



# Thyristor Modules MTx-130-28-F



Mean on-state current		$I_{TAV}$	130 A
Repetitive peak off-state voltage		$V_{DRM}$	2400...2800 V
Repetitive peak reverse voltage		$V_{RRM}$	
Turn-off time		$t_q$	250 $\mu$ s
$V_{DRM}, V_{RRM}, V$	2400	2600	2800
Voltage code	24	26	28
$T_j, ^\circ C$	-40...+125		

MT3		MT4			
<b>MT/D3</b>	<b>MD/T3</b>			<b>MT/D5</b>	

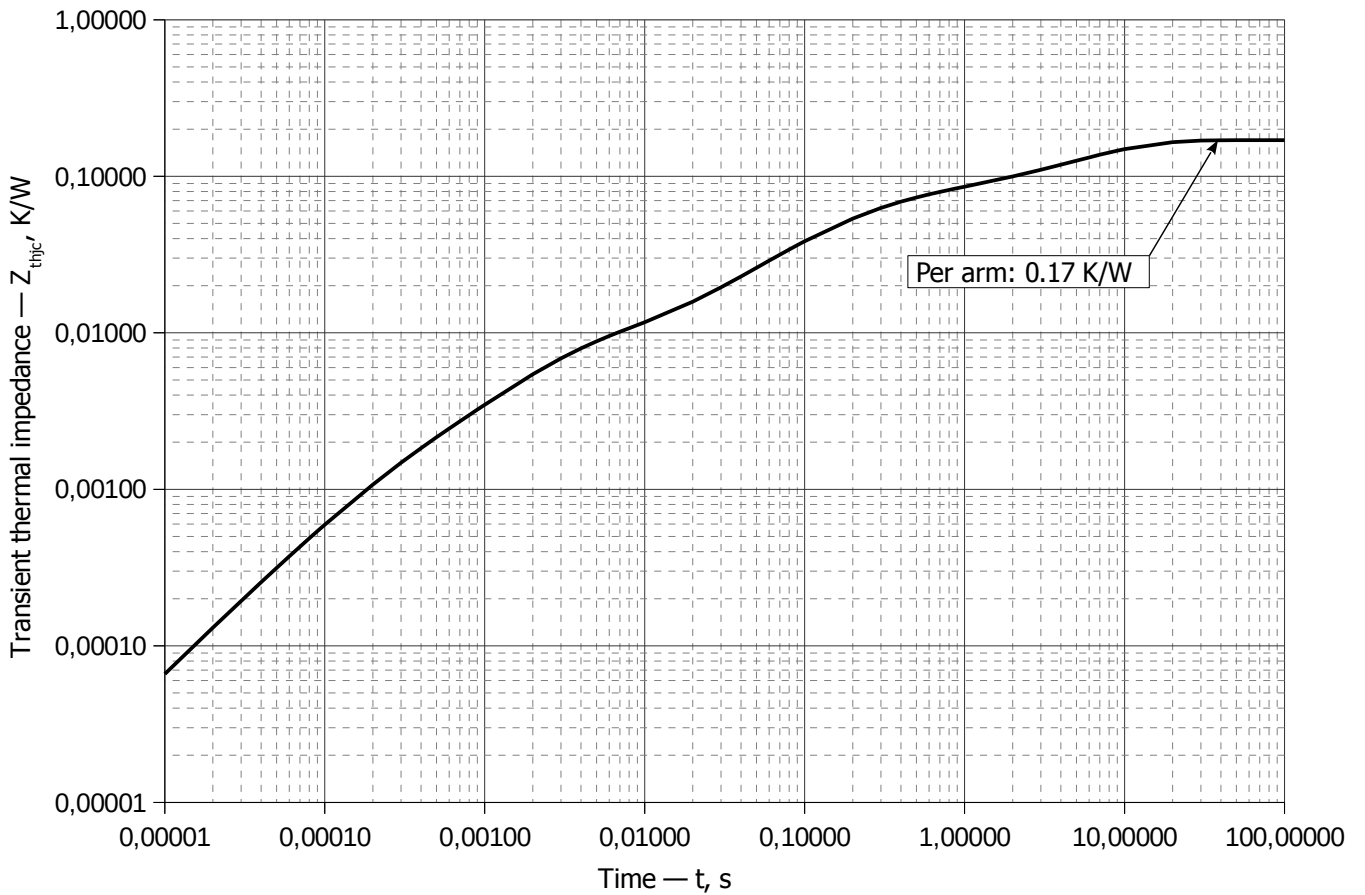
## MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions
<b>ON-STATE</b>				
$I_{TAV}$	Maximum allowable mean on-state current	A	130 148	$T_c = 91\text{ }^\circ\text{C}$ ; $T_c = 85\text{ }^\circ\text{C}$ ; 180° half-sine wave; 50 Hz
$I_{TRMS}$	RMS on-state current	A	204	$T_c = 91\text{ }^\circ\text{C}$ ; 180° half-sine wave; 50 Hz
$I_{TSM}$	Surge on-state current	kA	3.8 4.5	$T_j = T_{j\max}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 10\text{ ms}$ ; single pulse; $V_D = V_R = 0\text{ V}$ ; Gate pulse: $I_G = 2\text{ A}$ ; $t_{GP} = 50\text{ }\mu\text{s}$ ; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
			4.0 4.5	$T_j = T_{j\max}$ $T_j = 25\text{ }^\circ\text{C}$ 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	$\text{A}^2\text{s}\cdot 10^3$	70 100	$T_j = T_{j\max}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 10\text{ ms}$ ; single pulse; $V_D = V_R = 0\text{ V}$ ; Gate pulse: $I_G = 2\text{ A}$ ; $t_{GP} = 50\text{ }\mu\text{s}$ ; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
			60 80	$T_j = T_{j\max}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 8.3\text{ ms}$ ; single pulse; $V_D = V_R = 0\text{ V}$ ; Gate pulse: $I_G = 2\text{ A}$ ; $t_{GP} = 50\text{ }\mu\text{s}$ ; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
<b>BLOCKING</b>				
$V_{DRM}, V_{RRM}$	Repetitive peak off-state and Repetitive peak reverse voltages	V	2400...2800	$T_{j\min} < T_j < T_{j\max}$ ; 180° half-sine wave; 50 Hz; Gate open
$V_{DSM}, V_{RSM}$	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2500...2900	$T_{j\min} < T_j < T_{j\max}$ ; 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
<b>TRIGGERING</b>				
$I_{FGM}$	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
<b>SWITCHING</b>				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive ( $f = 1\text{ Hz}$ )	$\text{A}/\mu\text{s}$	800	$T_j = T_{j\max}$ ; $V_D = 0.67 \cdot V_{DRM}$ ; $I_{TM} = 840\text{ A}$ ; Gate pulse: $I_G = 2\text{ A}$ ; $V_G = 20\text{ V}$ ; $t_{GP} = 50\text{ }\mu\text{s}$ ; $di_G/dt = 2\text{ A}/\mu\text{s}$
<b>THERMAL</b>				
$T_{stg}$	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	
<b>MECHANICAL</b>				
a	Acceleration under vibration	$\text{m}/\text{s}^2$	50	

## CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions	
<b>ON-STATE</b>					
$V_{TM}$	Peak on-state voltage, max	V	1.80	$T_j=25\text{ °C}; I_{TM}=500\text{ A}$	
$V_{T(TO)}$	On-state threshold voltage, max	V	1.246	$T_j=T_{j\text{ max}};$	
$r_T$	On-state slope resistance, max	mΩ	0.915	$0.5\pi I_{TAV} < I_T < 1.5\pi I_{TAV}$	
$I_L$	Latching current, max	mA	500	$T_j=25\text{ °C}; V_D=12\text{ V};$ Gate pulse: $I_G=2\text{ A};$ $t_{GP}=50\text{ μs}; di_G/dt\geq 1\text{ A/μs}$	
$I_H$	Holding current, max	mA	250	$T_j=25\text{ °C};$ $V_D=12\text{ V};$ Gate open	
<b>BLOCKING</b>					
$I_{DRM}, I_{RRM}$	Repetitive peak off-state and Repetitive peak reverse currents, max	mA	40 2.50	$T_j=T_{j\text{ max}}$ $T_j=25\text{ °C}$	$V_D=V_{DRM}; V_R=V_{RRM}$
$(dv_D/dt)_{crit}$	Critical rate of rise of off-state voltage <sup>1)</sup> , min	V/μs	200, 320, 500, 1000, 1600, 2000, 2500	$T_j=T_{j\text{ max}};$ $V_D=0.67\cdot V_{DRM};$ Gate open	
<b>TRIGGERING</b>					
$V_{GT}$	Gate trigger direct voltage, max	V	3.00 2.50 1.50	$T_j=T_{j\text{ min}}$ $T_j=25\text{ °C}$ $T_j=T_{j\text{ max}}$	$V_D=12\text{ V}; I_D=3\text{ A};$ Direct gate current
$I_{GT}$	Gate trigger direct current, max	mA	400 250 150	$T_j=T_{j\text{ min}}$ $T_j=25\text{ °C}$ $T_j=T_{j\text{ max}}$	
$V_{GD}$	Gate non-trigger direct voltage, min	V	0.45	$T_j=T_{j\text{ max}};$ $V_D=0.67\cdot V_{DRM};$	
$I_{GD}$	Gate non-trigger direct current, min	mA	35.00	Direct gate current	
<b>SWITCHING</b>					
$t_{gd}$	Delay time, max	μs	0.90	$T_j=25\text{ °C}; V_D=1500\text{ V}; I_{TM}=I_{TAV};$ $di/dt=200\text{ A/μs};$	
$t_{gt}$	Turn-on time, max	μs	3.00	Gate pulse: $I_G=2\text{ A}; V_G=20\text{ V};$ $t_{GP}=50\text{ μs}; di_G/dt=2\text{ A/μs}$	
$t_q$	Turn-off time <sup>2)</sup> , max	μs	250	$dv_D/dt=50\text{ V/μs}; T_j=T_{j\text{ max}}; I_{TM}=I_{TAV};$ $di_R/dt=-10\text{ A/μs}; V_R=100\text{ V};$ $V_D=0.67 V_{DRM};$	
$Q_{rr}$	Recovered charge, max	μC	1080	$T_j=T_{j\text{ max}}; I_{TM}=I_{TAV};$	
$t_{rr}$	Reverse recovery time, max	μs	24	$di_R/dt=-10\text{ A/μs};$	
$I_{rr}$	Reverse recovery current, max	A	90	$V_R=100\text{ V}$	
<b>THERMAL</b>					
$R_{thjc}$	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		
<b>INSULATION</b>					
$V_{ISOL}$	Insulation test voltage	kV	3.00	Sine wave, 50 Hz; RMS	t=60 sec
			3.60		t=1 sec
<b>MECHANICAL</b>					
$M_1$	Mounting torque (M6) <sup>3)</sup>	Nm	6.00	Tolerance ± 15%	
$M_2$	Terminal connection torque (M6) <sup>3)</sup>	Nm	6.00	Tolerance ± 15%	
m	Weight, max	g	350		

PART NUMBERING GUIDE								NOTES																				
MT	3	-	130	-	28	-	A2 M2	-	F	-	N																	
1	2	3	4	5	6	7	8																					
1. Thyristor module (MT) Thyristor – Diode module (MT/D) Diode – Thyristor module (MD/T) 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.F) 8. Ambient Conditions: N – Normal								1) Critical rate of rise of off-state voltage <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><math>(dv_D/dt)_{crit}, \text{ V}/\mu\text{s}</math></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> 2) Turn-off time ( $dv_D/dt=50 \text{ V}/\mu\text{s}$ ) <table border="1"> <thead> <tr> <th>Symbol of group</th> <th>M2</th> </tr> </thead> <tbody> <tr> <td><math>t_{off}, \mu\text{s}</math></td> <td>250</td> </tr> </tbody> </table> 3) The screws must be lubricated	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	M2	$t_{off}, \mu\text{s}$	250
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	M2																											
$t_{off}, \mu\text{s}$	250																											



**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.

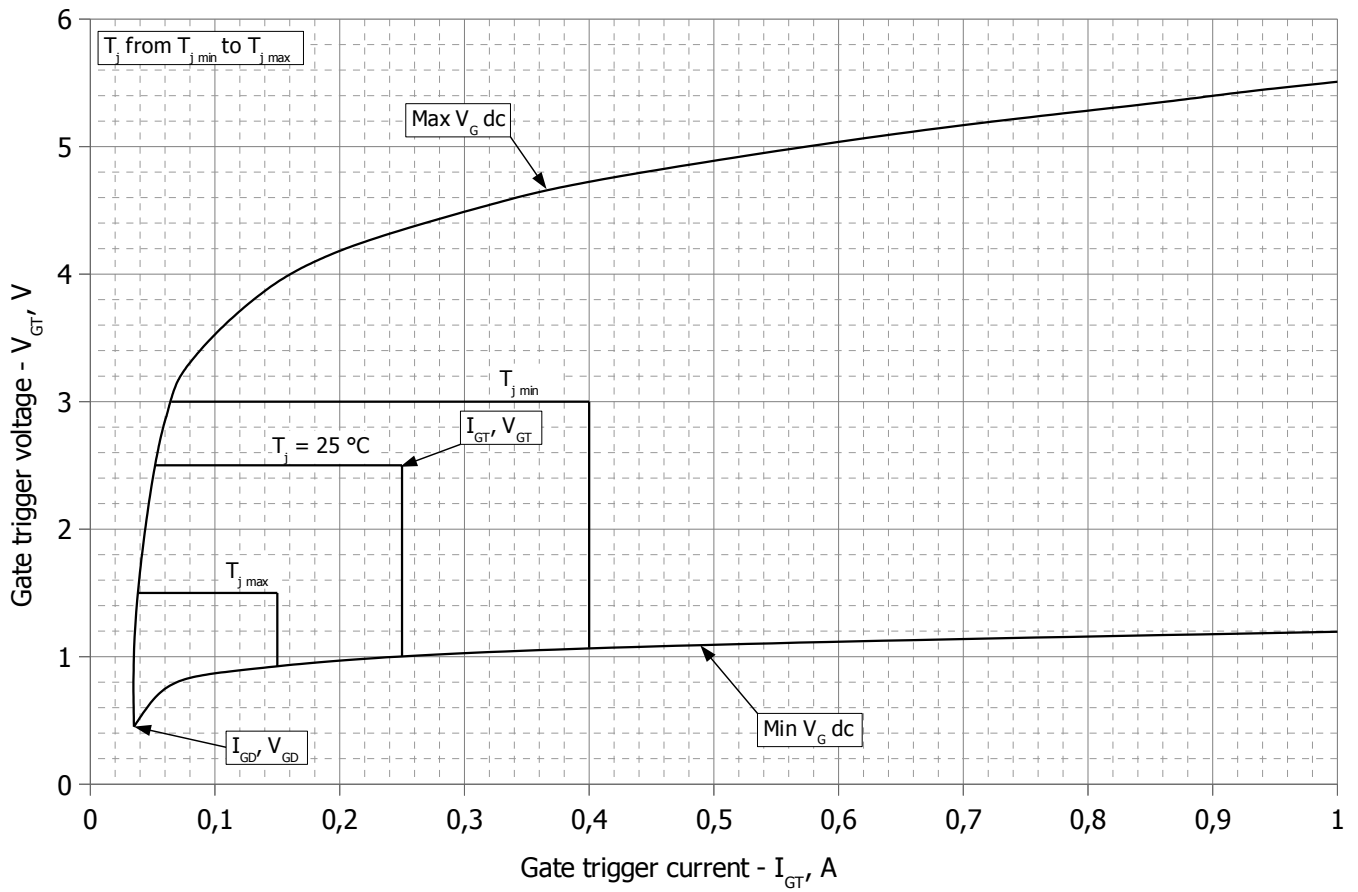
$Z_{thjc}$  = Thermal resistance at time  $t$ .

