



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	$T_c = 85\text{ }^\circ\text{C}$; 180° half-sine wave; 50 Hz
I_{TRMS}	RMS on-state current	A	259	
I_{TSM}	Surge on-state current	kA	4.7 5.5	$T_j = T_{j\text{ max}}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 10\text{ ms}$; single pulse; $V_D = V_R = 0\text{ V}$; Gate pulse: $I_G = 2\text{ A}$; $t_{GP} = 50\text{ }\mu\text{s}$; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
			5.0 6.0	$T_j = T_{j\text{ max}}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 8.3\text{ ms}$; single pulse; $V_D = V_R = 0\text{ V}$; Gate pulse: $I_G = 2\text{ A}$; $t_{GP} = 50\text{ }\mu\text{s}$; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
I^2t	Safety factor	$\text{A}^2\text{s}\cdot 10^3$	110 150	$T_j = T_{j\text{ max}}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 10\text{ ms}$; single pulse; $V_D = V_R = 0\text{ V}$; Gate pulse: $I_G = 2\text{ A}$; $t_{GP} = 50\text{ }\mu\text{s}$; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
			100 140	$T_j = T_{j\text{ max}}$ $T_j = 25\text{ }^\circ\text{C}$ 180° half-sine wave; $t_p = 8.3\text{ ms}$; single pulse; $V_D = V_R = 0\text{ V}$; Gate pulse: $I_G = 2\text{ A}$; $t_{GP} = 50\text{ }\mu\text{s}$; $di_G/dt \geq 1\text{ A}/\mu\text{s}$
BLOCKING				
V_{DRM}, V_{RRM}	Repetitive peak off-state and Repetitive peak reverse voltages	V	2000...2200	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 180° half-sine wave; 50 Hz; Gate open
V_{DSM}, V_{RSM}	Non-repetitive peak off-state and Non-repetitive peak reverse voltages	V	2100...2300	$T_{j\text{ min}} < T_j < T_{j\text{ max}}$; 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	5	$T_j = T_{j\text{ max}}$
V_{RGM}	Peak reverse gate voltage	V	5	
P_G	Gate power dissipation	W	3	$T_j = T_{j\text{ max}}$ for DC gate current
SWITCHING				
$(di_T/dt)_{crit}$	Critical rate of rise of on-state current non-repetitive (f=1 Hz)	$\text{A}/\mu\text{s}$	500	$T_j = T_{j\text{ max}}$; $V_D = 0.67 \cdot V_{DRM}$; $I_{TM} = 2 I_{TAV}$; 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	$T_j=25\text{ }^\circ\text{C}$; $I_{TM}=500\text{ A}$	
$V_{T(TO)}$	On-state threshold voltage, max	V	0.80	$T_j=T_{j\text{ max}}$;	
r_T	On-state slope resistance, max	m Ω	1.350	$0.5\pi I_{TAV} < I_T < 1.5\pi I_{TAV}$	
I_L	Latching current, max	mA	500	$T_j=25\text{ }^\circ\text{C}$; $V_D=12\text{ V}$; 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_H	Holding current, max	mA	250	$T_j=25\text{ }^\circ\text{C}$; $V_D=12\text{ V}$; Gate open	
BLOCKING					
I_{DRM} , I_{RRM}	Repetitive peak off-state and Repetitive peak reverse currents, max	mA	30 2.50	$T_j=T_{j\text{ max}}$ $T_j=25\text{ }^\circ\text{C}$	$V_D=V_{DRM}$; $V_R=V_{RRM}$
$(dv_D/dt)_{crit}$	Critical rate of rise of off-state voltage ¹⁾ , min	V/ μs	1000	$T_j=T_{j\text{ max}}$; $V_D=0.67\cdot V_{DRM}$; Gate open	
TRIGGERING					
V_{GT}	Gate trigger direct voltage, max	V	4.00 2.50 2.00	$T_j=T_{j\text{ min}}$ $T_j=25\text{ }^\circ\text{C}$ $T_j=T_{j\text{ max}}$	$V_D=12\text{ V}$; $I_D=3\text{ A}$; Direct gate current
I_{GT}	Gate trigger direct current, max	mA	400 250 200	$T_j=T_{j\text{ min}}$ $T_j=25\text{ }^\circ\text{C}$ $T_j=T_{j\text{ max}}$	
V_{GD}	Gate non-trigger direct voltage, min	V	0.25	$T_j=T_{j\text{ max}}$; $V_D=0.67\cdot V_{DRM}$;	
I_{GD}	Gate non-trigger direct current, min	mA	10.00	Direct gate current	
SWITCHING					
t_{gd}	Delay time, max	μs	2.50	$T_j=25\text{ }^\circ\text{C}$; $V_D=1000\text{ V}$; $I_{TM}=I_{TAV}$; $di/dt=200\text{ A}/\mu\text{s}$; Gate pulse: $I_G=2\text{ A}$; $V_G=20\text{ V}$; $t_{GP}=50\text{ }\mu\text{s}$; $di_G/dt=2\text{ A}/\mu\text{s}$	
t_q	Turn-off time ²⁾ , max	μs	160	$dv_D/dt=50\text{ V}/\mu\text{s}$; $T_j=T_{j\text{ max}}$; $I_{TM}=200\text{ A}$; $di_R/dt=-10\text{ A}/\mu\text{s}$; $V_R=100\text{ V}$; $V_D=0.67\text{ }V_{DRM}$;	
Q_{rr}	Total recovered charge, max	μC	855	$T_j=T_{j\text{ max}}$; $I_{TM}=200\text{ A}$;	
t_{rr}	Reverse recovery time, max	μs	18	$di_R/dt=-10\text{ A}/\mu\text{s}$;	
I_{rr}	Reverse recovery current, max	A	95	$V_R=100\text{ V}$	
THERMAL					
R_{thjc}	Thermal resistance, junction to case				
	per module	$^\circ\text{C}/\text{W}$	0.0900	180° half-sine wave, 50 Hz	
	per arm	$^\circ\text{C}/\text{W}$	0.1800		
	per module	$^\circ\text{C}/\text{W}$	0.0850	DC	
per arm	$^\circ\text{C}/\text{W}$	0.1700			
R_{thch}	Thermal resistance, case to heatsink				
	per module	$^\circ\text{C}/\text{W}$	0.0300		
	per arm	$^\circ\text{C}/\text{W}$	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 $\pm 15\%$	
M_2	Terminal connection torque (M6) ³⁾	Nm	6.00	Tolerance $\pm 15\%$	
m	Weight, max	g	350		

