



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

Double Thyristor Module
For Phase Control
MTx-165-22-F

Mean on-state current	I_{TAV}	165 A
Repetitive peak off-state voltage	V_{DRM}	2000...2200 V
Repetitive peak reverse voltage	V_{RRM}	
Turn-off time	t_q	160 μs
V_{DRM}, V_{RRM}, V	2000	2200
Voltage code	20	22
$T_j, ^\circ C$	-40...+125	

MT3		MT4			
MT/D3	MD/T3			MT/D5	

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	165 164	$T_c=84\text{ }^{\circ}\text{C}$; $T_c=85\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	259	$T_c=84\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	4.7 5.5	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			5.0 6.0	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	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	$\text{A}^2\text{s}\cdot 10^3$	110 150	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt\geq 1\text{ A}/\mu\text{s}$
			100 140	$T_j=T_{j\max}$ $T_j=25\text{ }^{\circ}\text{C}$	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	2000...2200	$T_{j\min}<T_j<T_{j\max}$; 180° half-sine wave; 50 Hz; Gate open	
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2100...2300	$T_{j\min}<T_j<T_{j\max}$; 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	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/ μs	1000	$T_j=T_{j\max}$; $V_D=0.67\cdot V_{DRM}$; $I_{TM}=950\text{ A}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt=2\text{ A}/\mu\text{s}$	
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	1.50	T _j =25 °C; I _{TM} =500 A	
V _{T(TO)}	On-state threshold voltage, max	V	1.123	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.763	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	30 2.50	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	0.60	T _j =T _{j max} ; V _D =0.67·V _{DRM} ;	
I _{GD}	Gate non-trigger direct current, min	mA	80.00	Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	0.80	T _j =25 °C; V _D =1000 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time, max	μs	2.00	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	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	840	T _j =T _{j max} ; I _{TM} = I _{TAV} ;	
t _{rr}	Reverse recovery time, max	μs	19	di _R /dt=-10 A/μs;	
I _{rr}	Reverse recovery current, max	A	88	V _R =100 V	
THERMAL					
R _{thjc}	Thermal resistance, junction to case				
	per module	°C/W	0.0850	180° half-sine wave, 50 Hz	
	per arm	°C/W	0.1700		
	per module	°C/W	0.0800	DC	
	per arm	°C/W	0.1600		
R _{thch}	Thermal resistance, case to heatsink				
	per module	°C/W	0.0300		
	per arm	°C/W	0.0600		
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 (M6) ³⁾	Nm	6.00	Tolerance ± 15%	
M ₂	Terminal connection torque (M6) ³⁾	Nm	6.00	Tolerance ± 15%	
m	Weight, max	g	350		

PART NUMBERING GUIDE													NOTES															
MT	3	-	165	-	22	-	A2	T2	-	F	-	N																
1	2		3		4		5	6		7		8																
1. Thyristor module (MT) Thyristor – Diode module (MT/D) Diode – Thyristor module (MD/T)													1) Critical rate of rise of off-state voltage															
2. Circuit Schematic:																												
3. Average On-state Current, A																												
4. Voltage Code																												
5. Critical rate of rise of off-state voltage																												
6. Group of turn-off time (dv _D /dt=50 V/μs)																												
7. Package Type (M.F)																												
8. Ambient Conditions: N – Normal													2) Turn-off time (dv _D /dt=50 V/μs)															
													Symbol of Group															
													(dv _D /dt) _{crit} V/μs															
													P2		K2		E2		A2		T1		P1		M1			
													200		320		500		1000		1600		2000		2500			
													Symbol of group								T2							
													t _q , μs								160							
																					3) The screws must be lubricated							

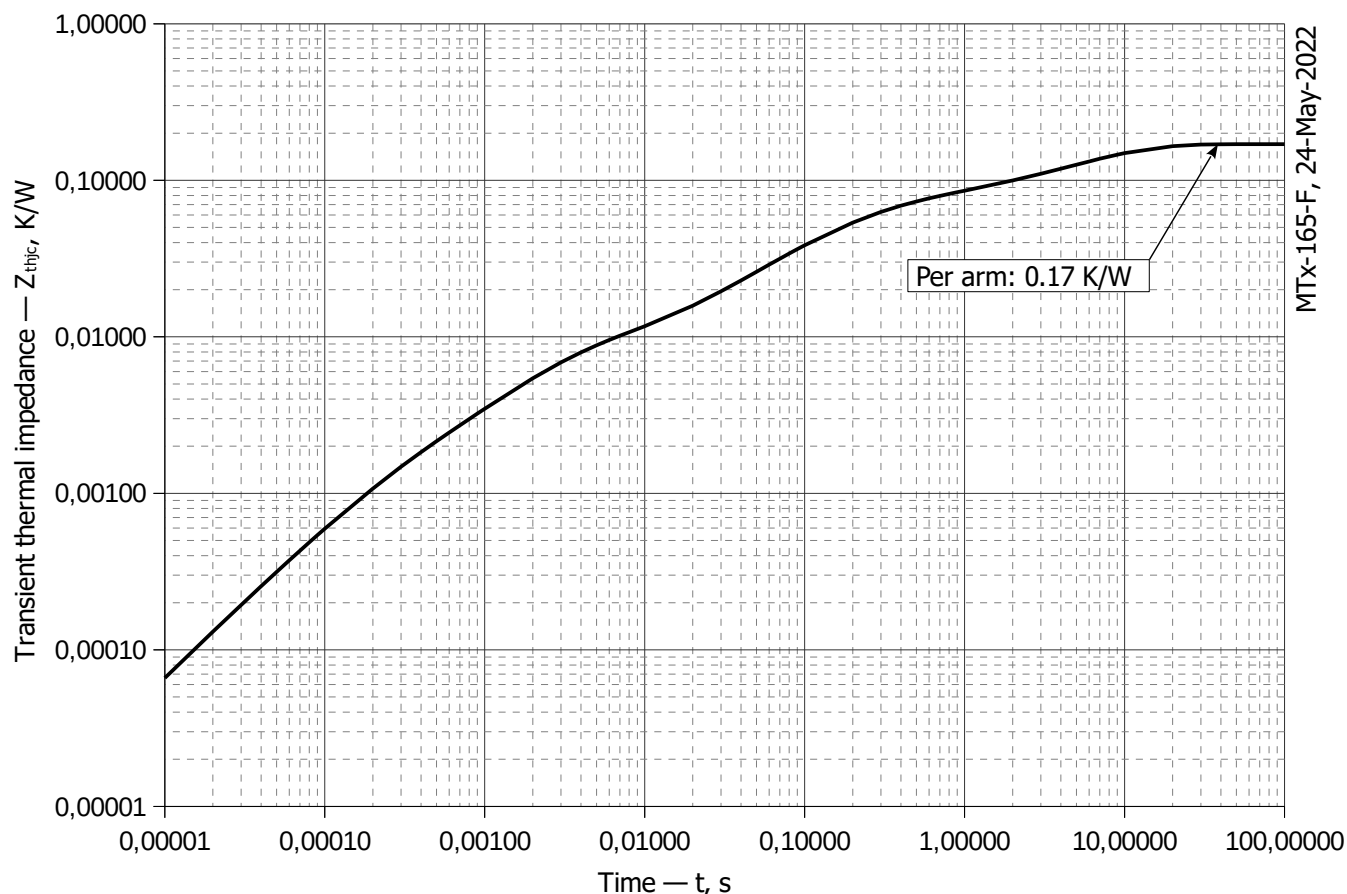


Fig 1 – Transient thermal impedance Z_{thjc} vs. time t

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	0.0007228424	0.0066399867	0.0153862565	0.0389709604	0.0142906115	0.09398934
τ_i , s	0.0002111	0.002366	0.06905	0.1909	0.6646	6.64

