

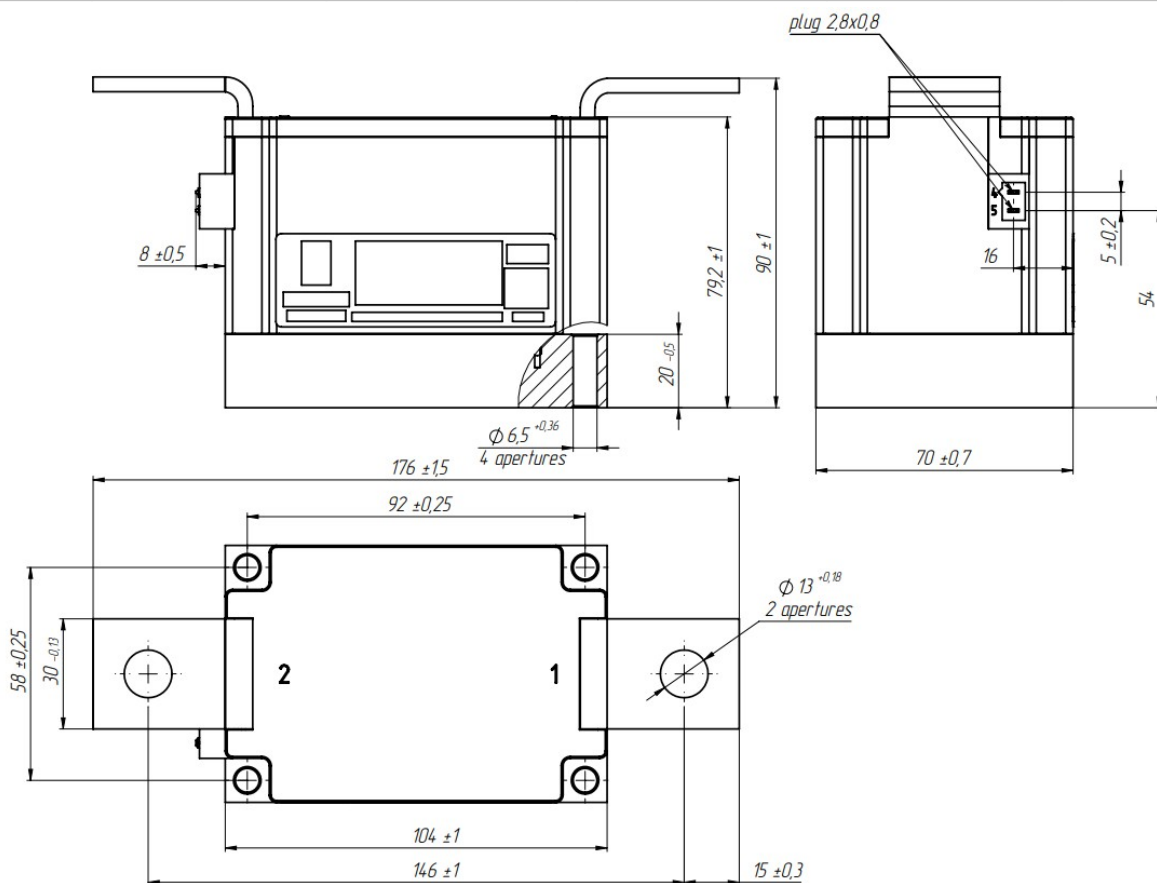
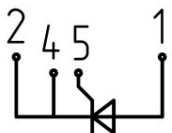


Electrically isolated base plate
Industrial standard package
Simplified mechanical design, rapid assembly
Pressure contact

Single Thyristor Module
For Phase Control
MT1-560-36-E1M

Maximum allowable mean on-state current		I _{TAV}		560 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 _{ij} , °C	−50...+125				

MT1



MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I_{TAV}	Maximum allowable mean on-state current	A	560 633	$T_c=91\text{ }^{\circ}\text{C}$; $T_c=85\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TRMS}	RMS on-state current	A	879	$T_c=91\text{ }^{\circ}\text{C}$; 180° half-sine wave; 50 Hz	
I_{TSM}	Surge on-state current	kA	22.0 25.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=500\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
			23.0 26.0	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=500\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
I^2t	Safety factor	$\text{A}^2\text{s}\cdot 10^3$	2400 3100	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=10\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=500\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
			2100 2800	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^{\circ}\text{C}$	180° half-sine wave; $t_p=8.3\text{ ms}$; single pulse; $V_D=V_R=0\text{ V}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=500\text{ }\mu\text{S}$; $di_G/dt=1\text{ A}/\mu\text{S}$
BLOCKING					
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	3000...3600	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 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	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 180° half-sine wave; single pulse; Gate open	
V_D, V_R	Direct off-state and Direct reverse voltages	V	$0.6\cdot V_{DRM}$ $0.6\cdot V_{RRM}$	$T_j=T_{j\text{ max}}$; Gate open	
TRIGGERING					
I_{FGM}	Peak forward gate current	A	8	$T_j=T_{j\text{ max}}$	
V_{RGM}	Peak reverse gate voltage	V	5		
P_G	Gate power dissipation	W	4	$T_j=T_{j\text{ max}}$ for DC gate current	
SWITCHING					
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive ($f=1\text{ Hz}$)	$\text{A}/\mu\text{S}$	500	$T_j=T_{j\text{ max}}$; $V_D=0.67\cdot V_{DRM}$; $I_{TM}=1600\text{ A}$; 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	$^{\circ}\text{C}$	-50...+50		
T_j	Operating junction temperature	$^{\circ}\text{C}$	-50...+125		
$T_{c\text{ op}}$	Operating temperature	$^{\circ}\text{C}$	-50...+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	1.90	T _j =25 °C; I _{TM} =2500 A	
V _{T(TO)}	On-state threshold voltage, max	V	0.948	T _j =T _{j max} ;	
r _T	On-state slope resistance, max	mΩ	0.407	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 =I _{FGM} ; V _G =20 V; t _{GP} =500 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	0.50	T _j =T _{j max} ; V _D =0.67·V _{DRM} ;	
I _{GD}	Gate non-trigger direct current, min	mA	70.00	Direct gate current	
SWITCHING					
t _{gd}	Delay time, max	μs	1.40	T _j =25 °C; V _D =1500 V; I _{TM} =I _{TAV} ; di/dt=200 A/μs;	
t _{gt}	Turn-on time, max	μs	6.00	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	400	dv _D /dt=50 V/μs; T _j =T _{j max} ; I _{TM} = I _{TAV} ; di _R /dt=-10 A/μs; V _R =100 V; V _D =0.67·V _{DRM}	
Q _{rr}	Recovered charge, max	μC	3910	T _j =T _{j max} ; I _{TM} =500 A;	
t _{rr}	Reverse recovery time, max	μs	61	di _R /dt=-5 A/μs;	
I _{rr}	Reverse recovery current, max	A	128	V _R =100 V	
THERMAL					
R _{thjc}	Thermal resistance, junction to case			180° half-sine wave, 50 Hz	
	per module	°C/W	0.0400		
R _{thch}	Thermal resistance, case to heatsink				
	per module	°C/W	0.0100		
INSULATION					
V _{ISOL}	Insulation test voltage	kV	7.00	Sine wave, 50 Hz; RMS	t=60 sec
			8.40		t=1 sec
MECHANICAL					
M ₁	Mounting torque (M6) ³⁾	Nm	6.00	Tolerance ± 15%	
M ₂	Terminal connection torque (M12) ³⁾	Nm	18.00	Tolerance ± 15%	
m	Weight, max	g	2750		