$R_i$  = Amplitude of  $p_{th}$  term.

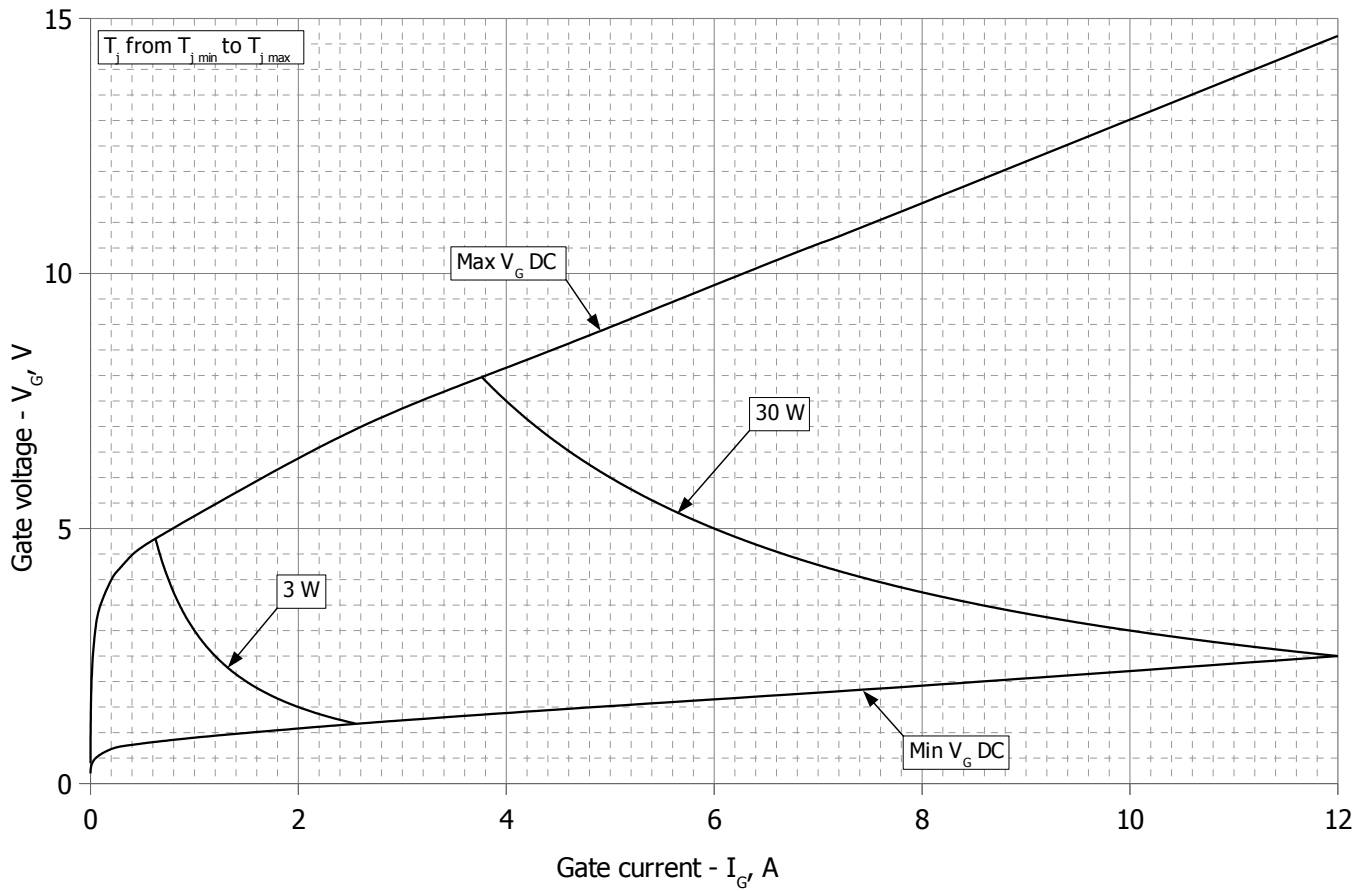
$\tau_i$  = Time constant of  $r_{th}$  term.

<b>i</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b><math>R_i</math>, K/W</b>	0.0007228424	0.0066399867	0.0153862565	0.0389709604	0.0142906115	0.09398934
<b><math>\tau_i</math>, s</b>	0.0002111	0.002366	0.06905	0.1909	0.6646	6.64

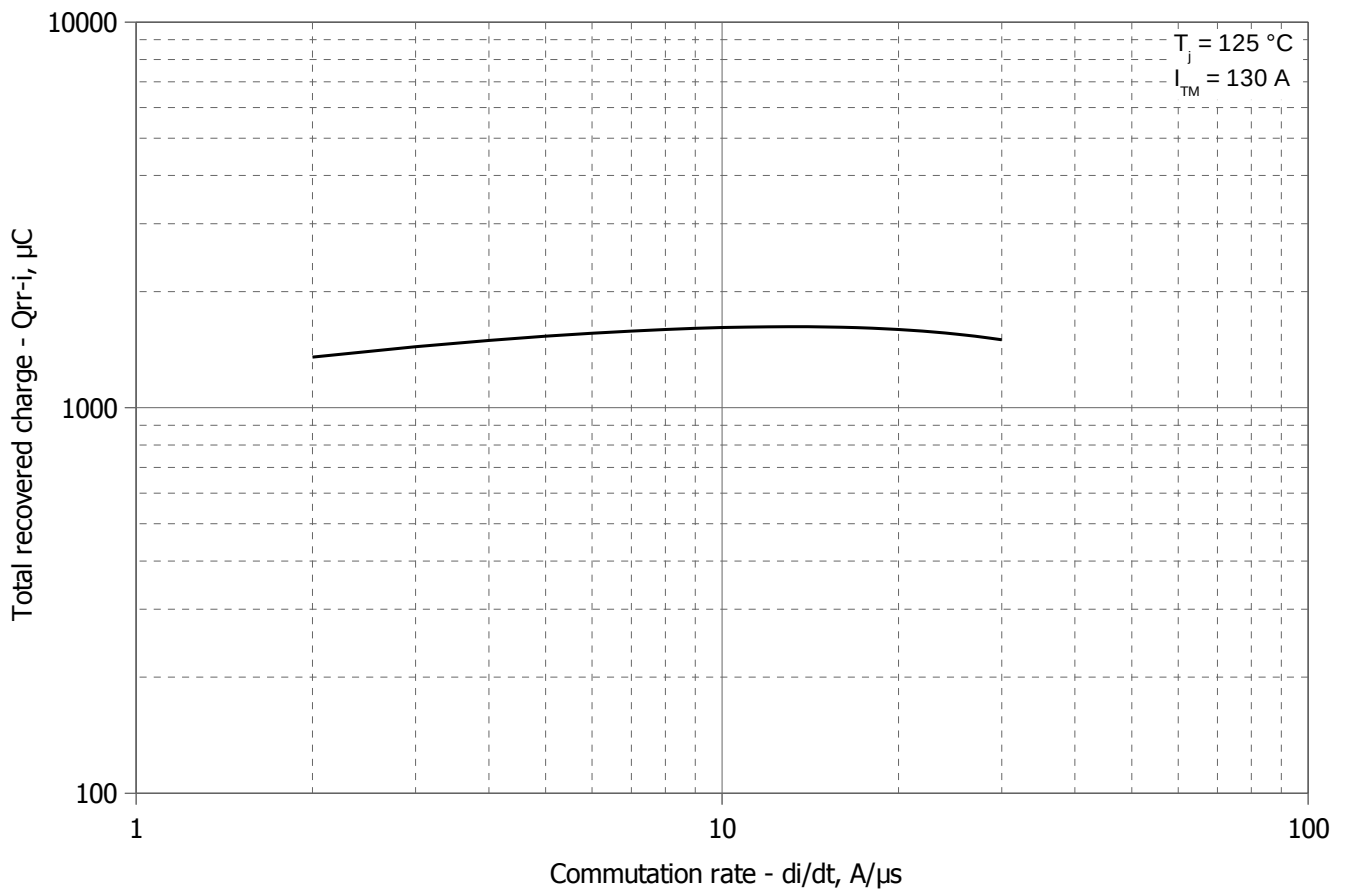
**Transient thermal impedance junction to case  $Z_{thjc}$  model (see Fig. 2)**