Transient thermal impedance junction to case Z_{thjc} model (see Fig. 1)

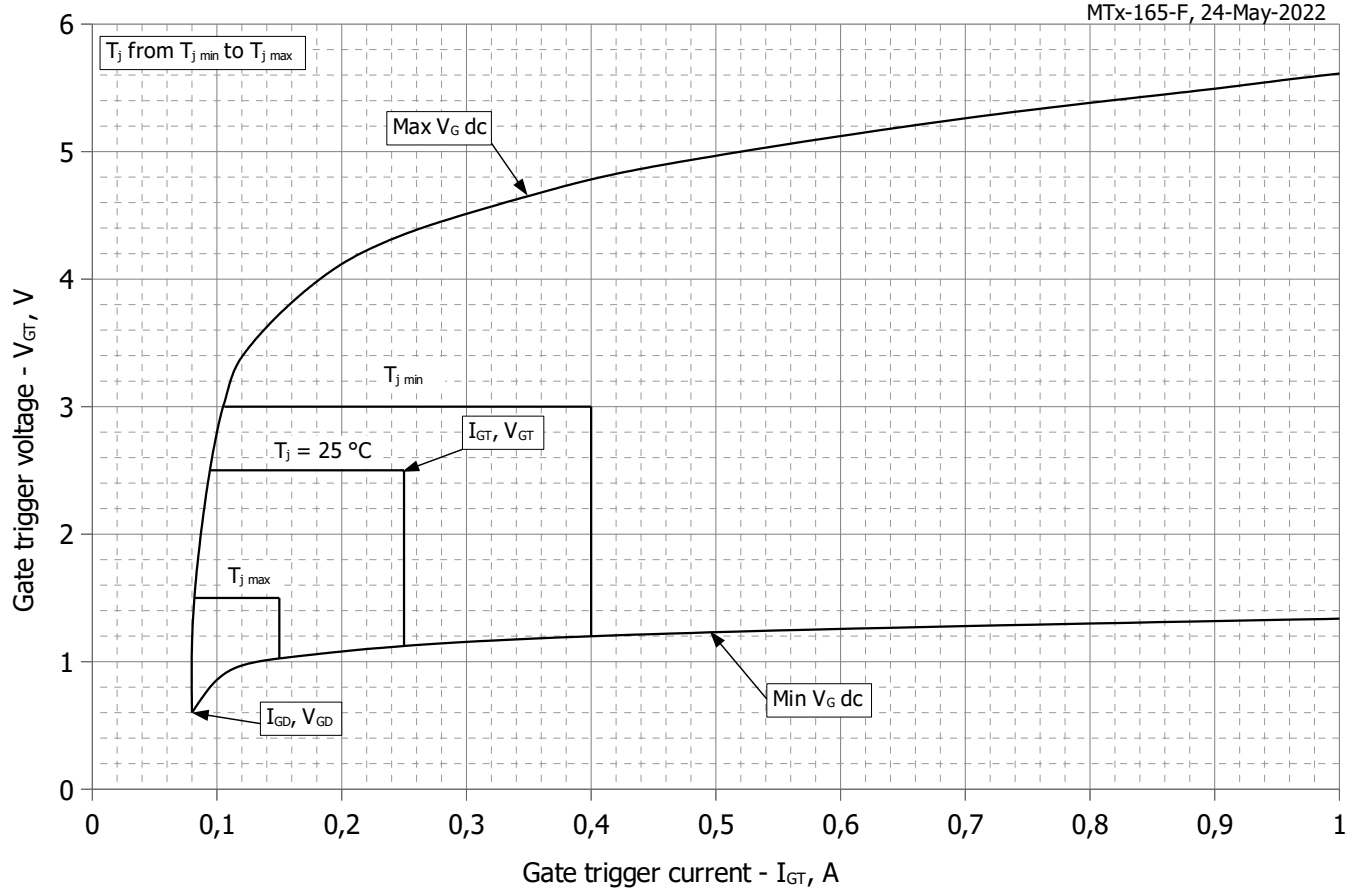


Fig 2 – Gate characteristics – Trigger limits

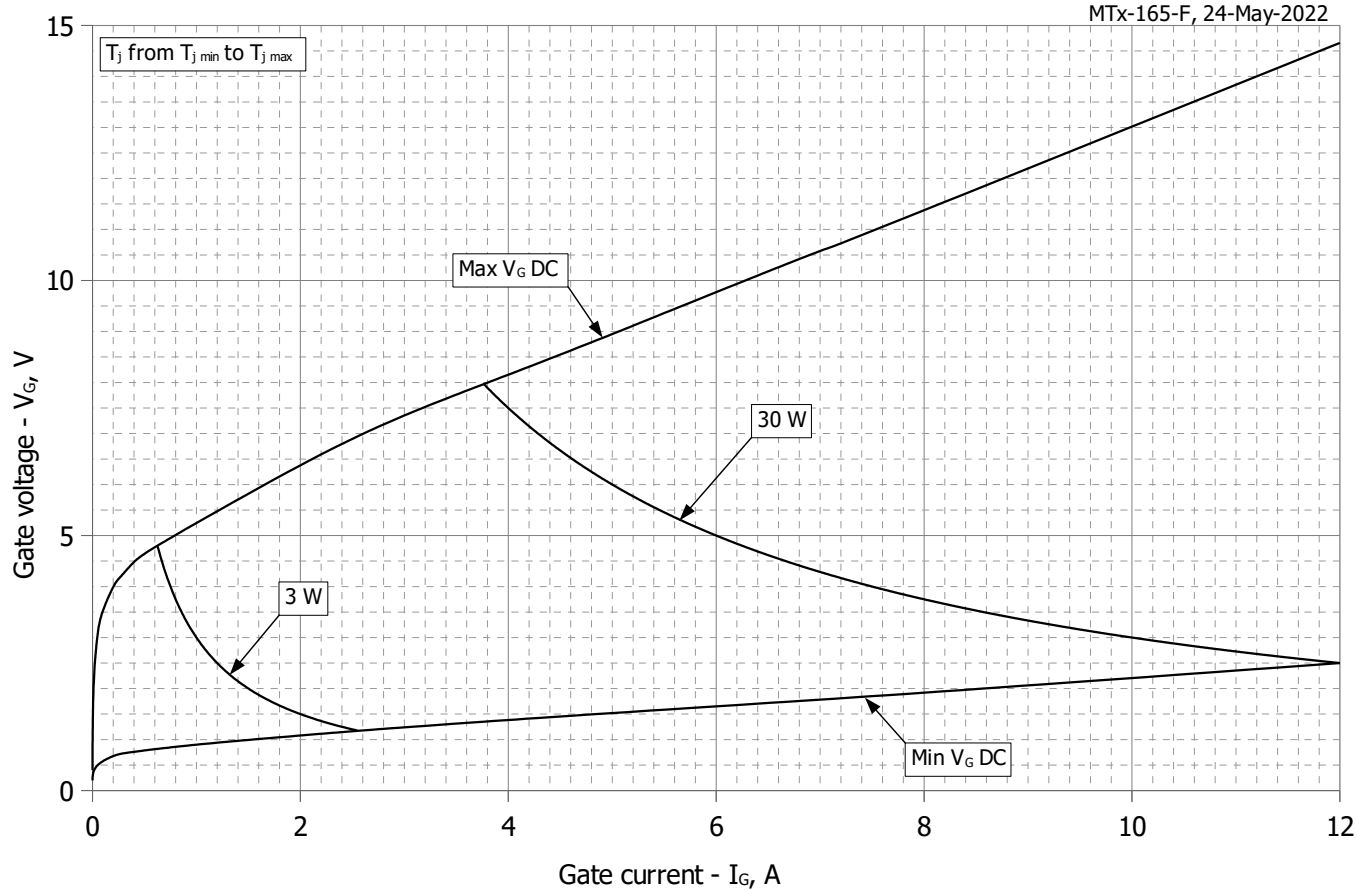