PART NUMBERING GUIDE													NOTES																											
MT	1	-	560	-	36	-	A2	H2	-	E1M	-	N																												
1	2		3		4		5	6		7		8																												
1. MT - Thyristor module 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 ($dv_D/dt=50\text{ V}/\mu\text{s}$) 7. Package Type (M.E1M) 8. Ambient Conditions: N – Normal⁴⁾													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><td>T1</td><td>P1</td><td>M1</td></tr><tr><td>$(dv_D/dt)_{crit}, \text{ V}/\mu\text{s}$</td><td>200</td><td>320</td><td>500</td><td>1000</td><td>1600</td><td>2000</td><td>2500</td></tr></table> 2) Turn-off time ($dv_D/dt=50\text{ V}/\mu\text{s}$) <table><tr><td>Symbol of Group</td><td>H2</td></tr><tr><td>$t_{qr}, \mu\text{s}$</td><td>400</td></tr></table> 3) The screws must be lubricated 4) Additionally: - ambient operating temperature $-50...+60\text{ }^\circ\text{C}$; - maximum altitude above sea level 1700 meters; - frost and dew resistance.								Symbol of Group	P2	K2	E2	A2	T1	P1	M1	$(dv_D/dt)_{crit}, \text{ V}/\mu\text{s}$	200	320	500	1000	1600	2000	2500	Symbol of Group	H2	$t_{qr}, \mu\text{s}$	400
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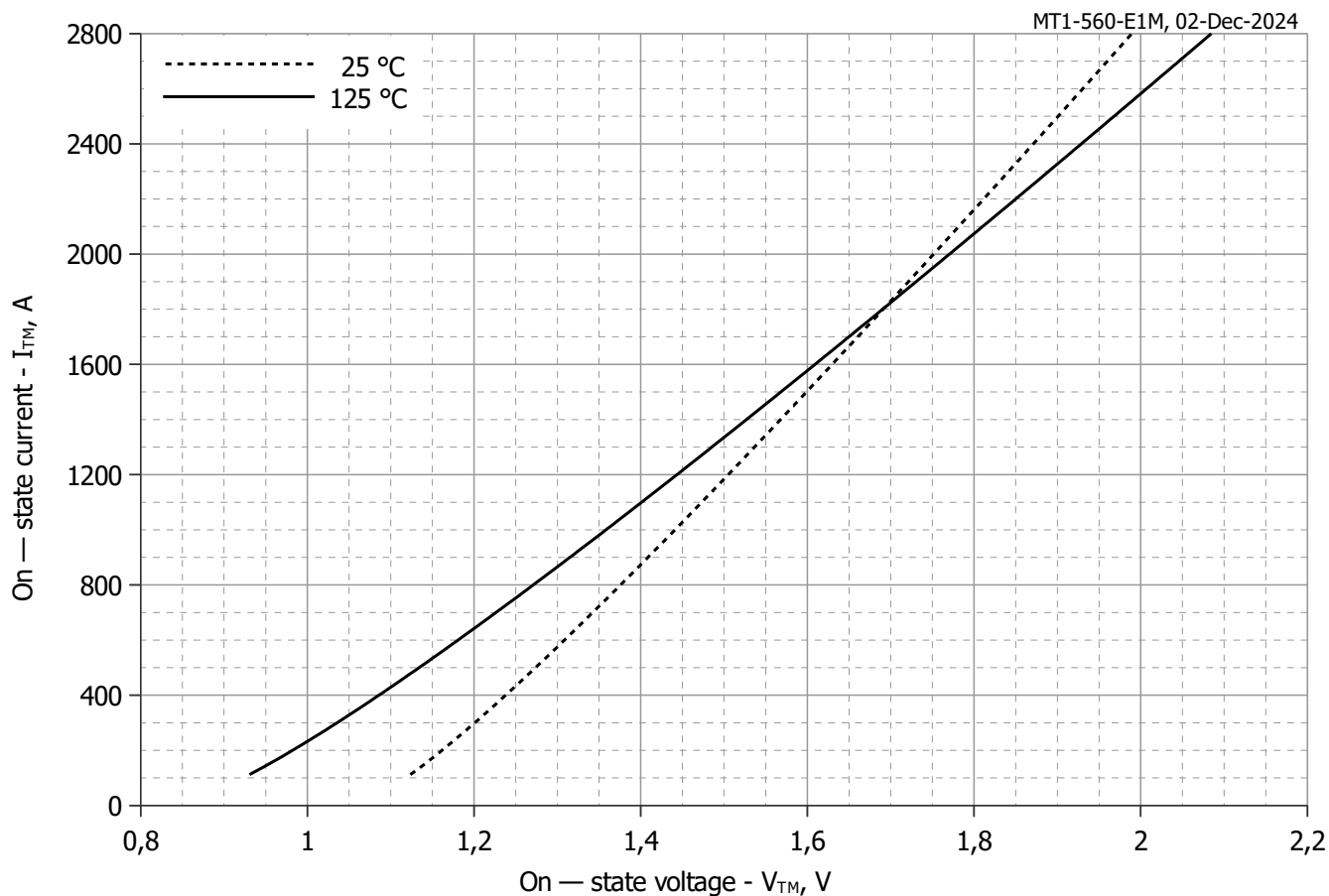


Fig 1 – On-state characteristics of Limit device

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	1.05284828	0.83406998
B	0.00024983	0.00032169
C	-0.00146269	-0.00304789
D	0.00469749	0.00707038

On-state characteristic model (see Fig. 1)

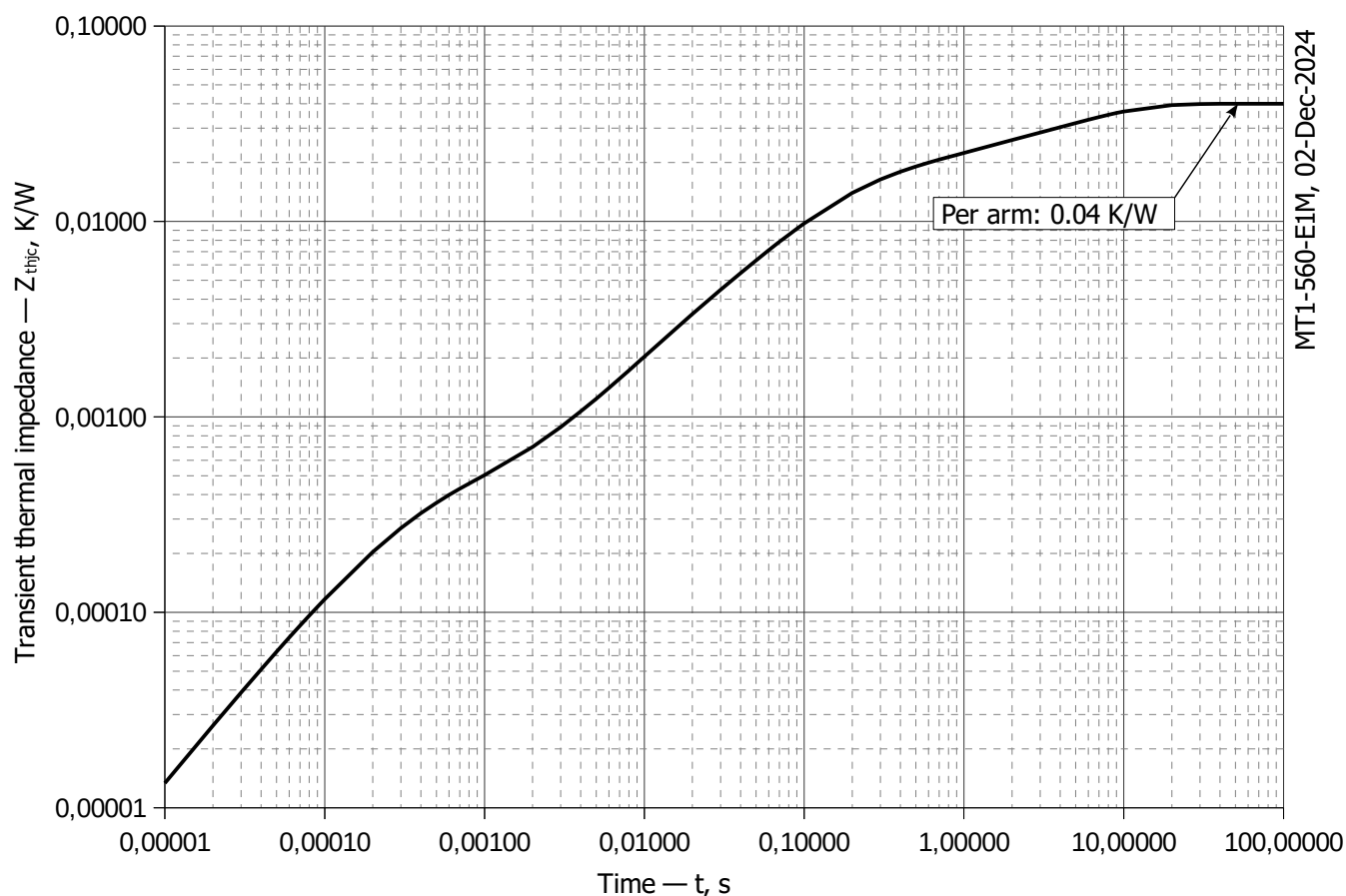


Fig 2 – Transient thermal impedance Z_{thjc} vs. time t

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	0.0189958	0.005931	0.009502	0.004252	0.001006	0.0003132
τ_i , s	5.887	0.7389	0.1616	0.08215	0.01267	0.0002712