PART NUMBERING GUIDE

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)
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

NOTES

¹⁾ Critical rate of rise of off-state voltage

Symbol of group	A2
$(dv_D/dt)_{crit}, \text{ V}/\mu\text{s}$	1000

²⁾ Turn-off time ($dv_D/dt=50\text{ V}/\mu\text{s}$)

Symbol of group	T2
$t_{qr}, \mu\text{s}$	160

³⁾ The screws must be lubricated



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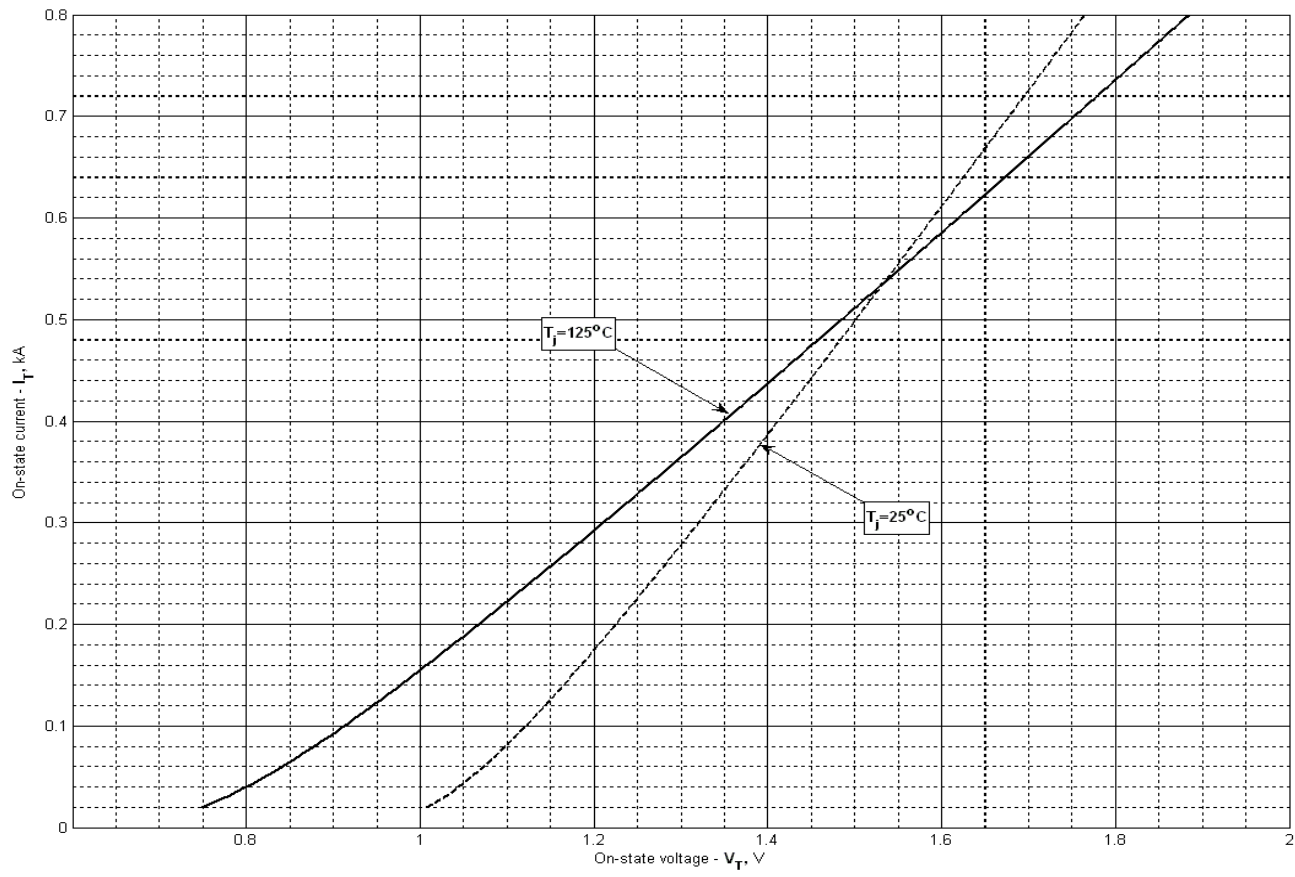