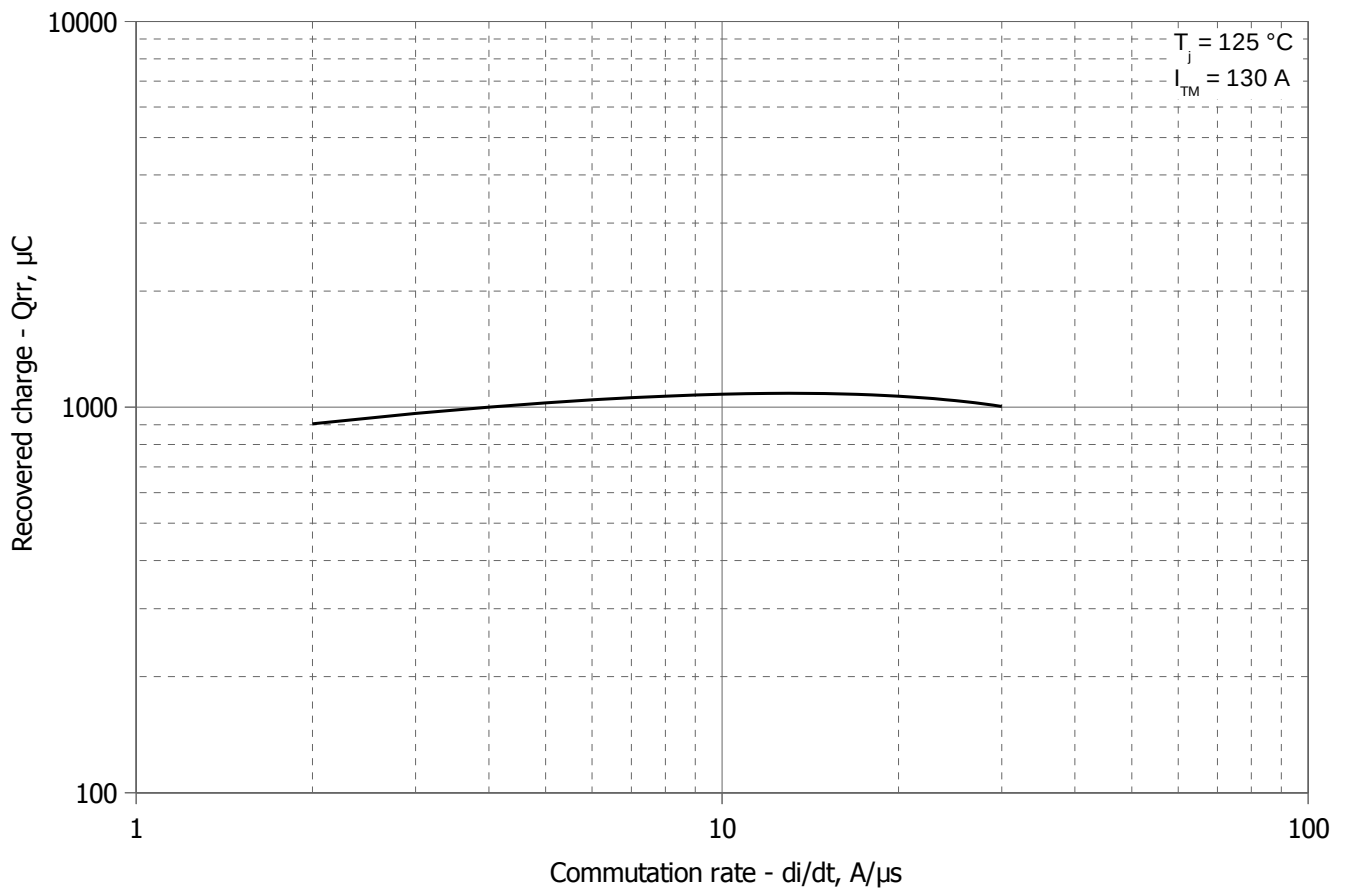
**Fig 2 – Gate characteristics – Trigger limits**