Fig 3 - Gate characteristics – Power curves

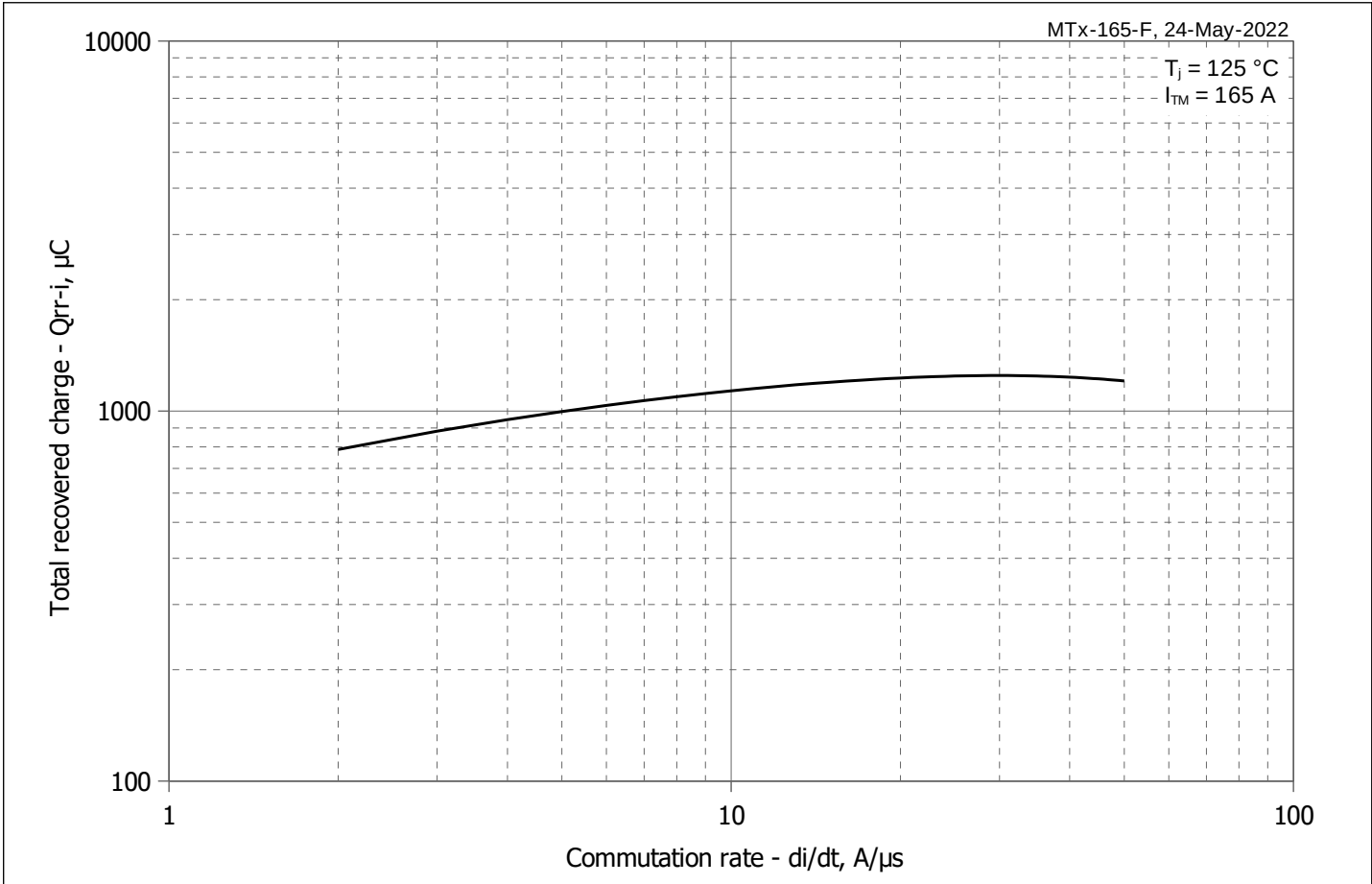


Fig 4 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

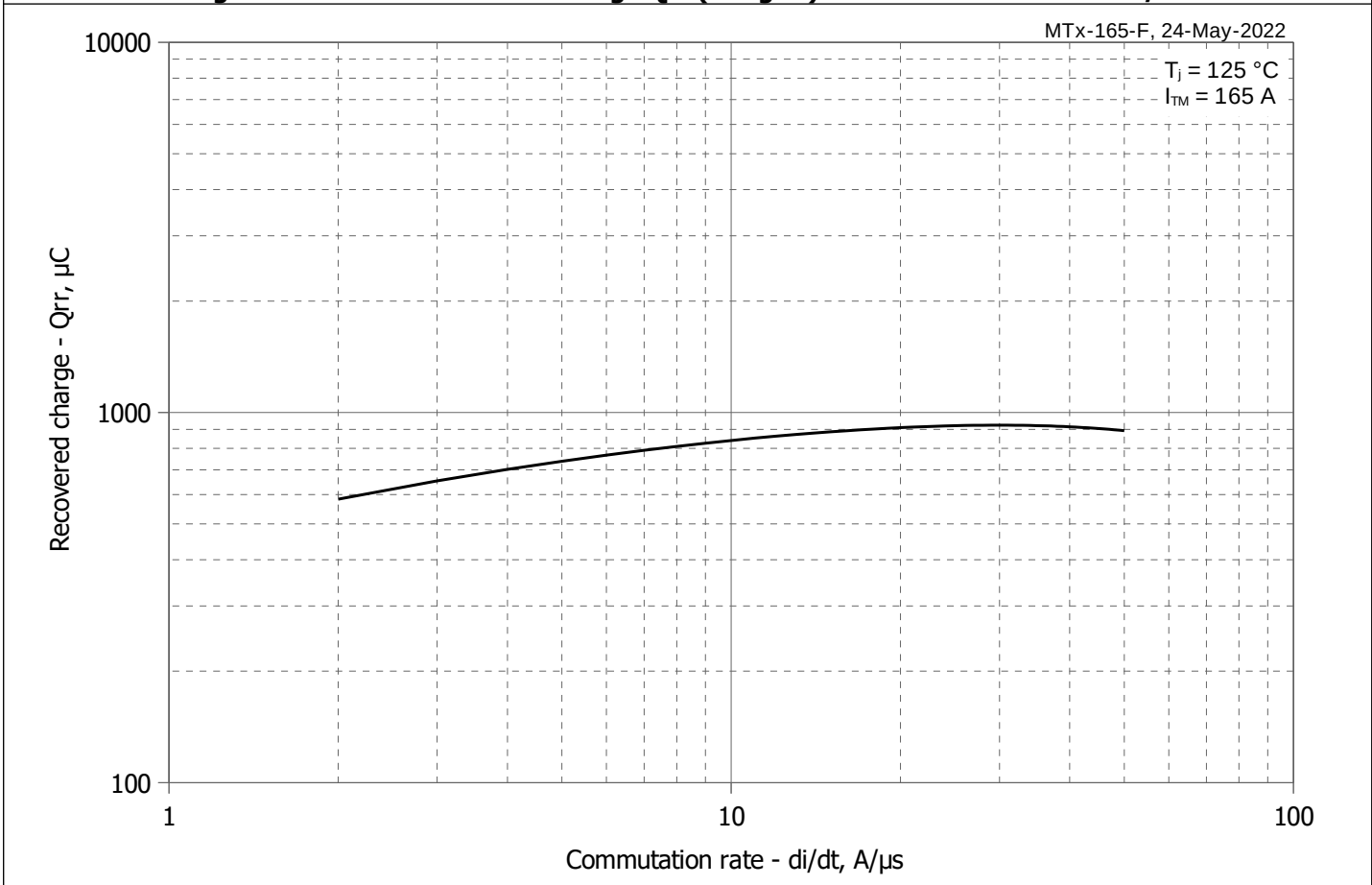