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

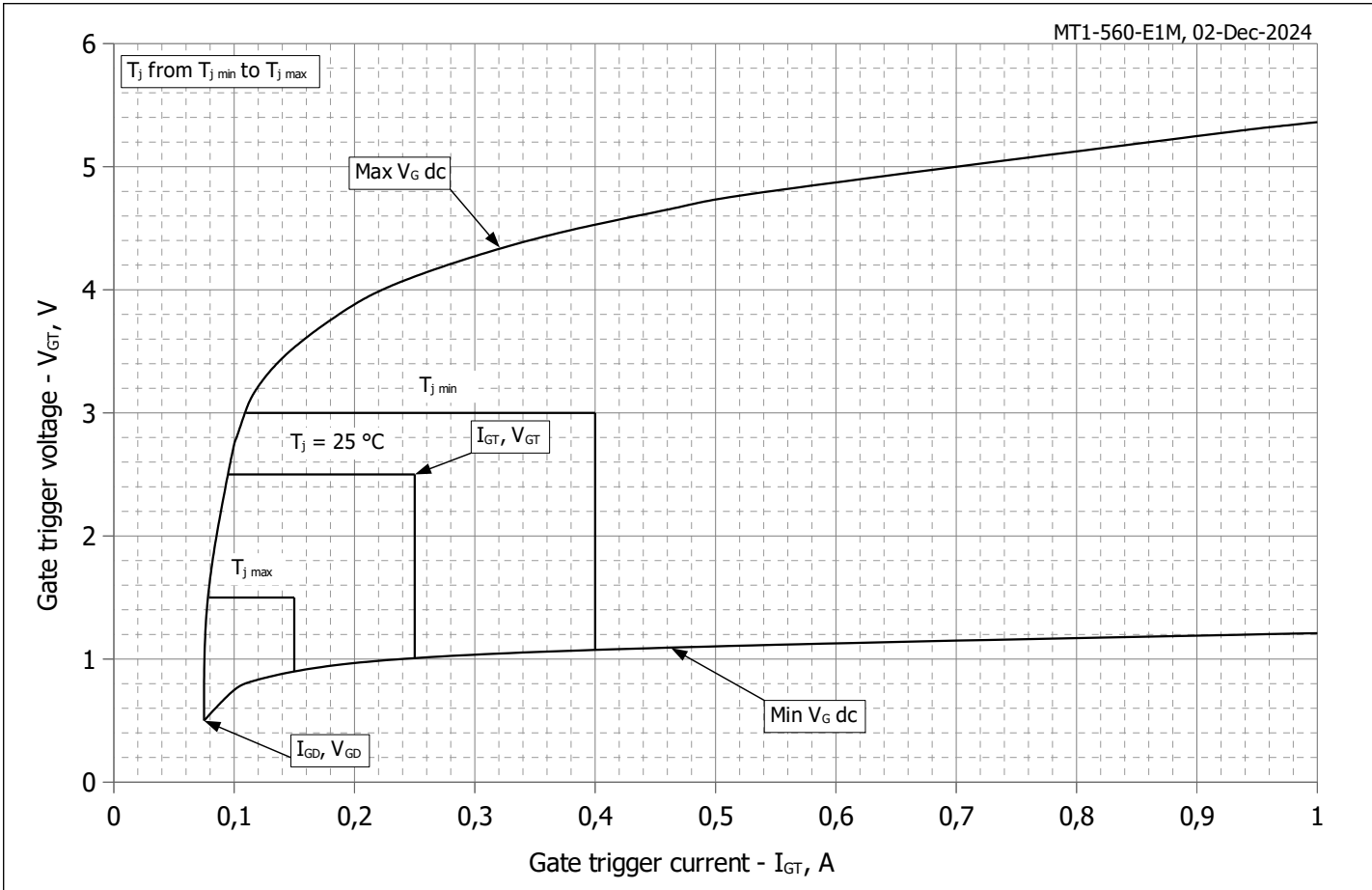


Fig 3 – Gate characteristics – Trigger limits

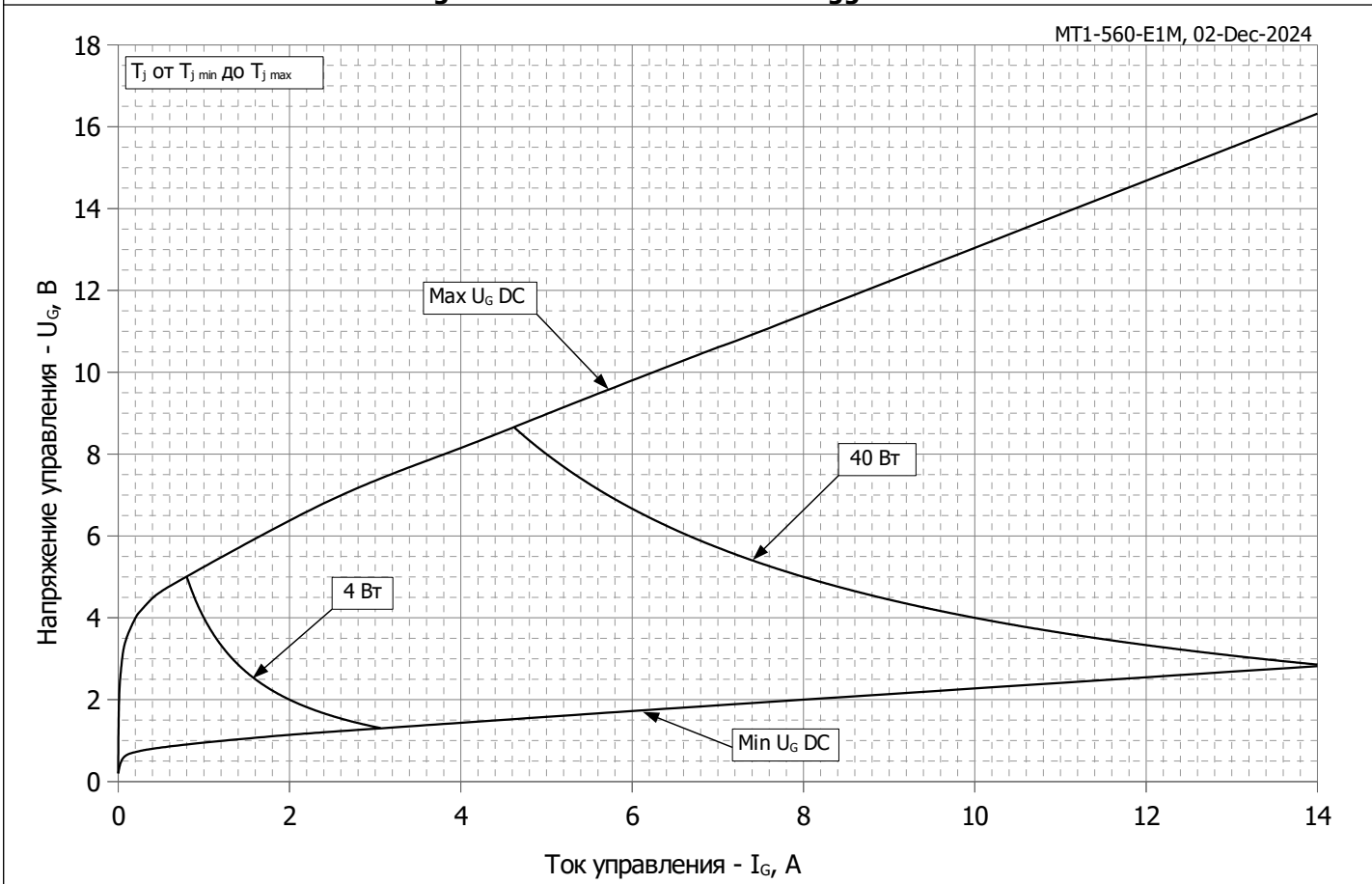


Fig 4 - Gate characteristics –Power curves