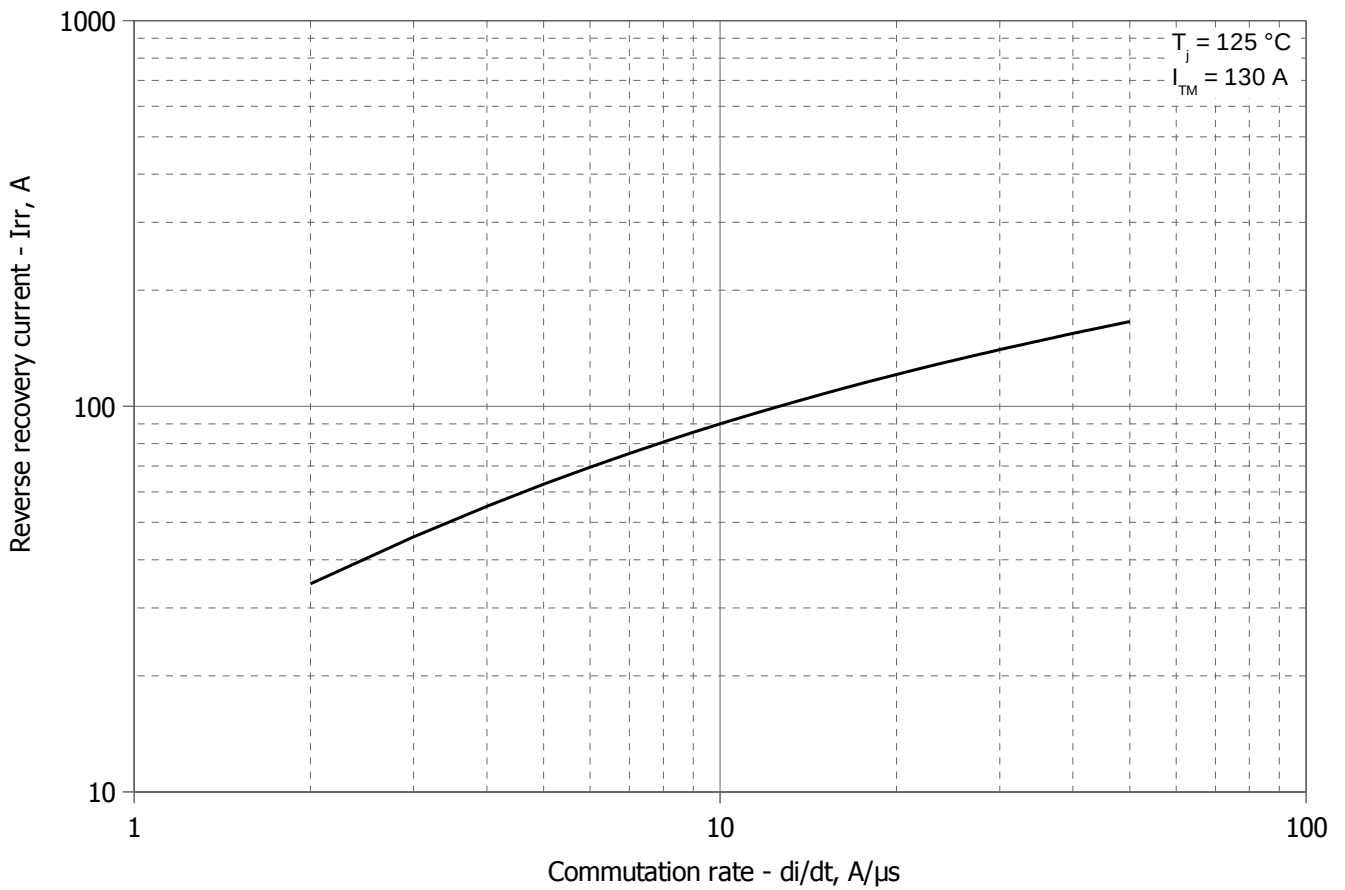
**Fig 3 - Gate characteristics – Power curves**



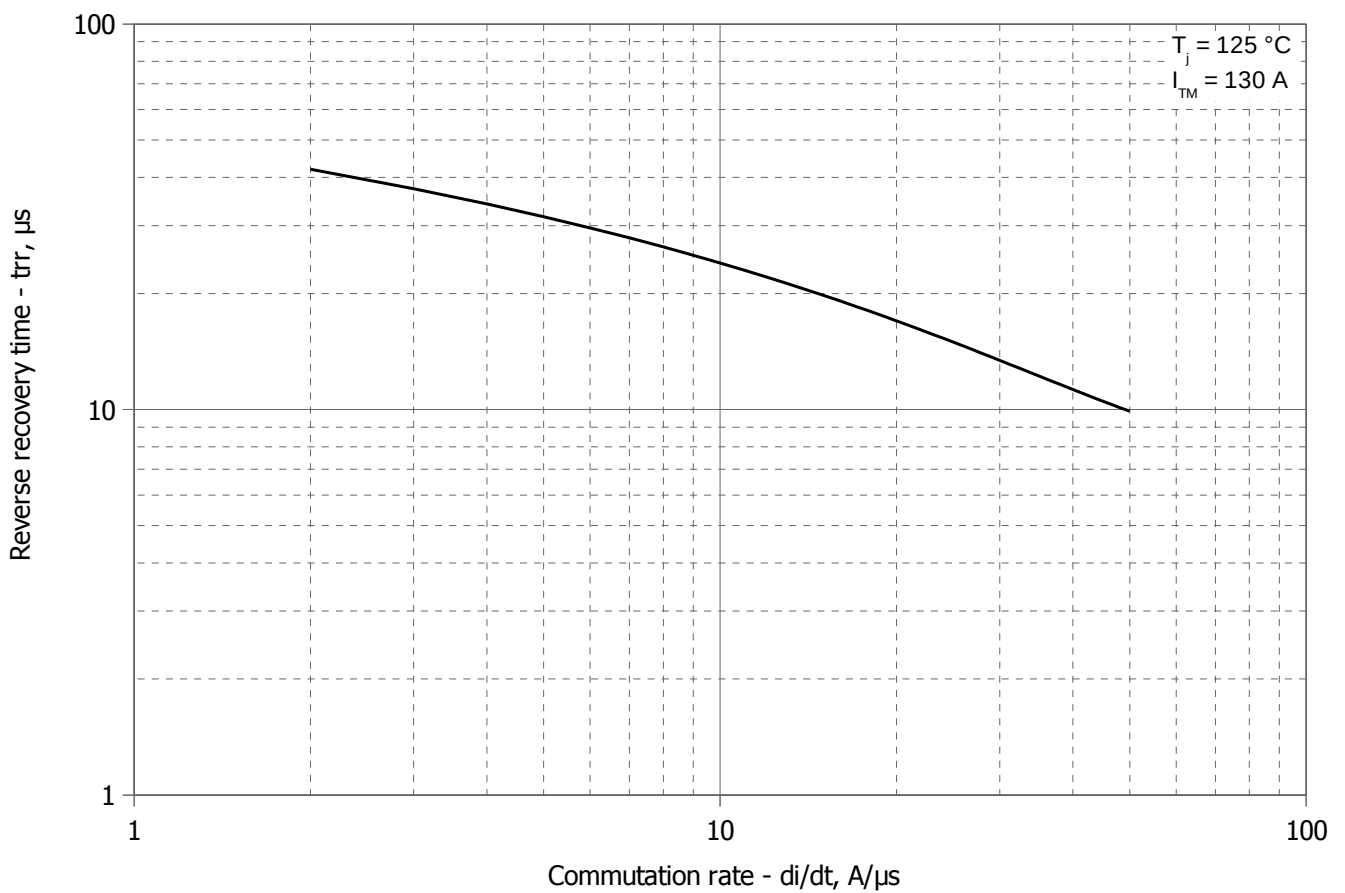
**Fig 4 – Maximum recovered charge  $Q_{rr-i}$  (integral) vs. commutation rate  $di_R/dt$**