Fig 5 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

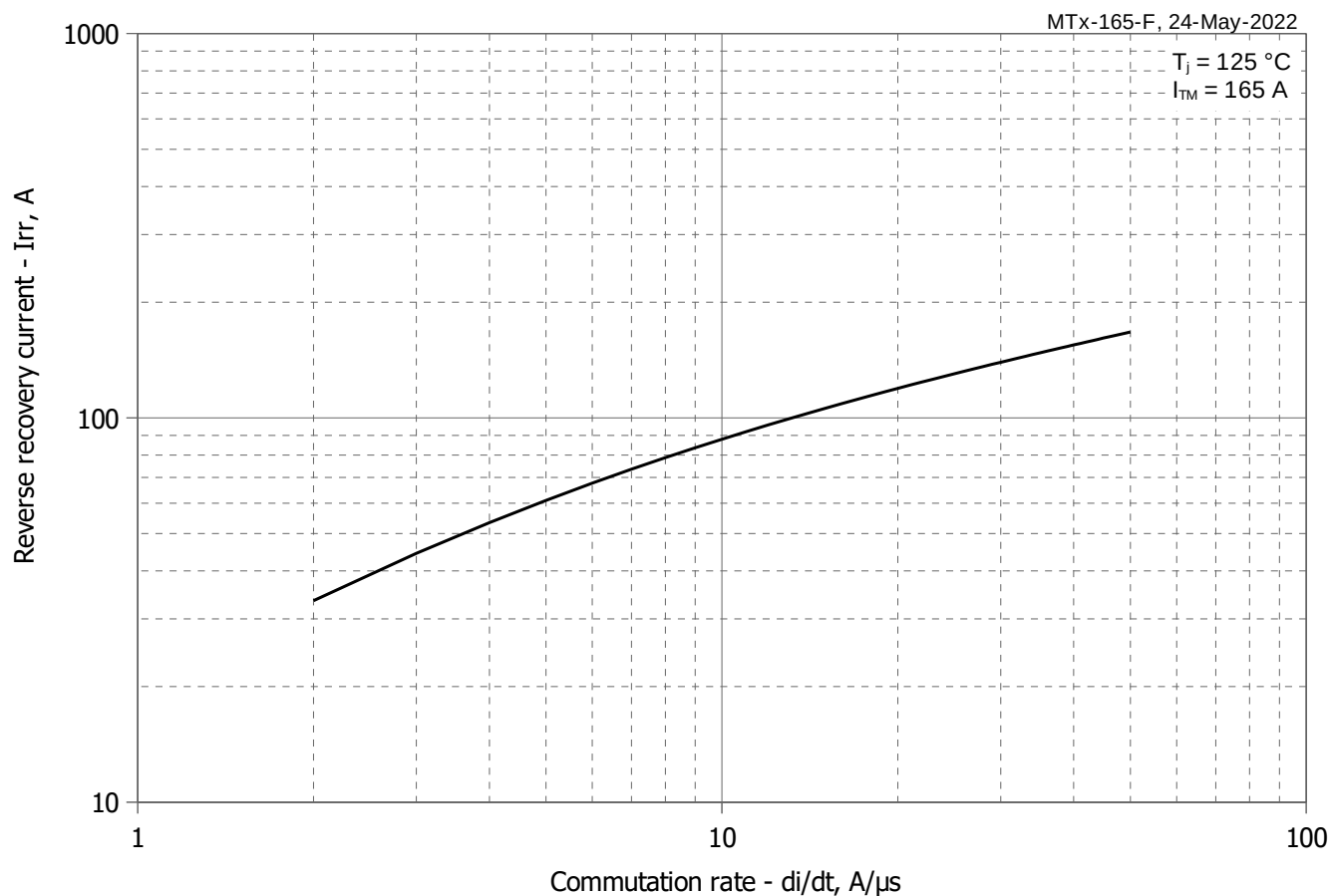


Fig 6 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

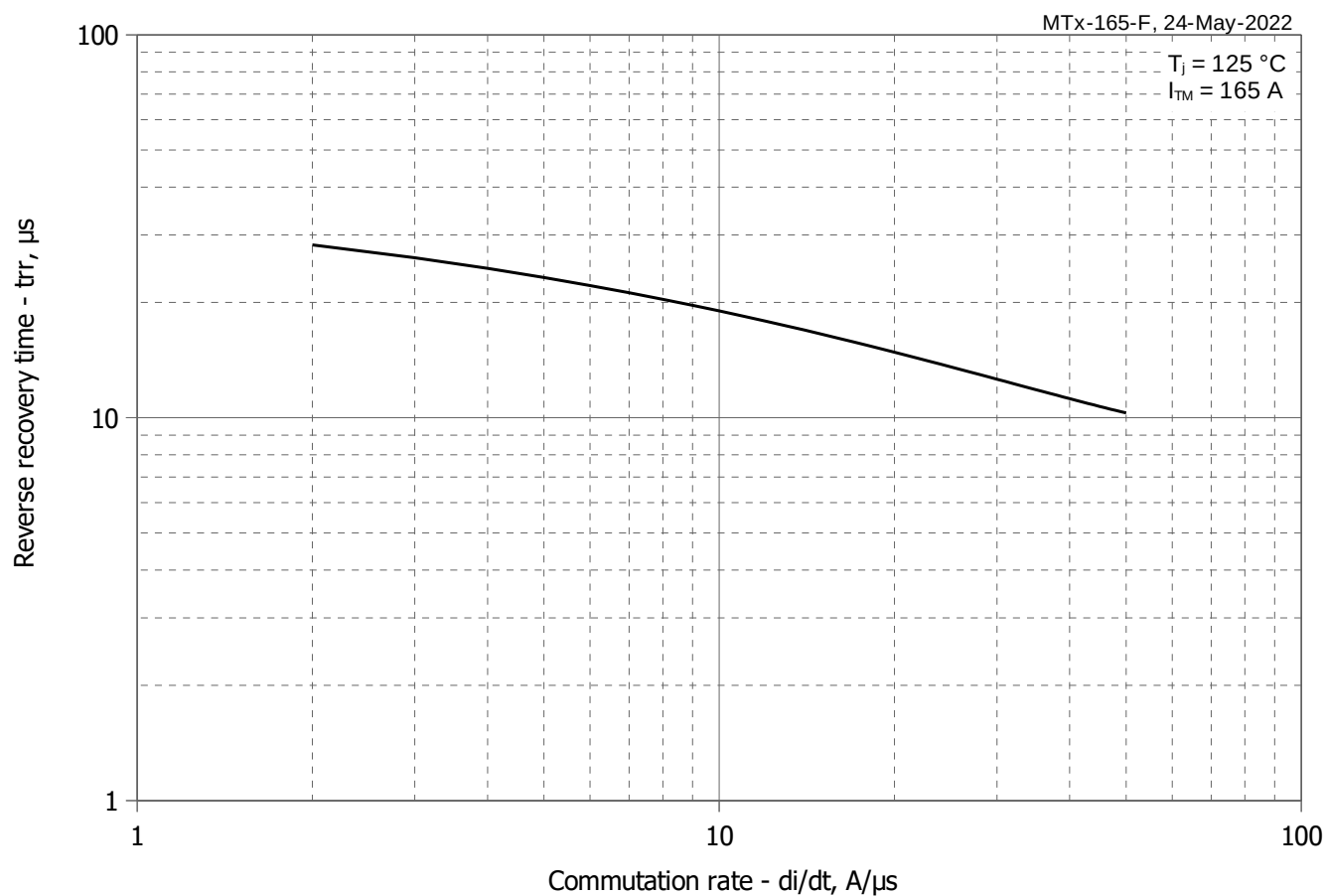