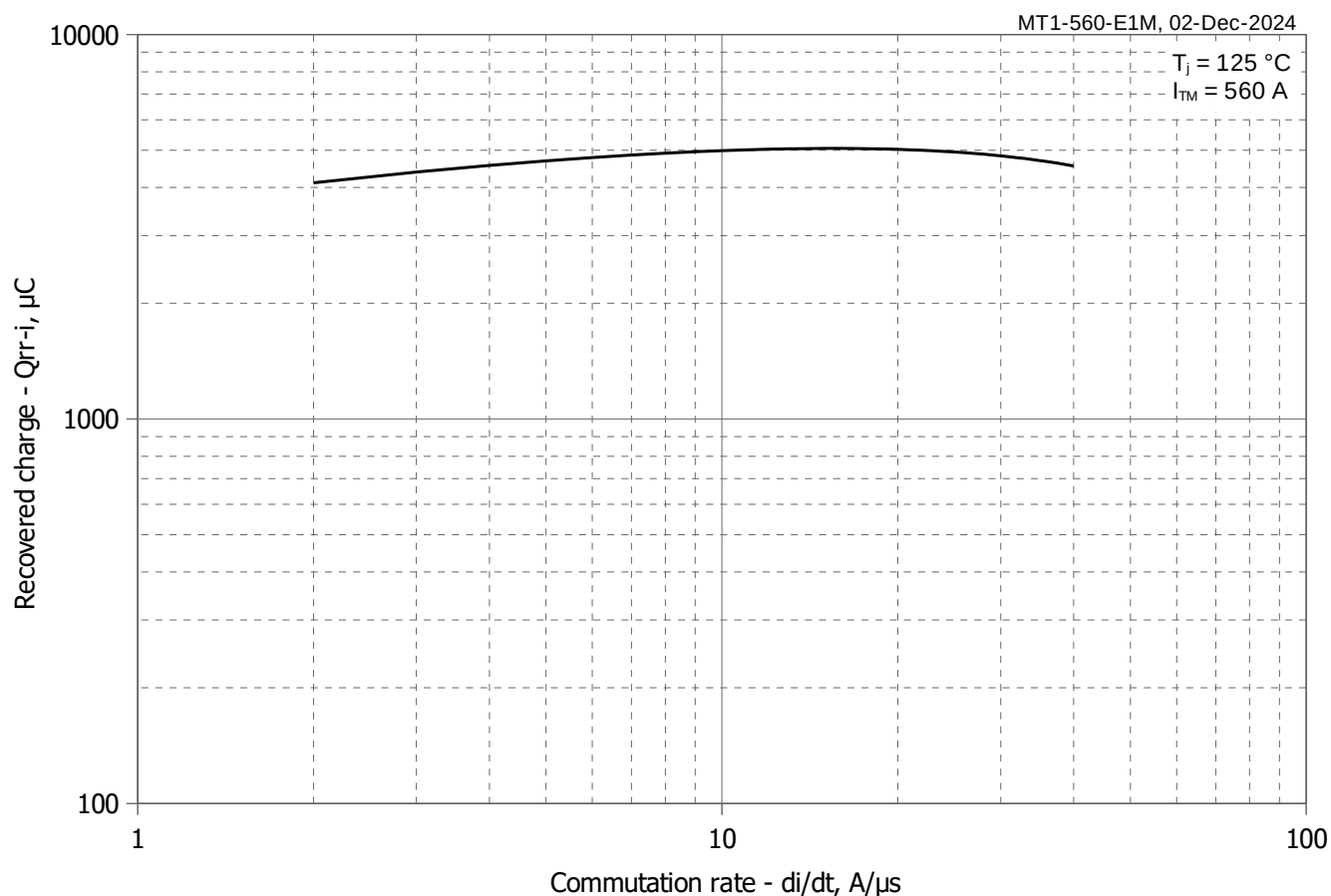


Fig 5 – Maximum recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

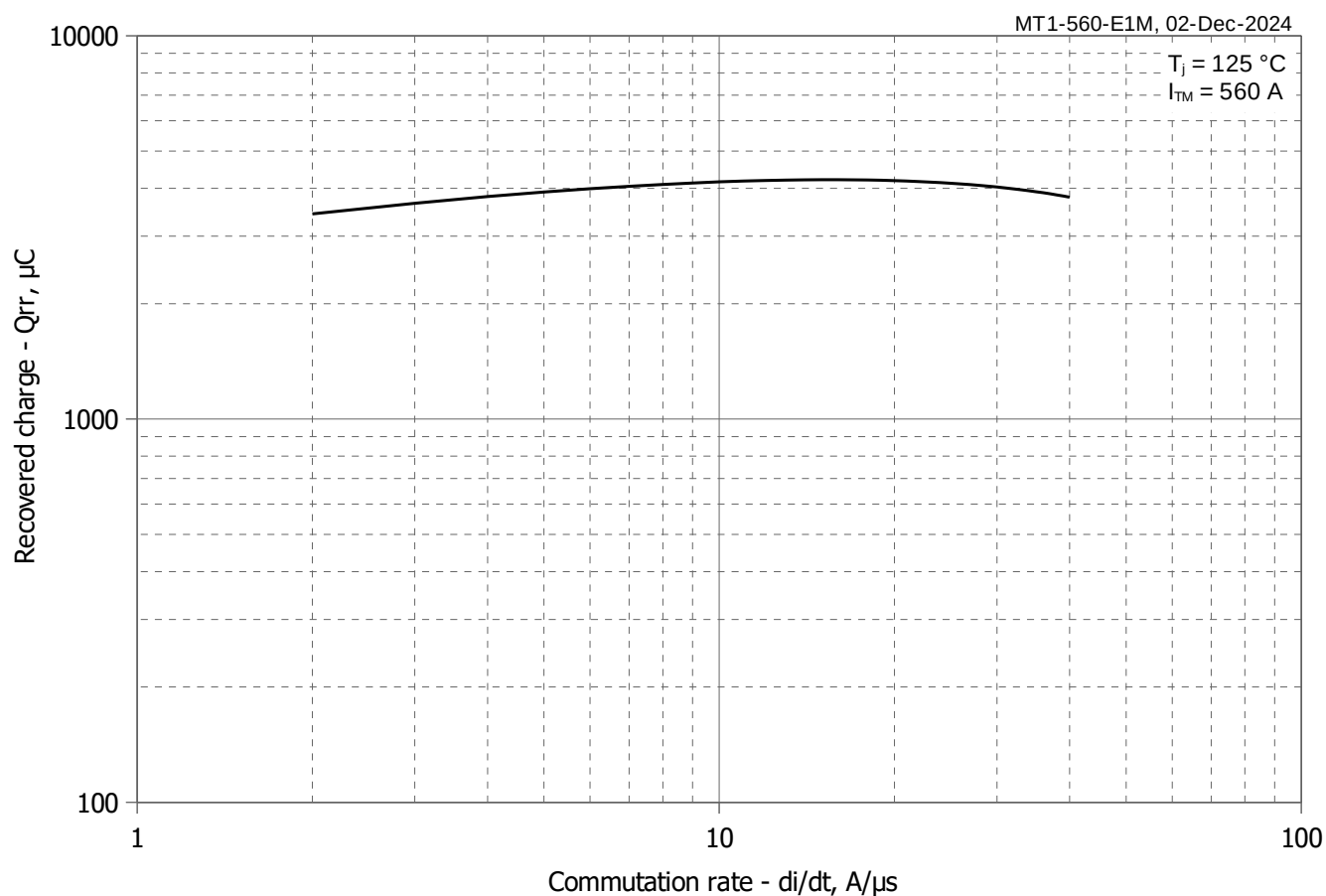


Fig 6 – Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