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

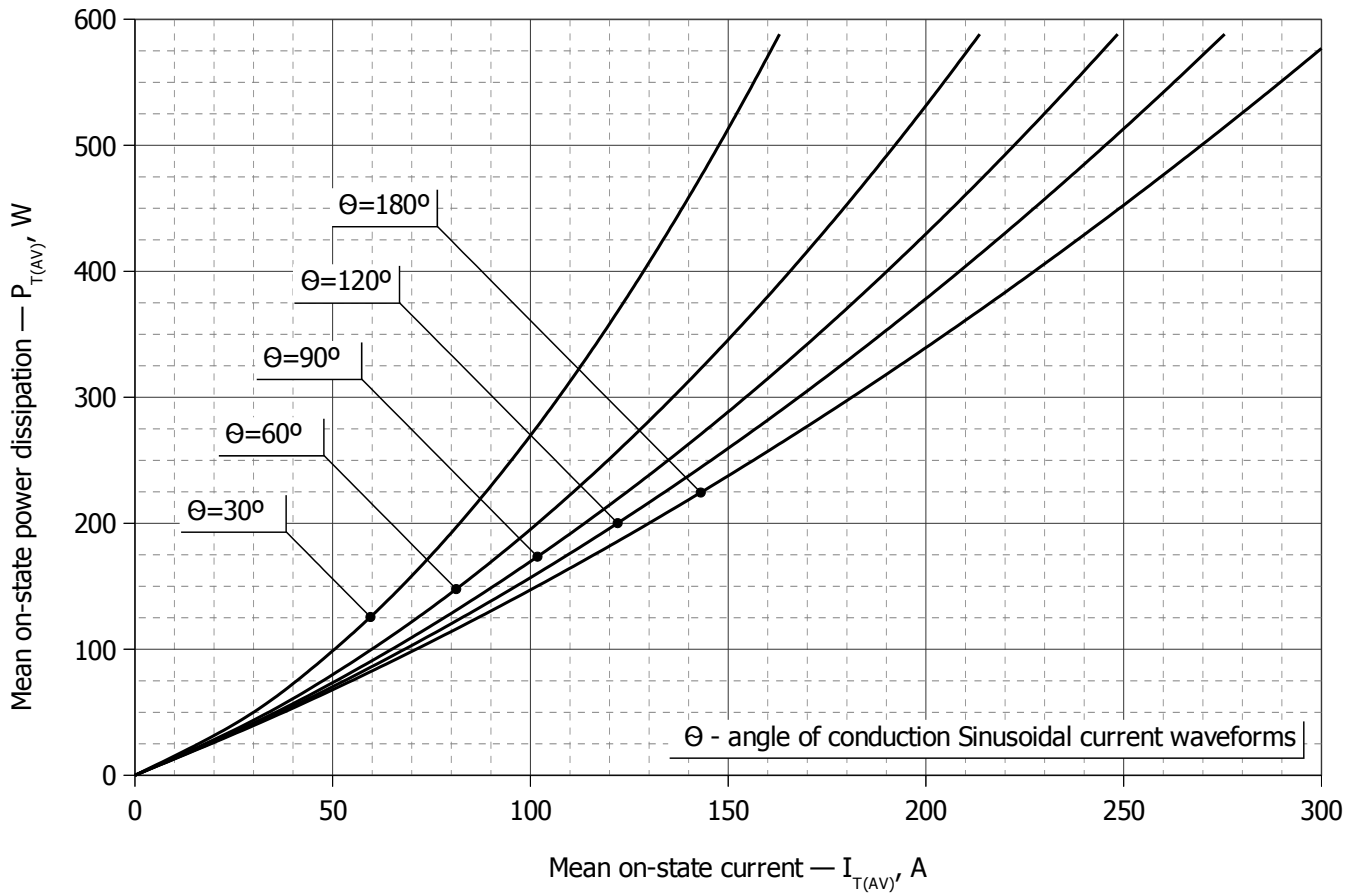


**Fig 6 – Maximum reverse recovery current  $I_{rr}$  vs. commutation rate  $di_R/dt$**

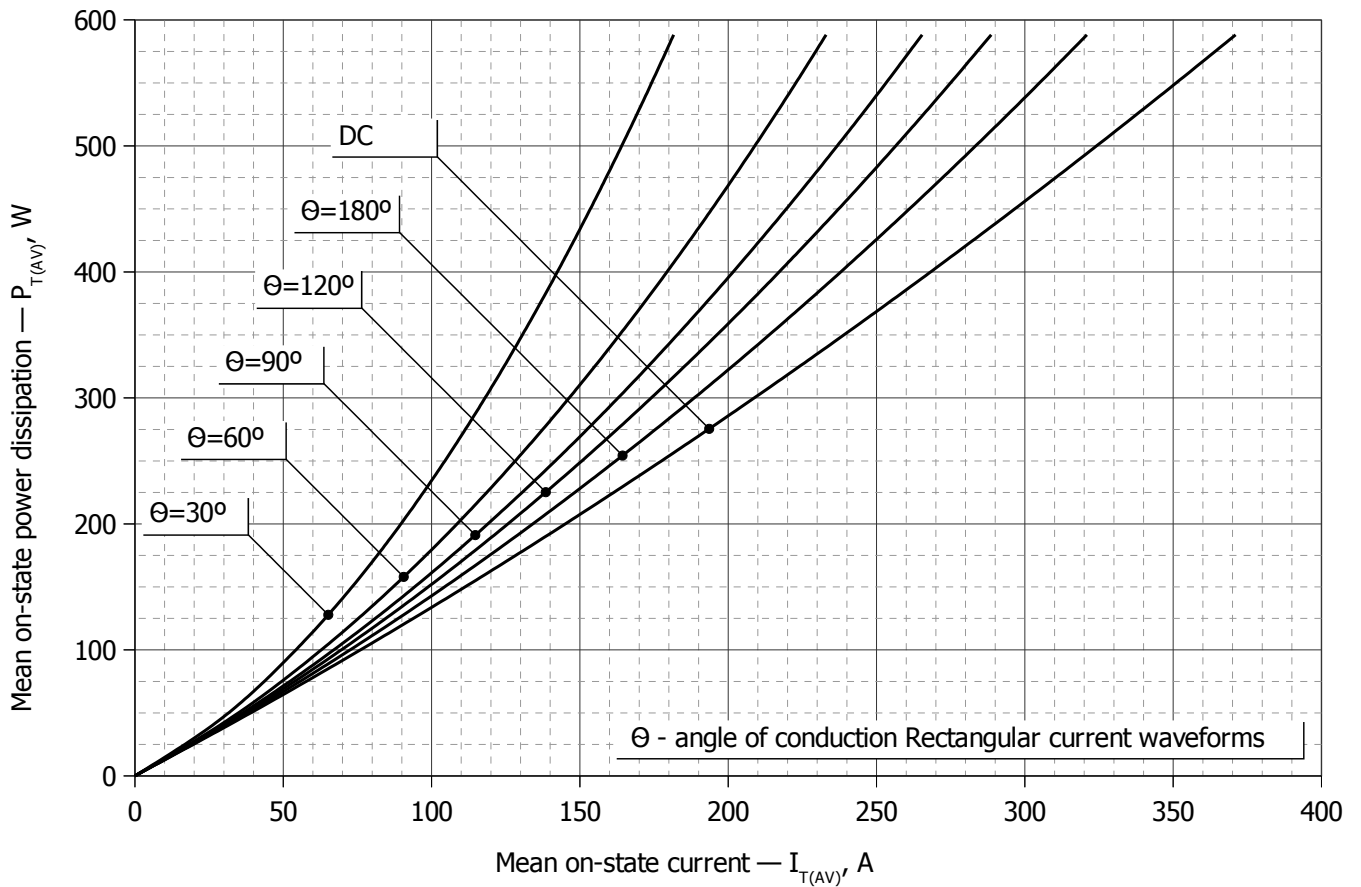


**Fig 7 – Maximum recovery time  $t_{rr}$  vs. commutation rate  $di_R/dt$  (25% chord)**

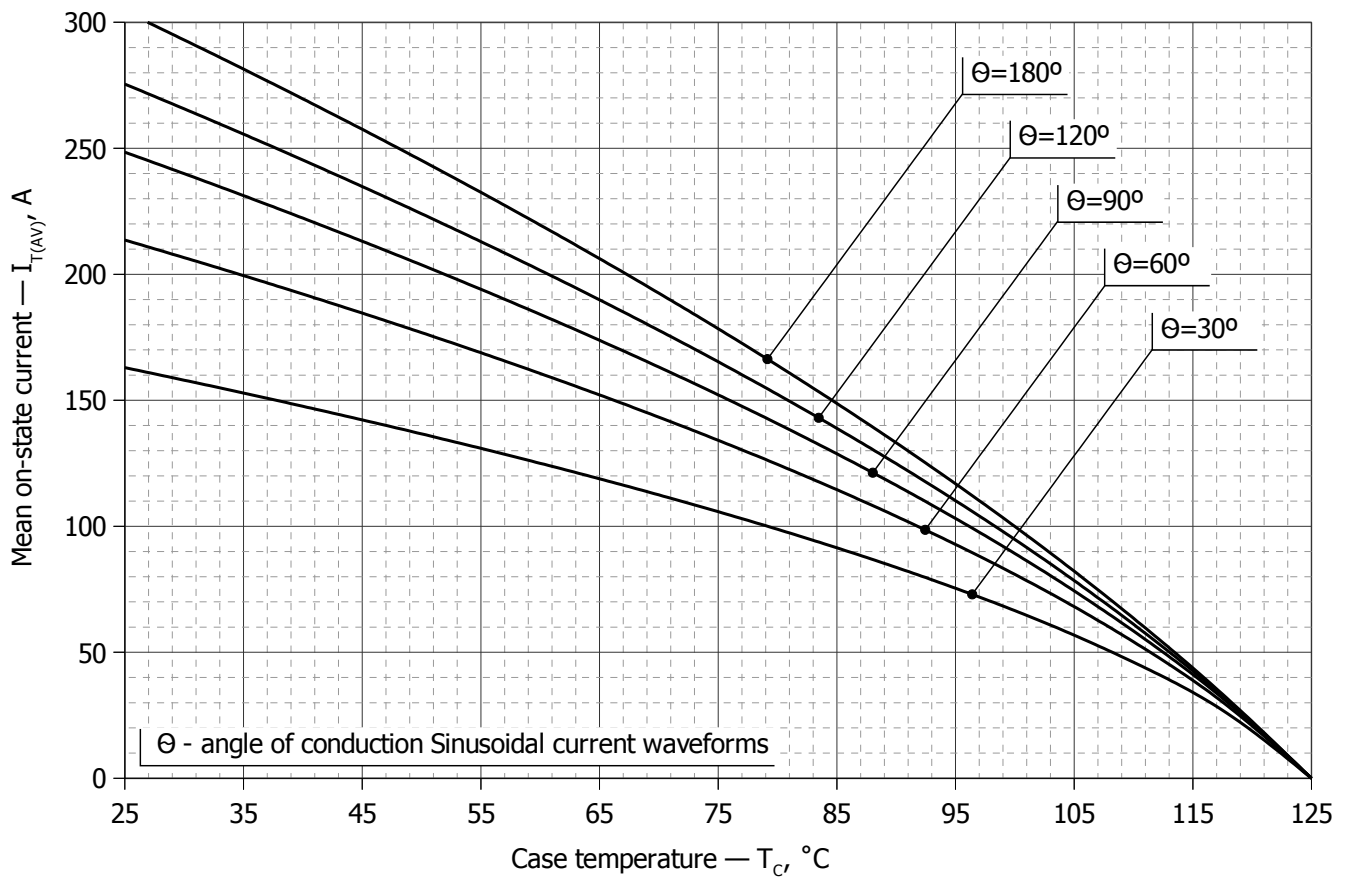




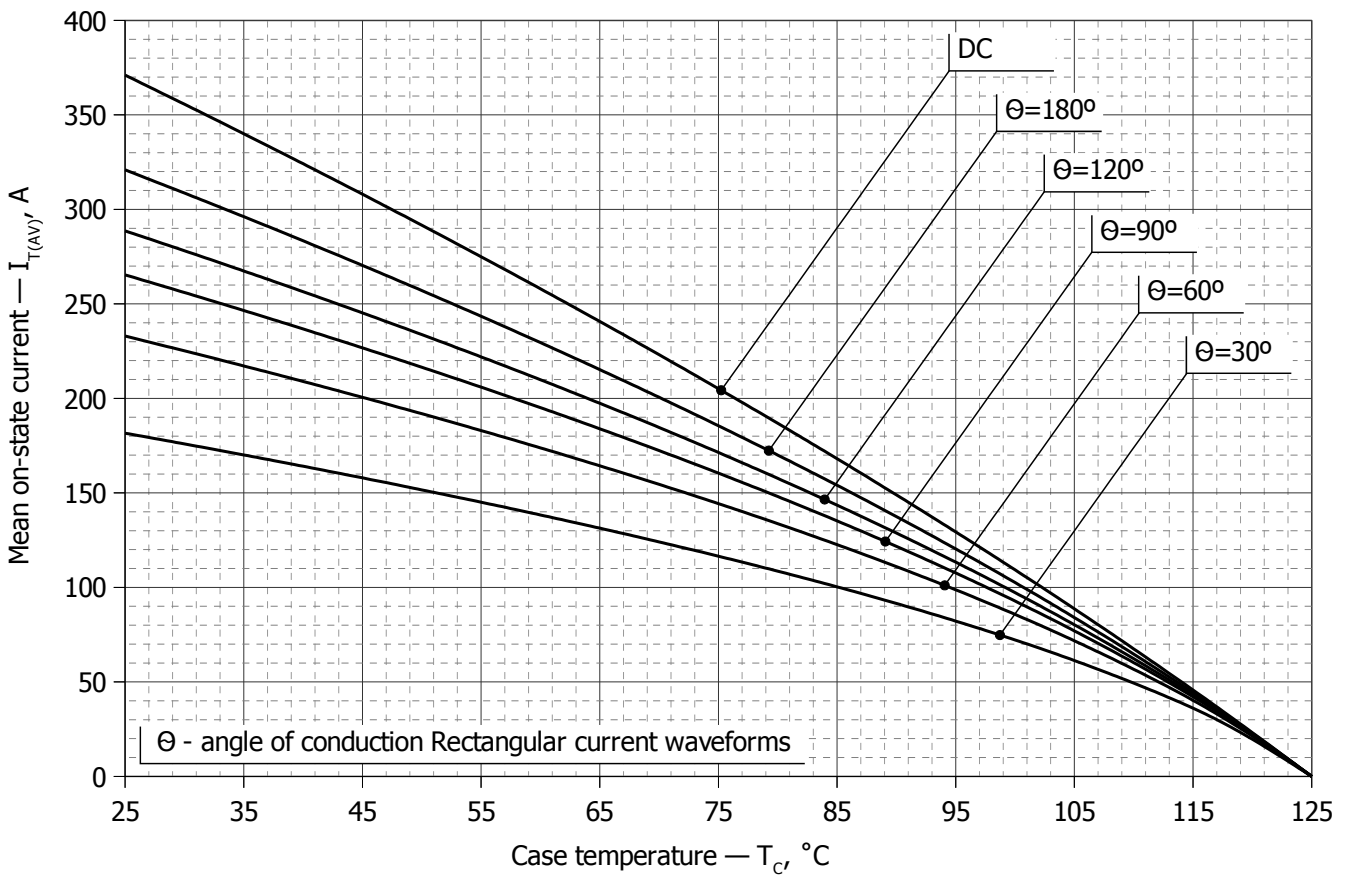
**Fig. 8 - Mean on-state power dissipation  $P_{TAV}$  vs. mean on-state current  $I_{TAV}$  for sinusoidal current waveforms at different conduction angles ( $f=50\text{Hz}$ )**



