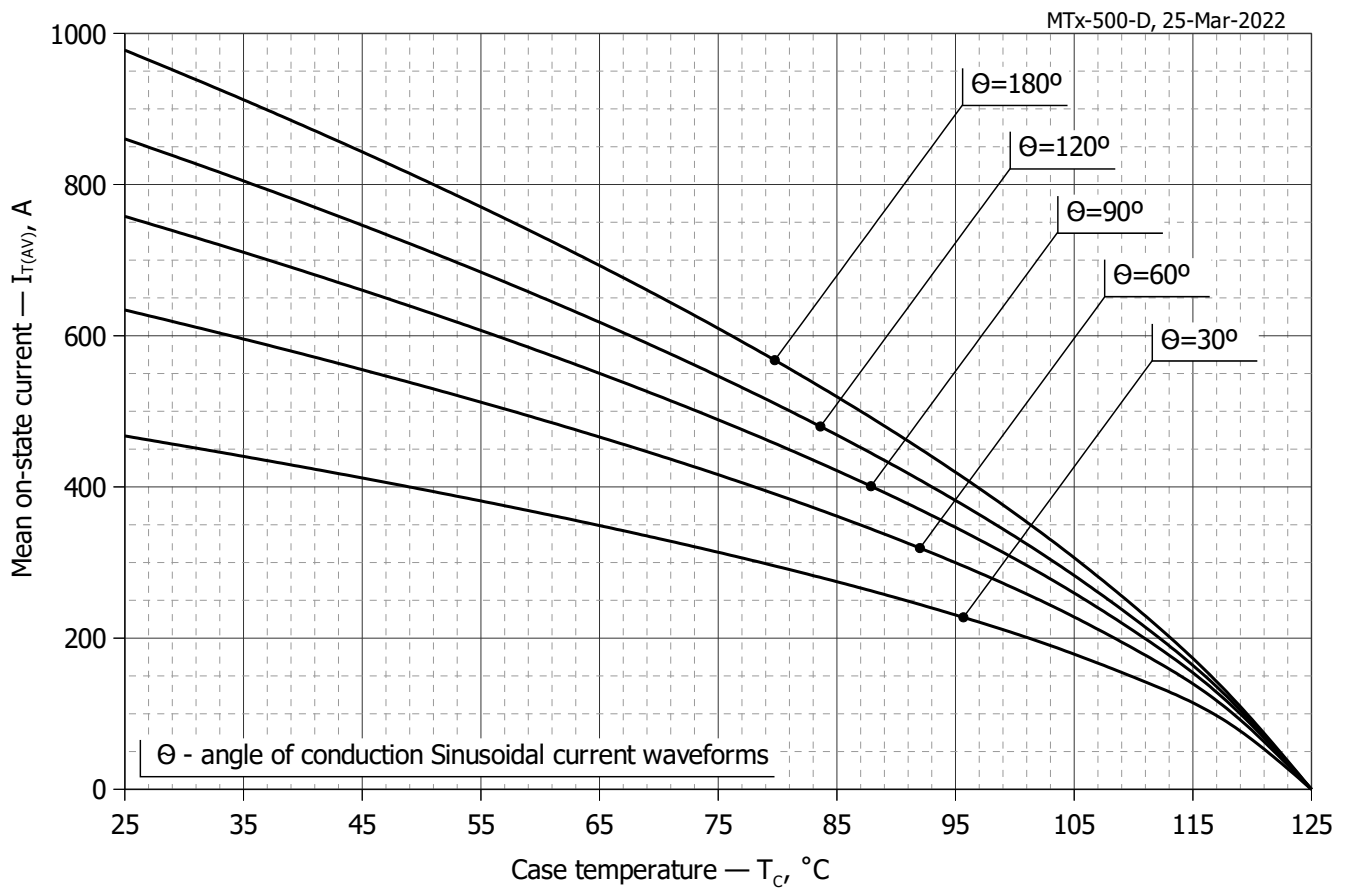


Fig. 11 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