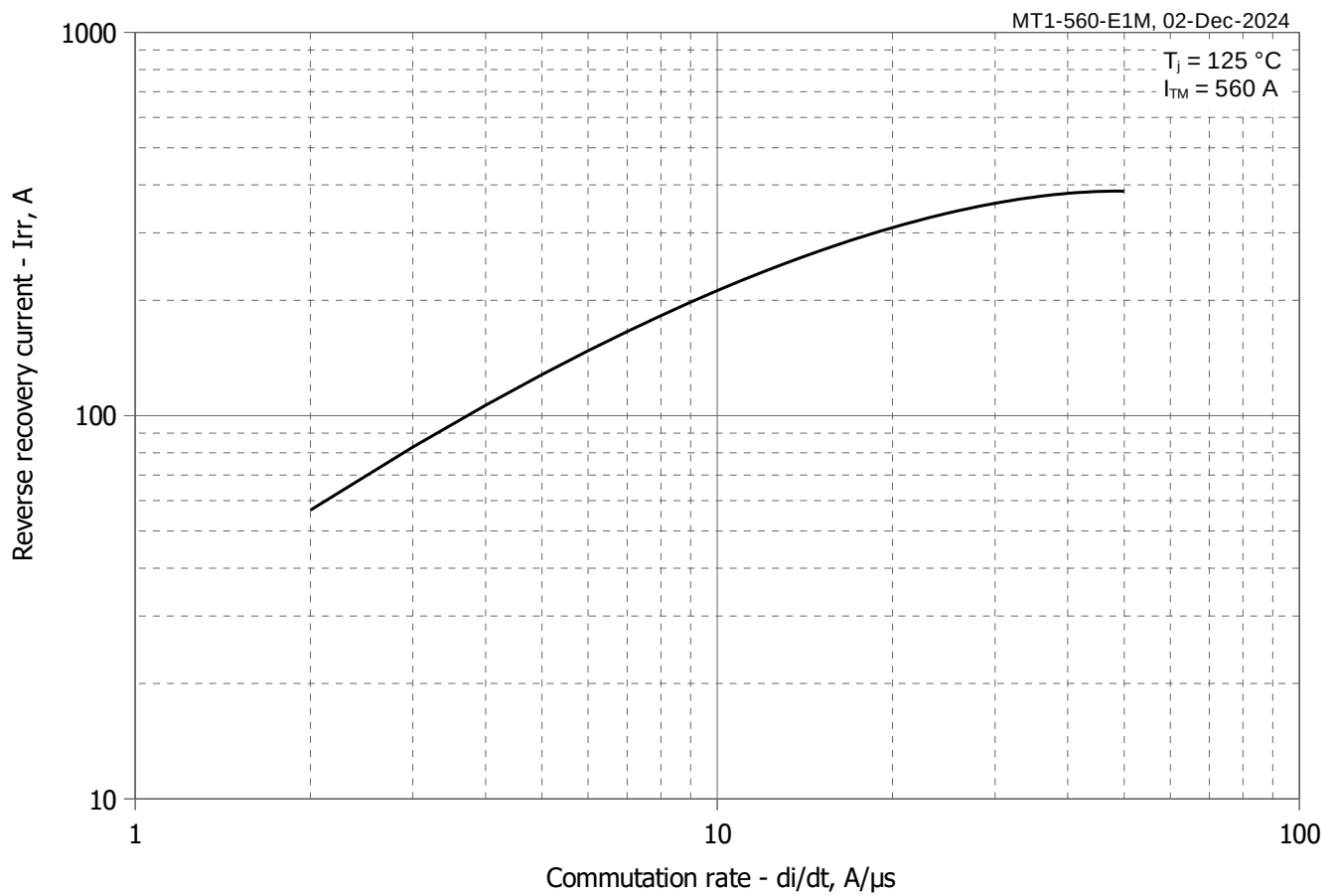


Fig 7 – Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

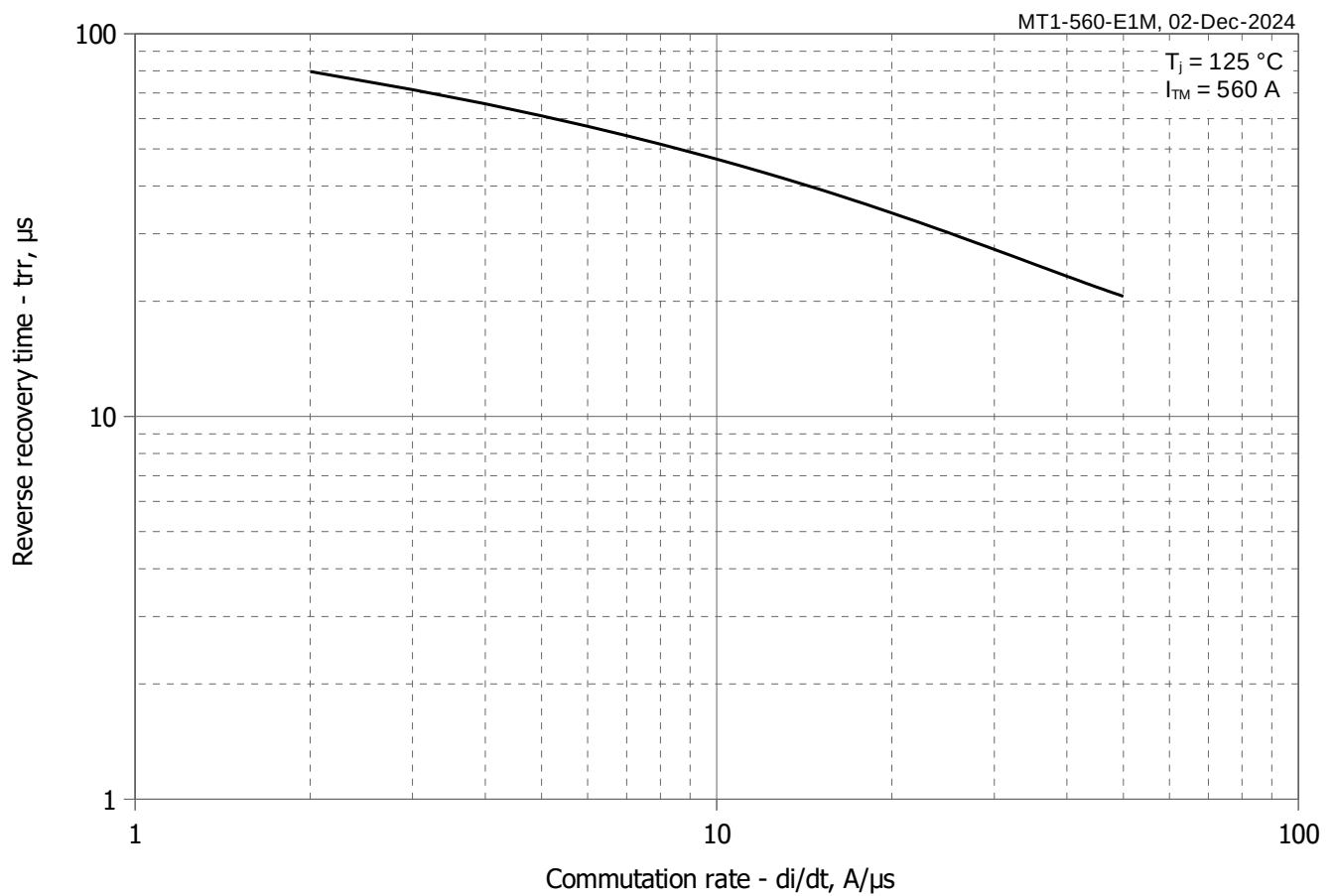


Fig 8 – Maximum recovery time t_r vs. commutation rate di_R/dt (25% chord)