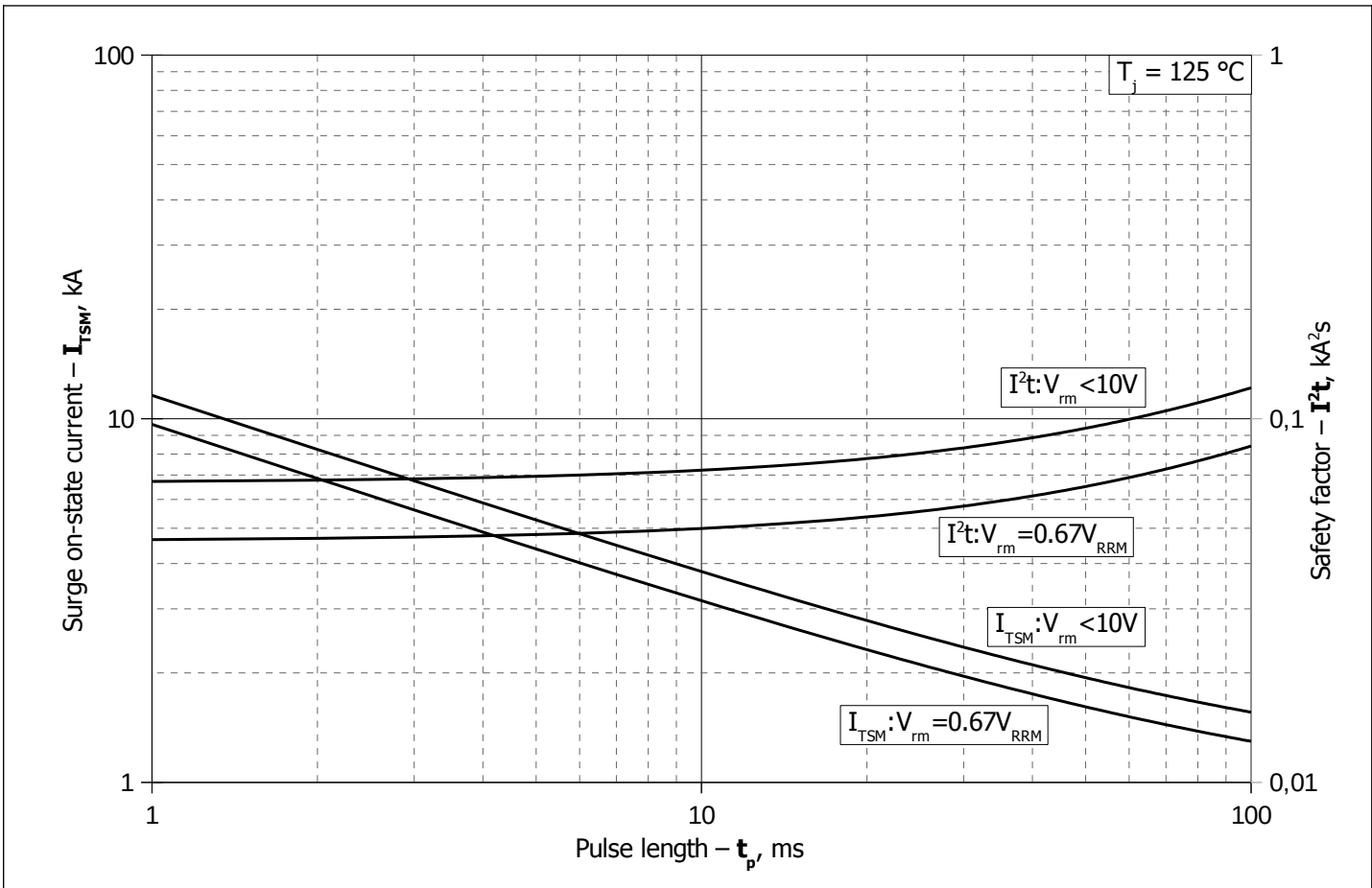
**Fig. 9 - Mean on-state power dissipation  $P_{TAV}$  vs. mean on-state current  $I_{TAV}$  for rectangular current waveforms at different conduction angles and for DC ( $f=50\text{Hz}$ )**



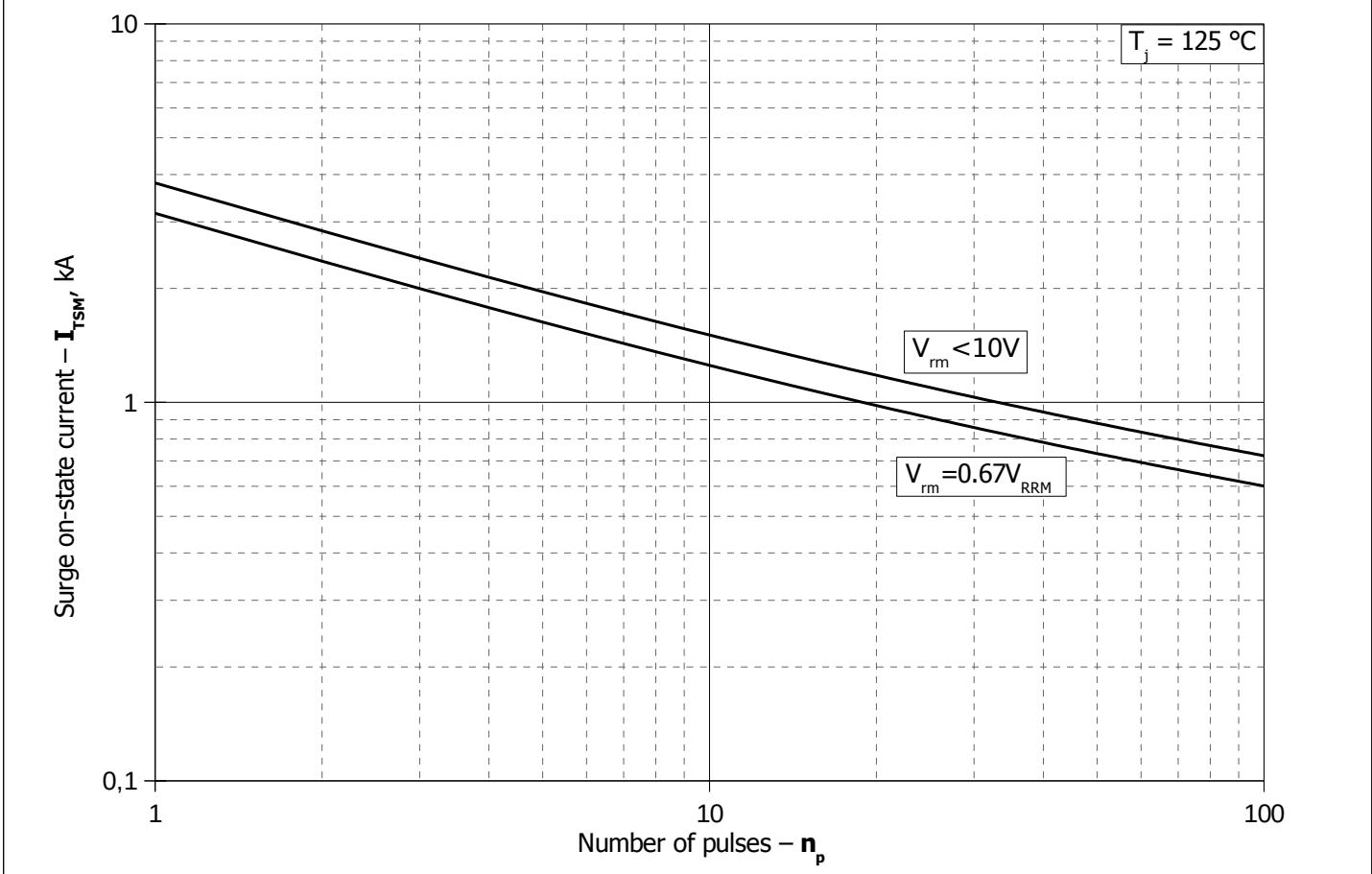
**Fig. 10 – Mean on-state current  $I_{TAV}$  vs. case temperature  $T_c$  for sinusoidal current waveforms at different conduction angles ( $f=50\text{Hz}$ )**



**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  $n_p$**