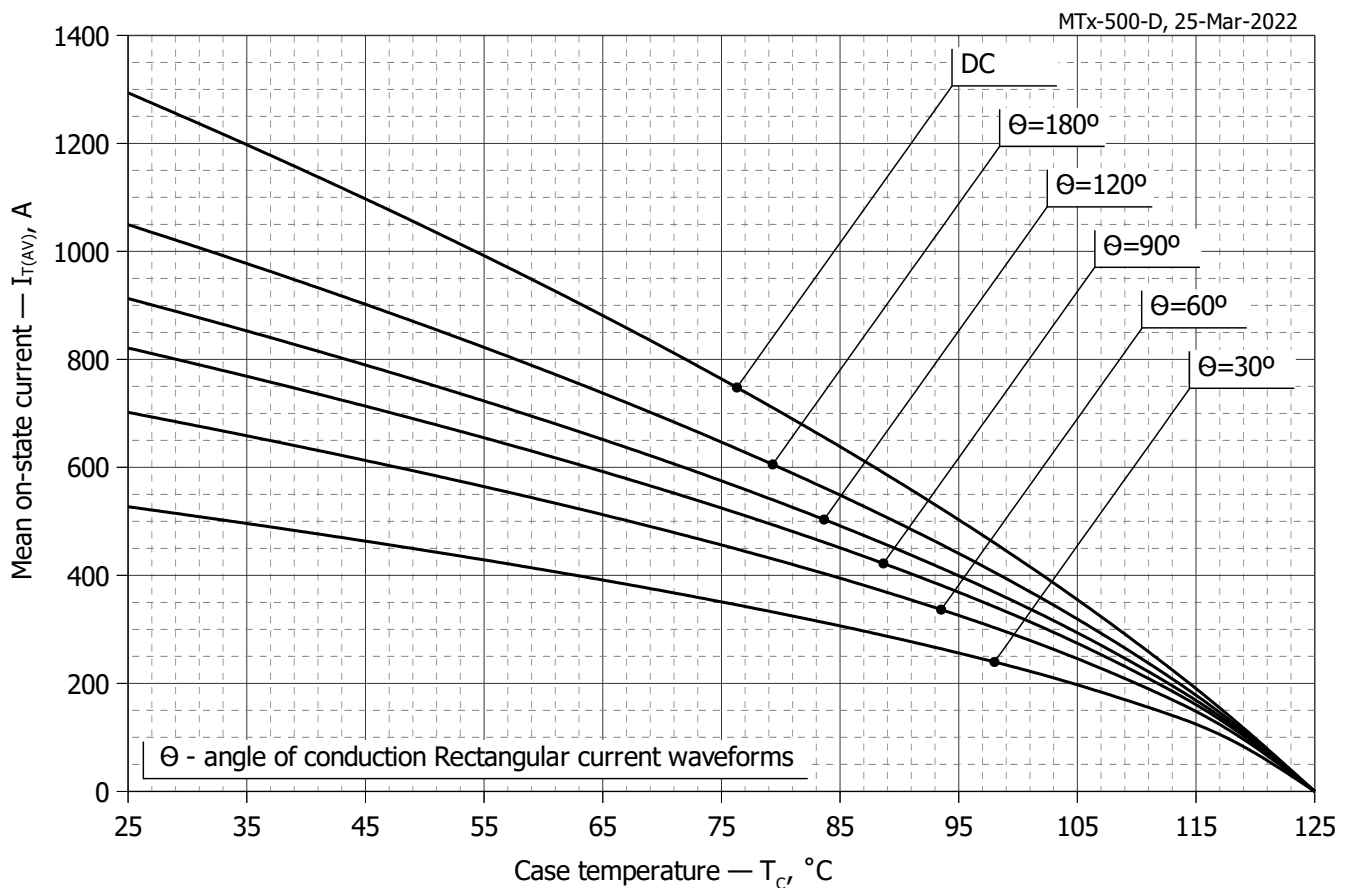


Fig. 12 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