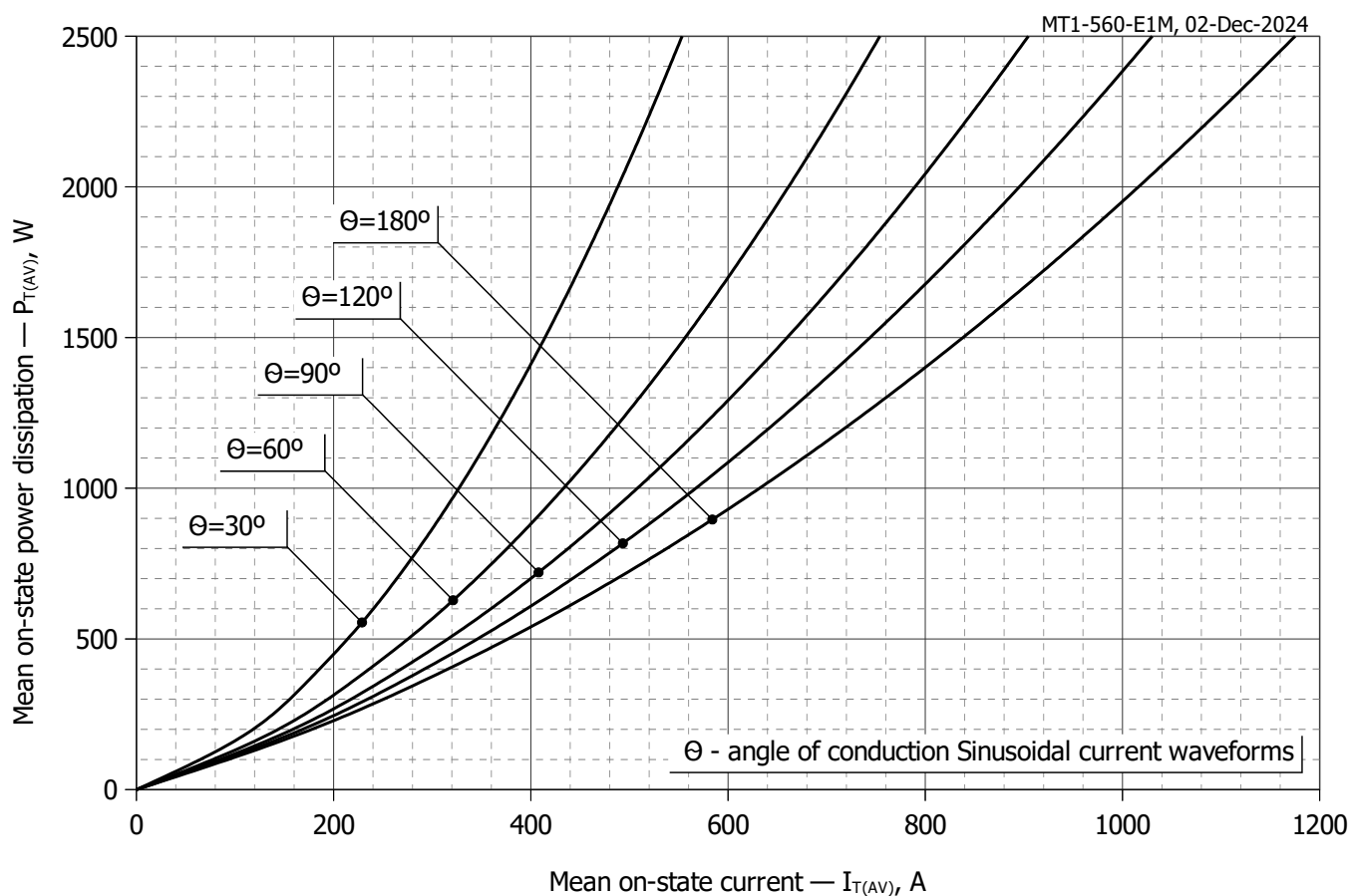


Fig. 9 - Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

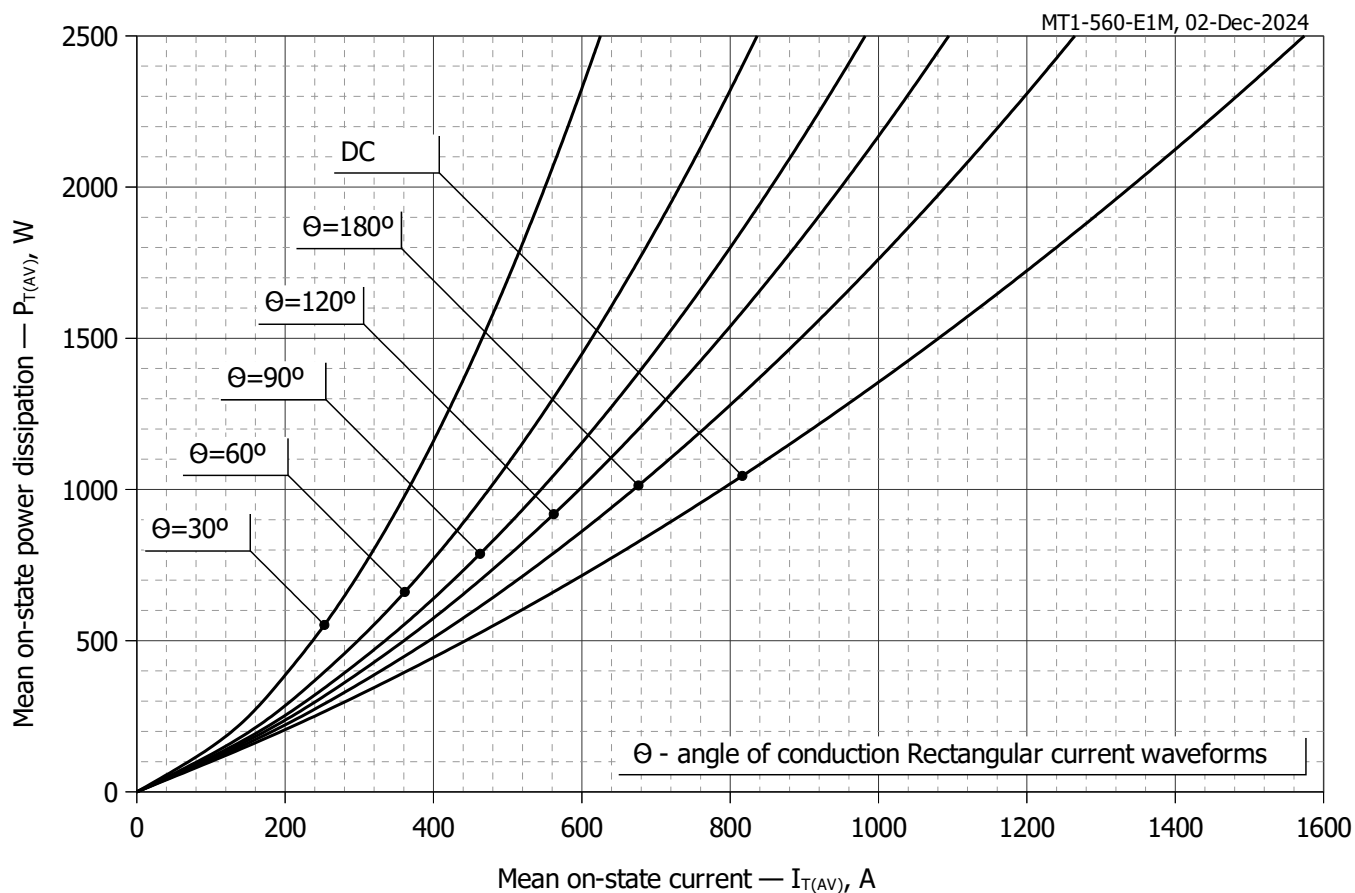


Fig. 10 – Mean on-state power dissipation P_{TAV} vs. mean on-state current I_{TAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