Fig 7 – Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

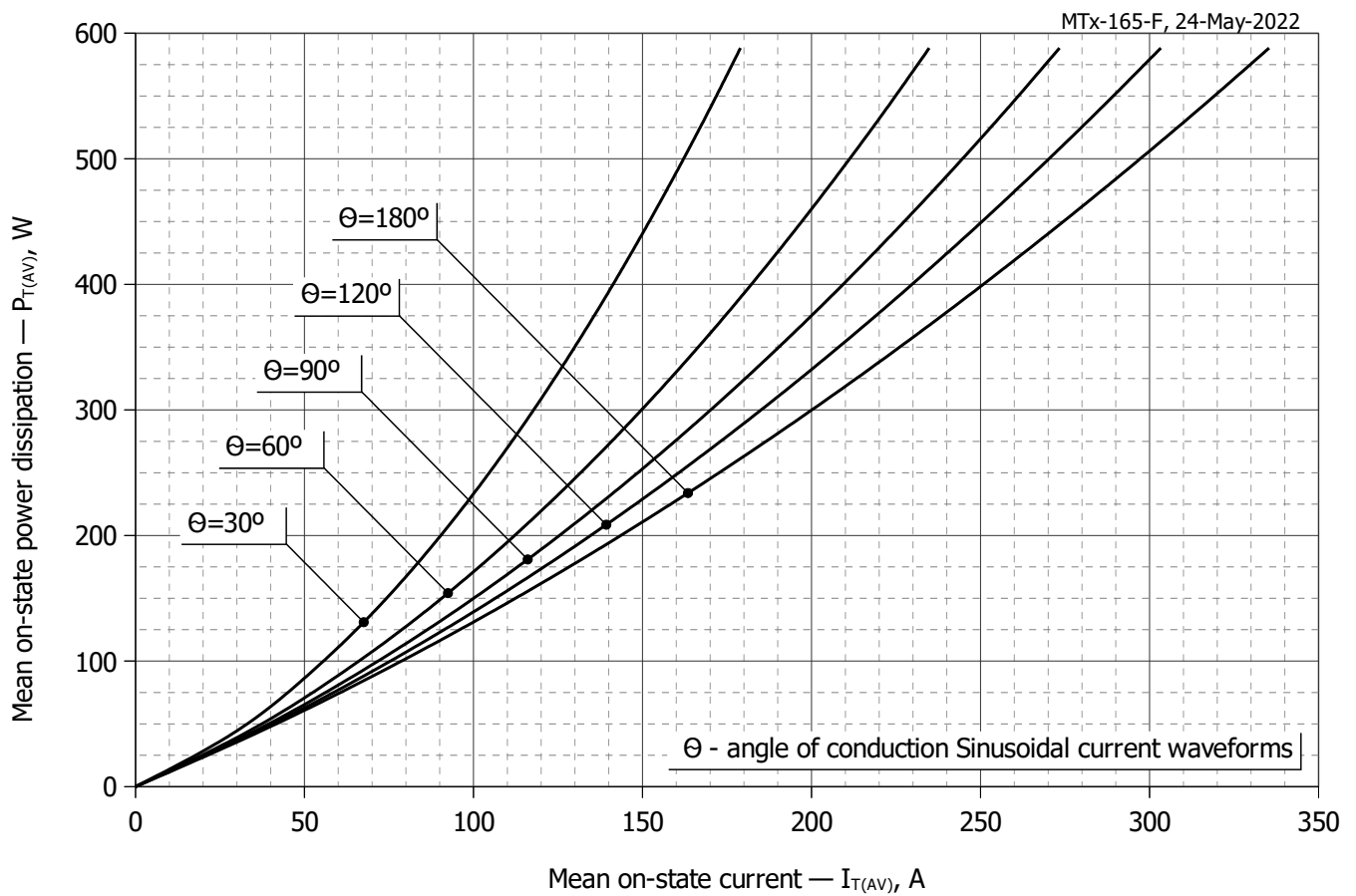


Fig. 8 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

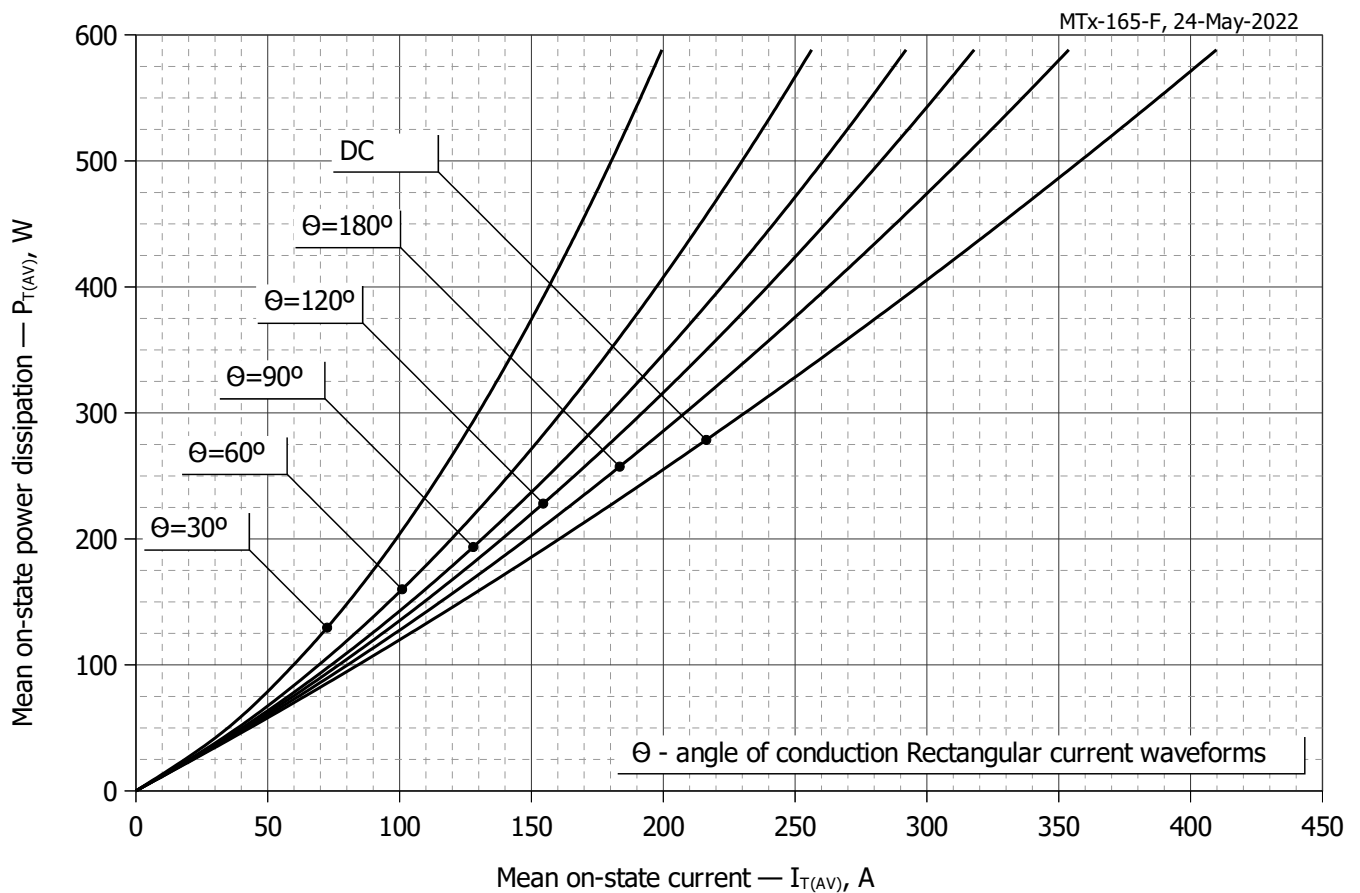