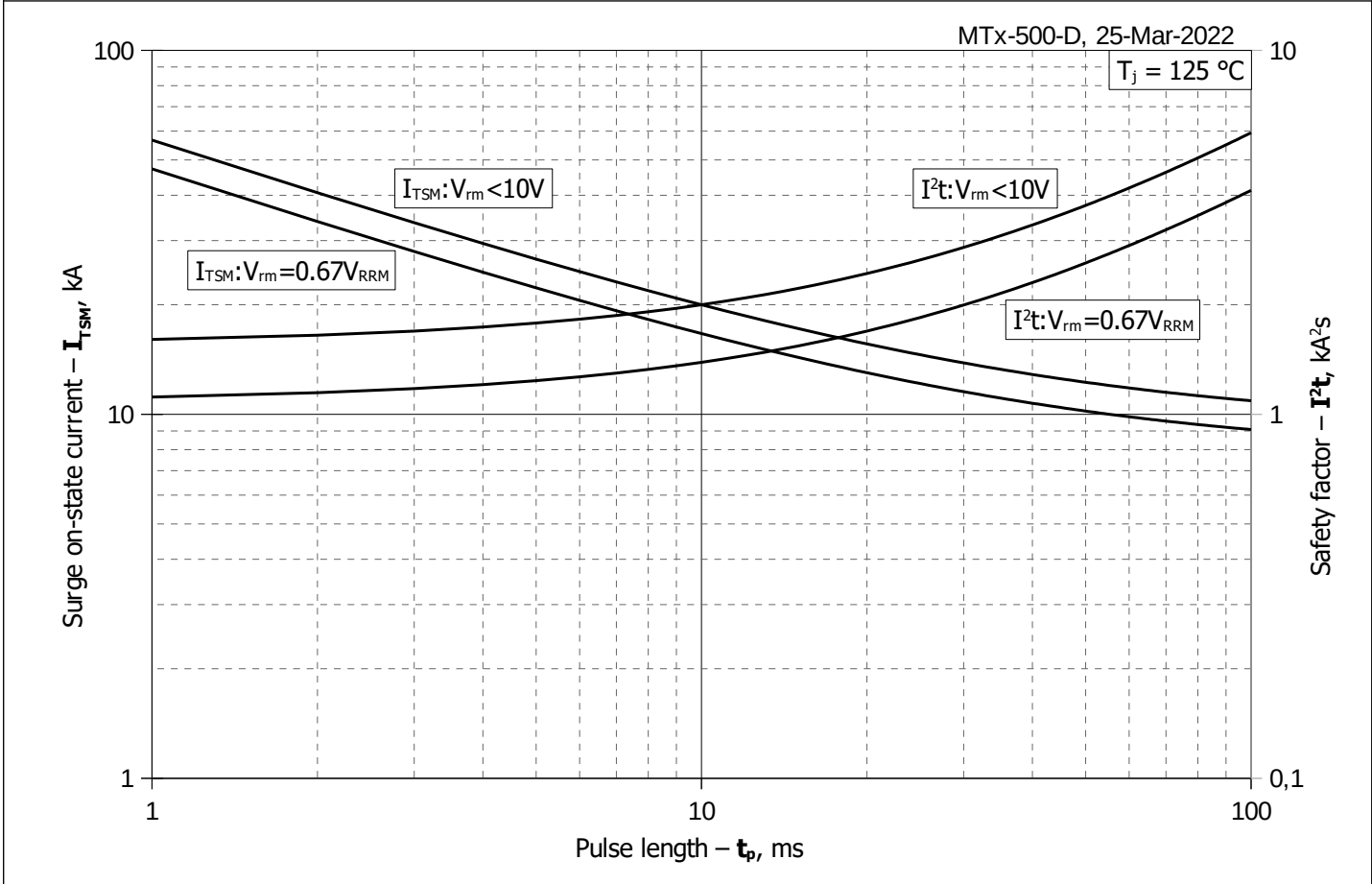


Fig. 13 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