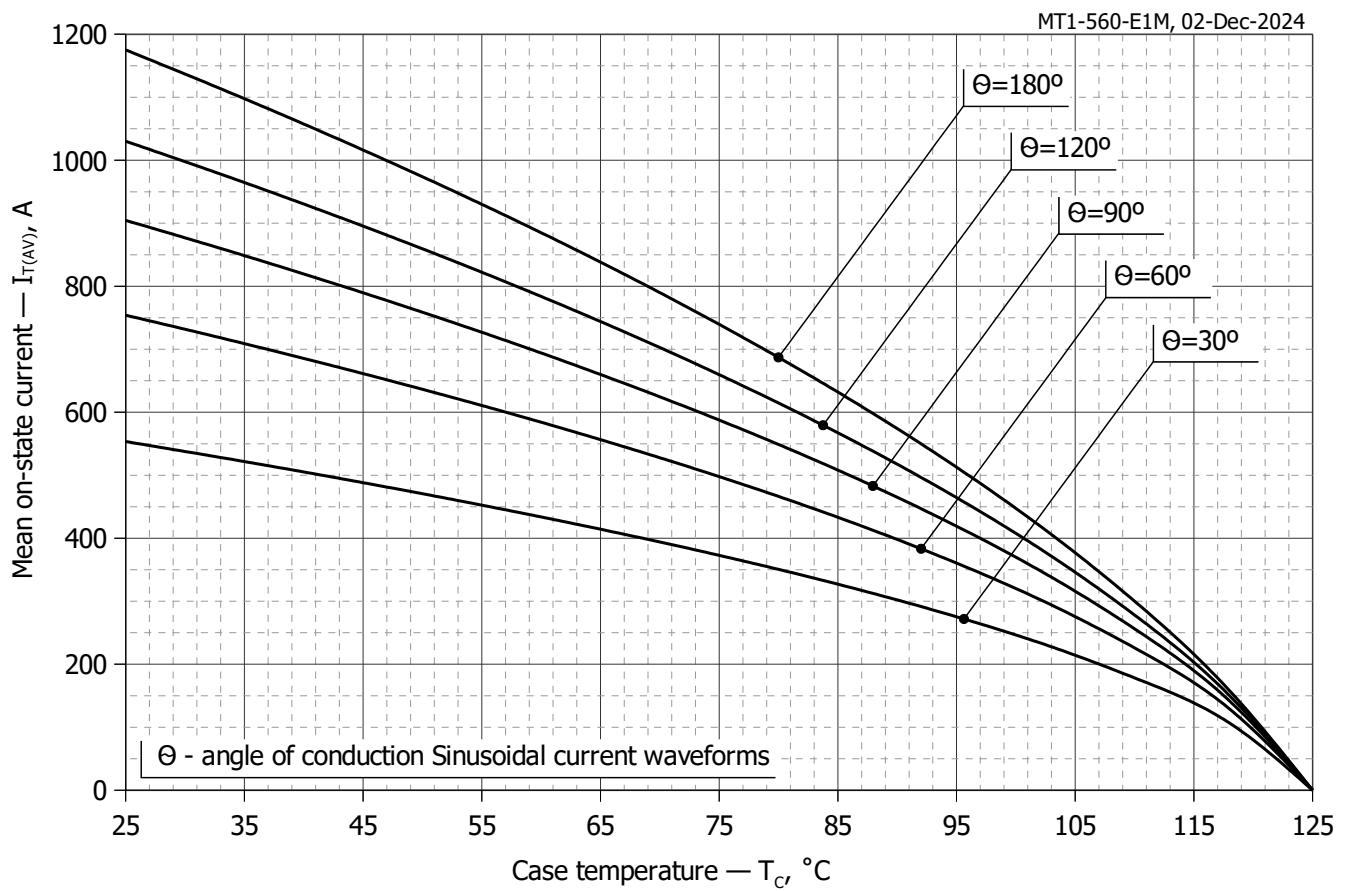


Fig. 11 – Mean on-state current I_{TAV} vs. case temperature T_C for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$)

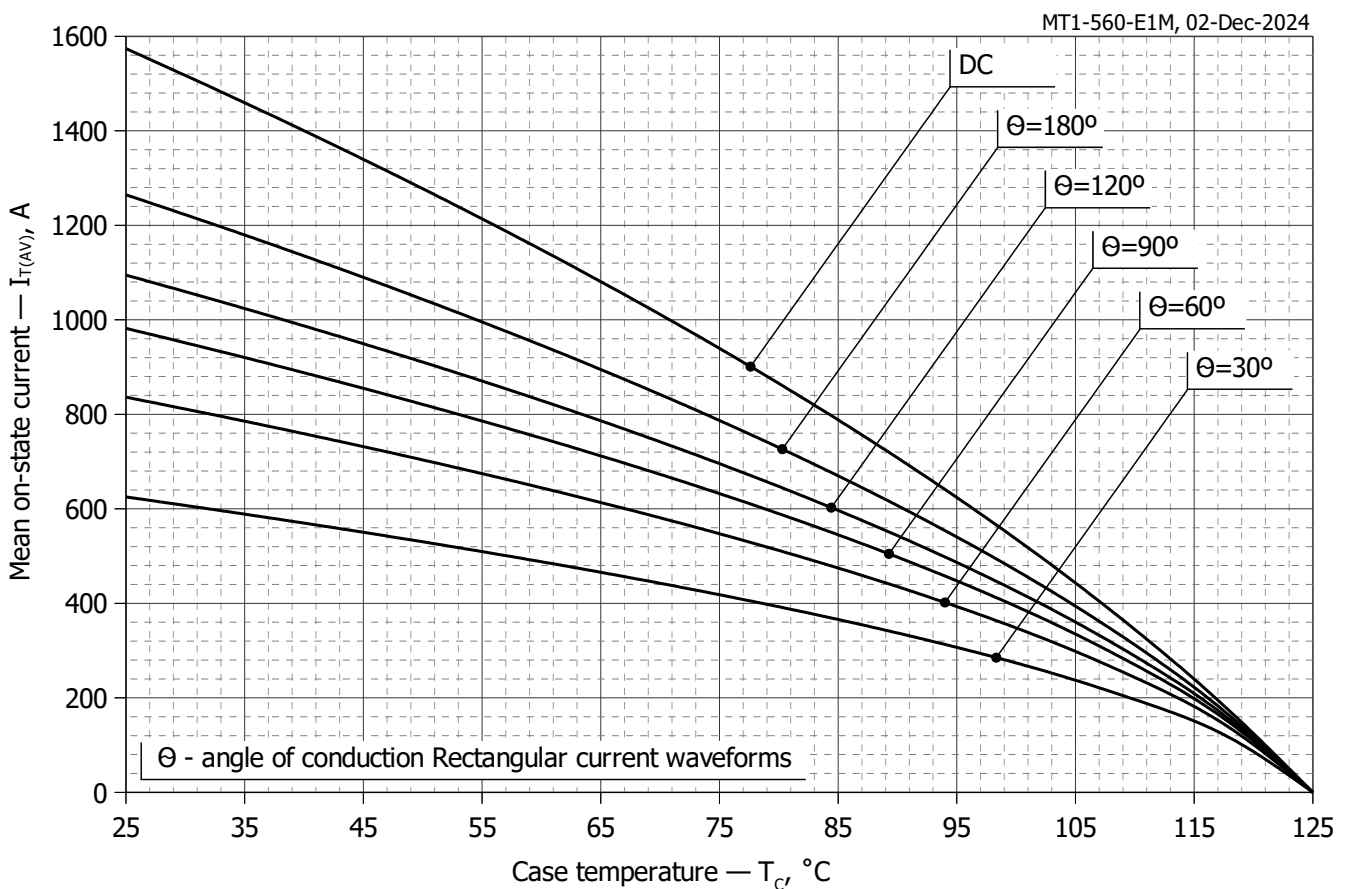


Fig. 12 - Mean on-state current I_{TAV} vs. case temperature T_C for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$)