Fig. 9 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

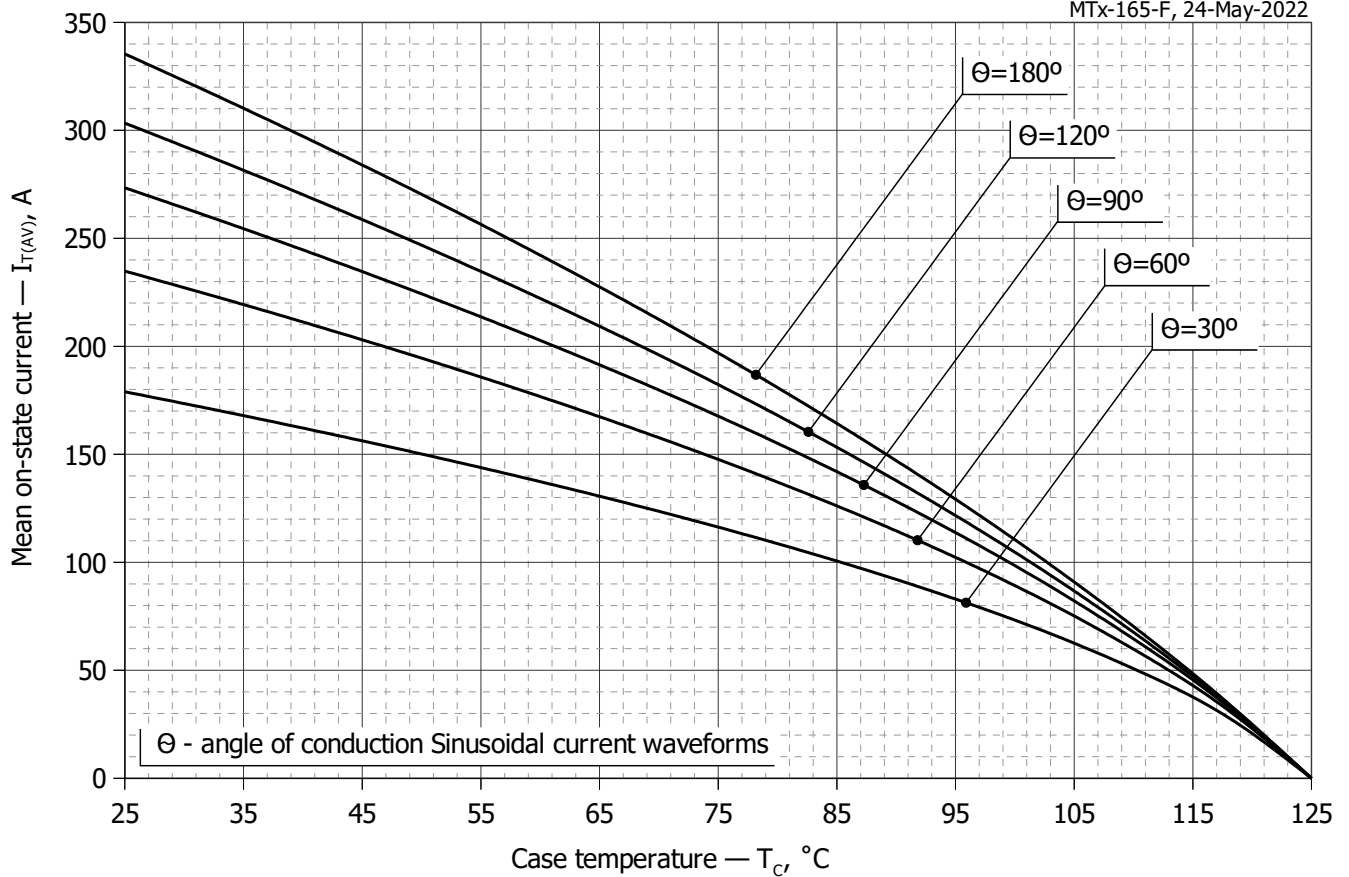


Fig. 10 – Mean on-state current I_{TAV} vs. case temperature T_c