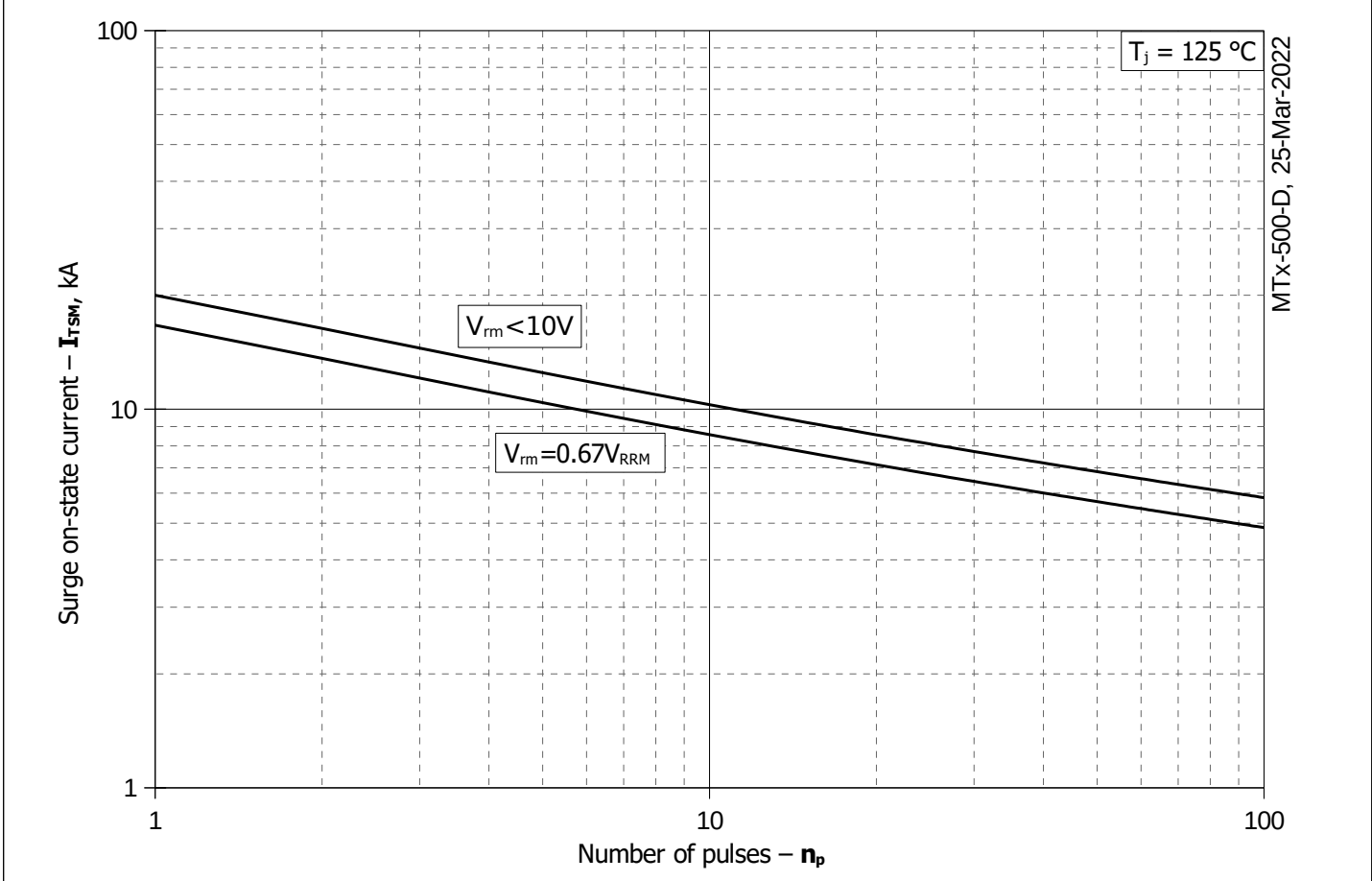


Fig. 14 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p