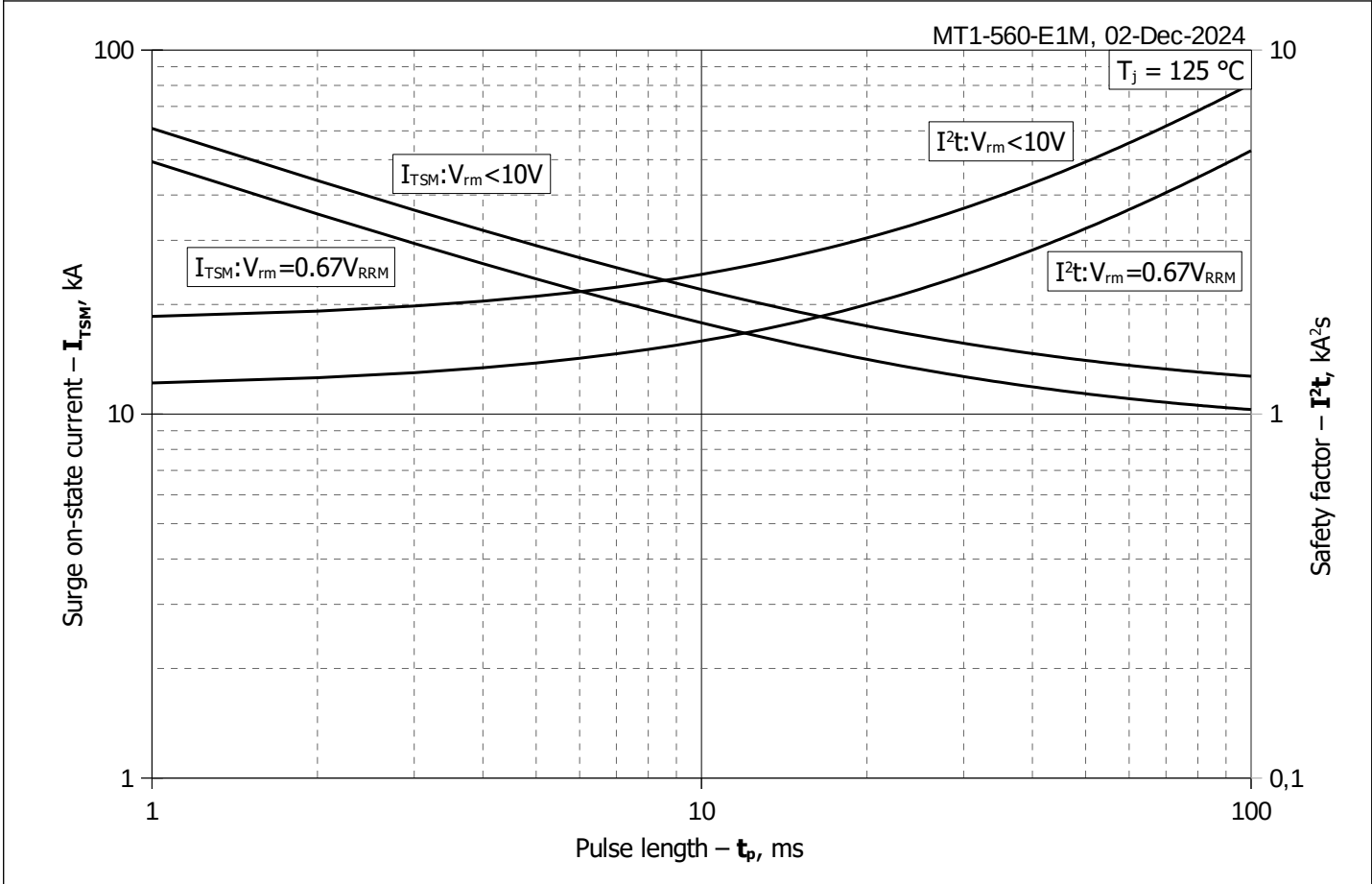


Fig. 13 – Maximum surge on-state current I_{TSM} and safety factor I^2t vs. pulse length t_p

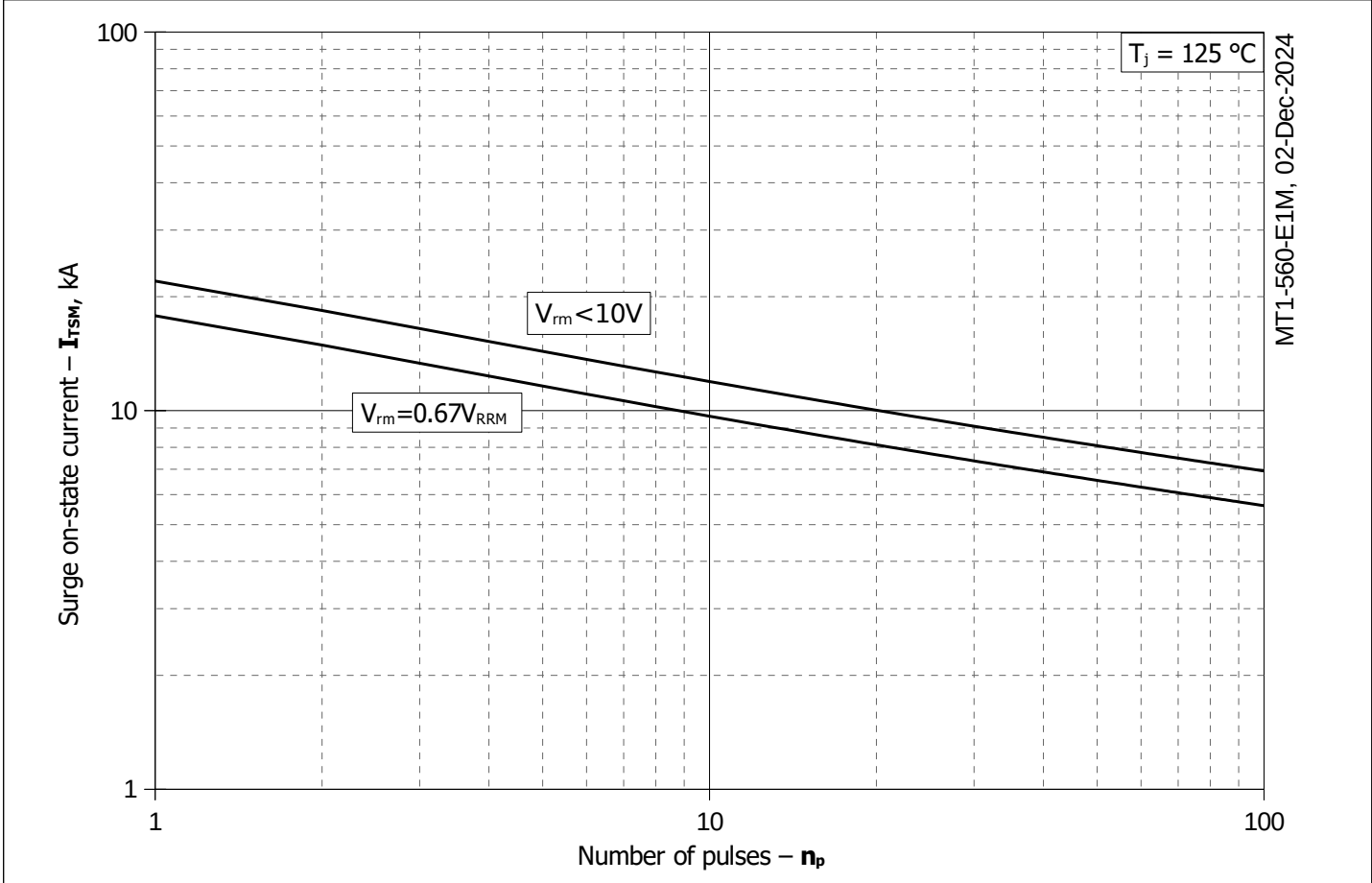


Fig. 14 - Maximum surge on-state current I_{TSM} vs. number of pulses n_p