for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

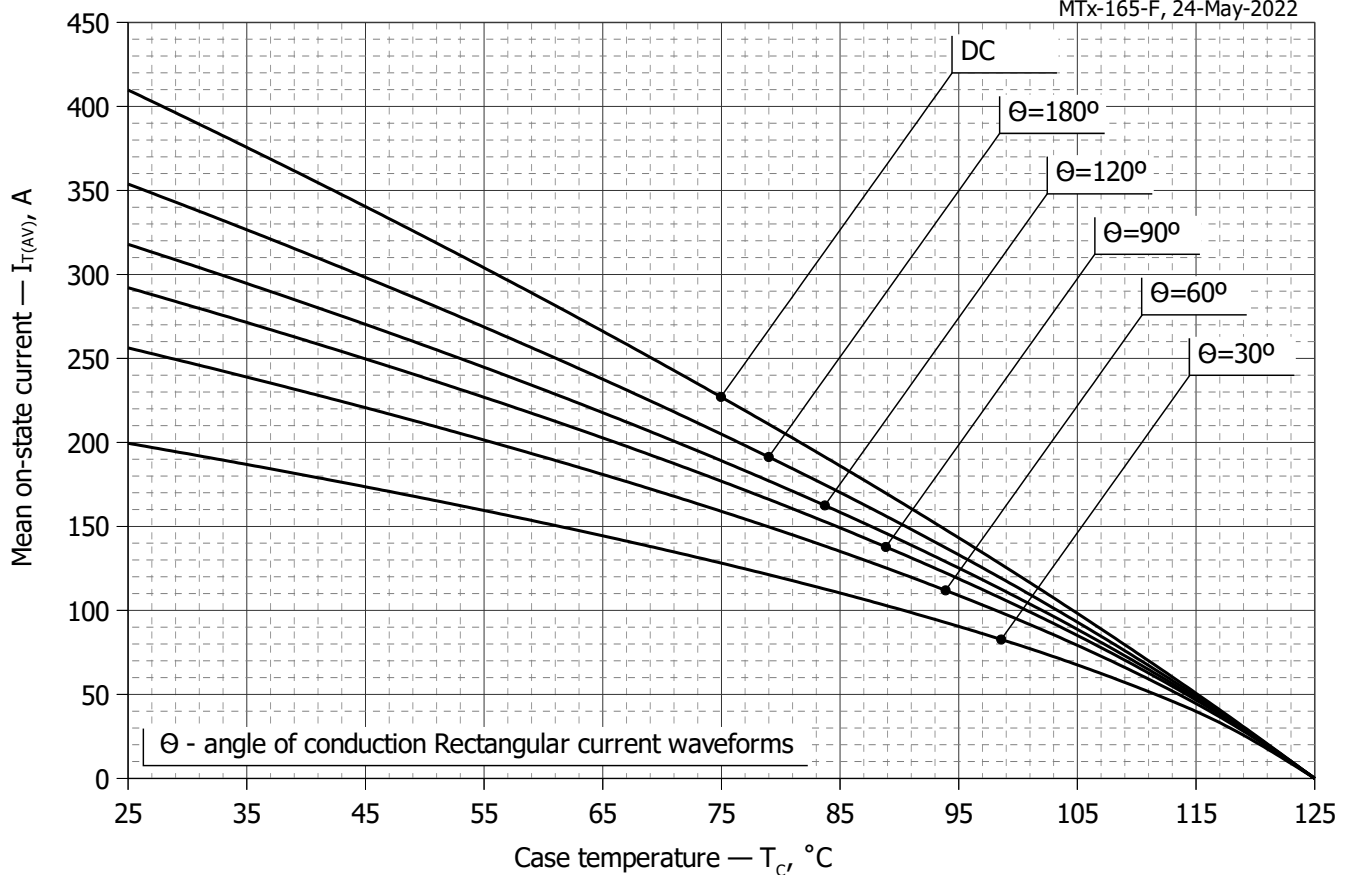


Fig. 11 - Mean on-state current I_{TAV} vs. case temperature T_c for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

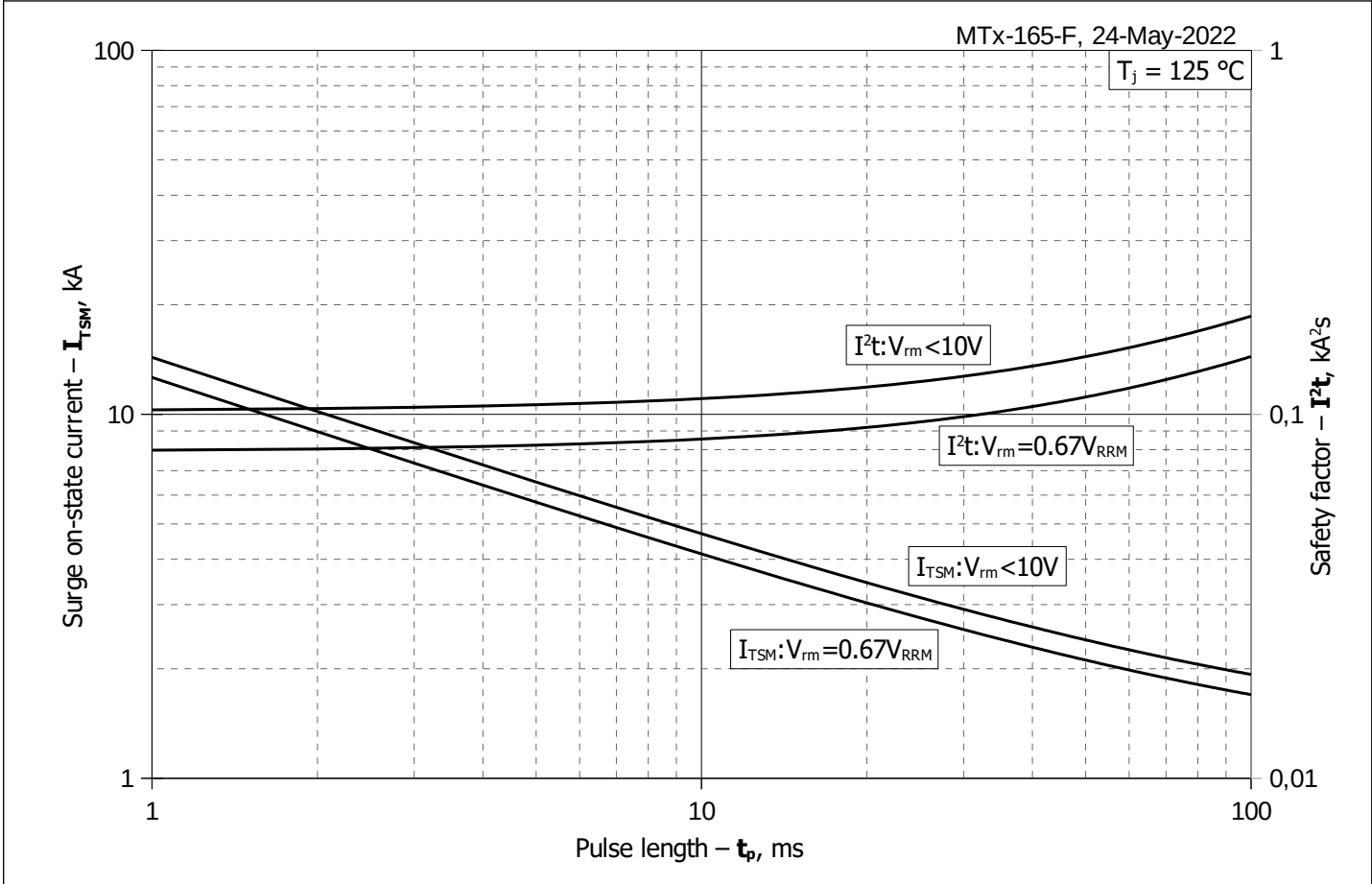


Fig. 12 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

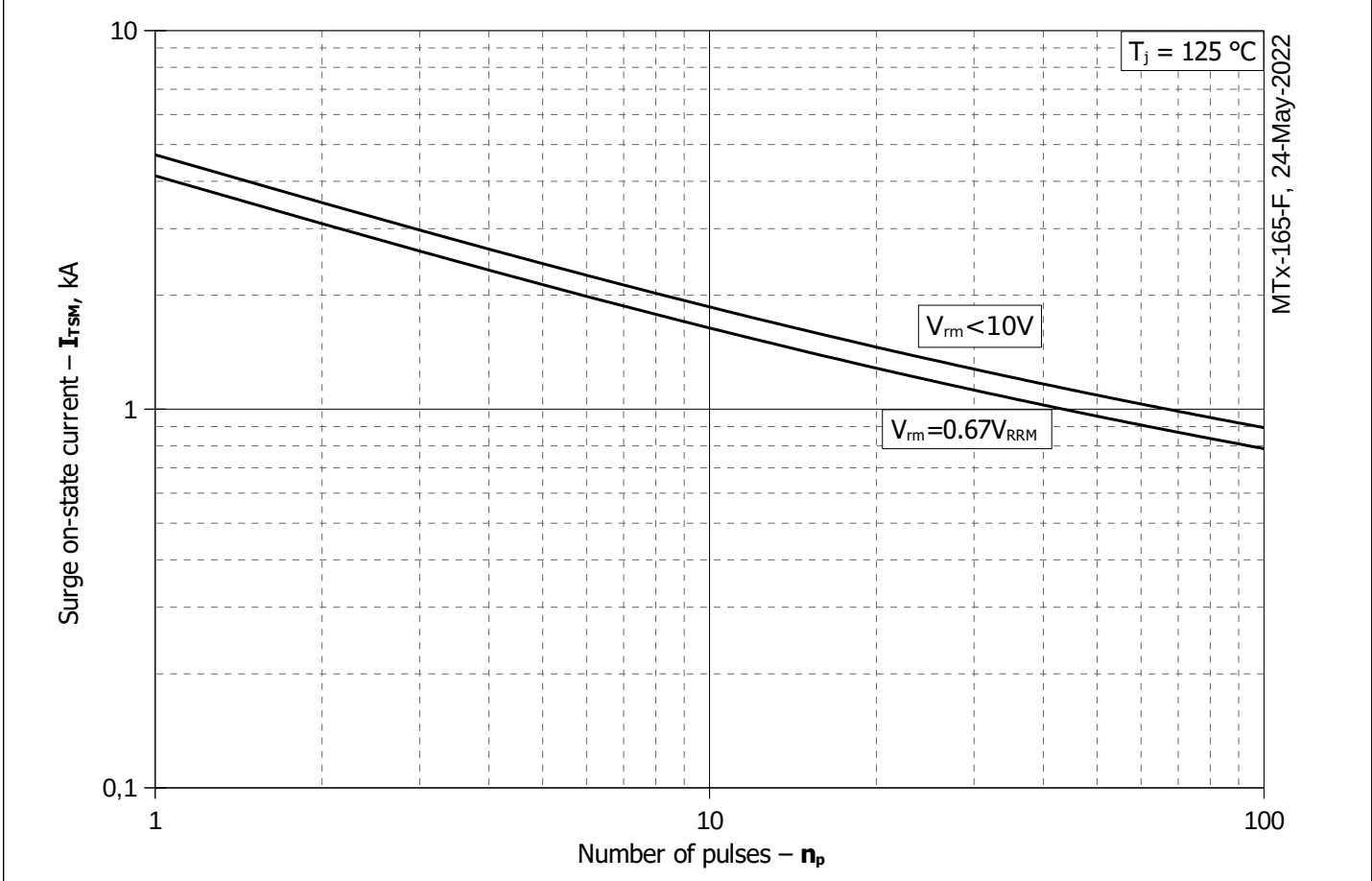


Fig. 13 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p