Fig 1 – On-state characteristics of Limit device

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	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\text{max}}$
A	0.943585	0.659211
B	0.891706	1.352412
C	-0.442302	-0.590725
D	0.411509	0.549600

On-state characteristic model (see Fig. 1)

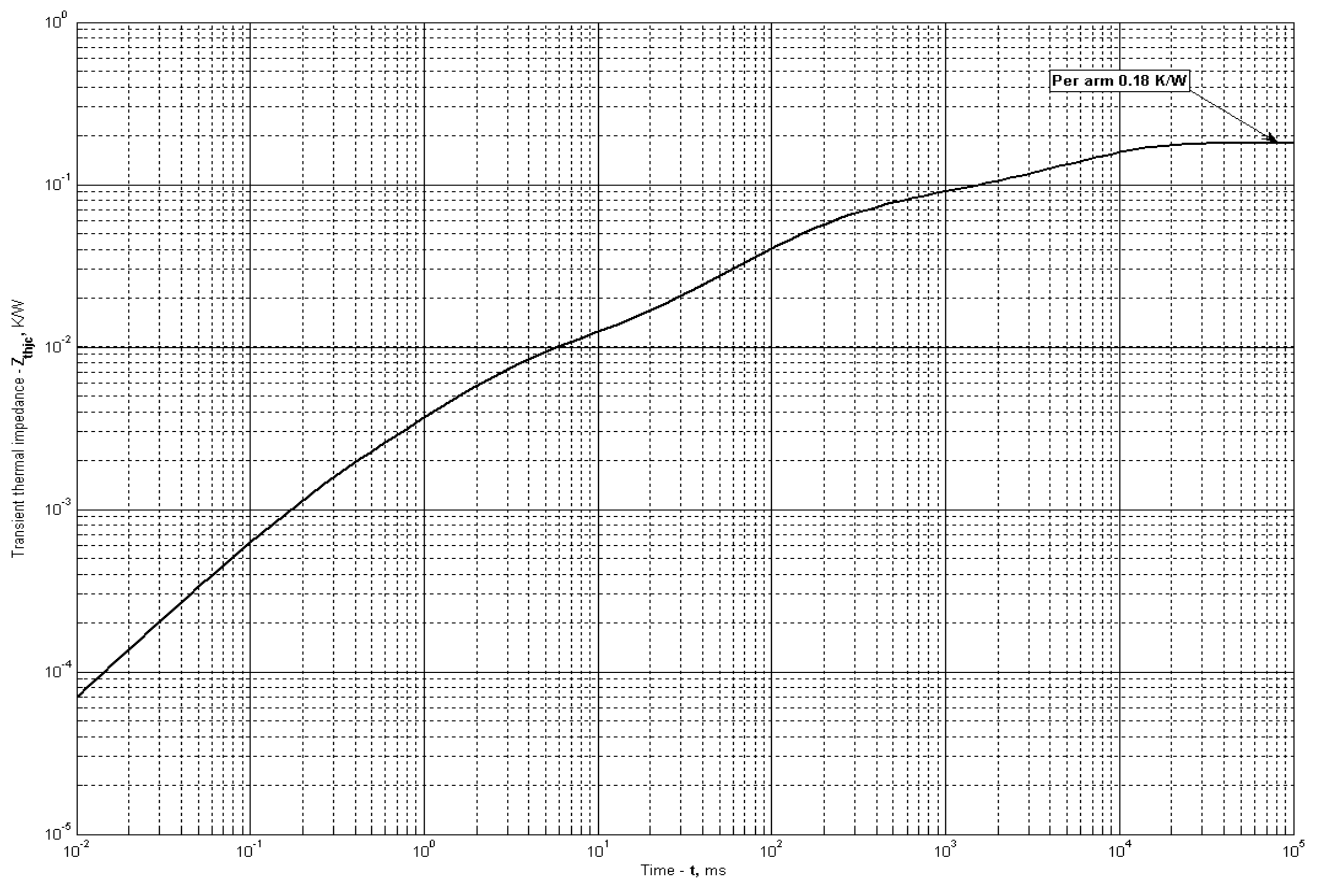


Fig 2 – Transient thermal impedance

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
$R_i, K/W$	0.0007653	0.00703	0.01629	0.04126	0.01513	0.09951
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. 2)

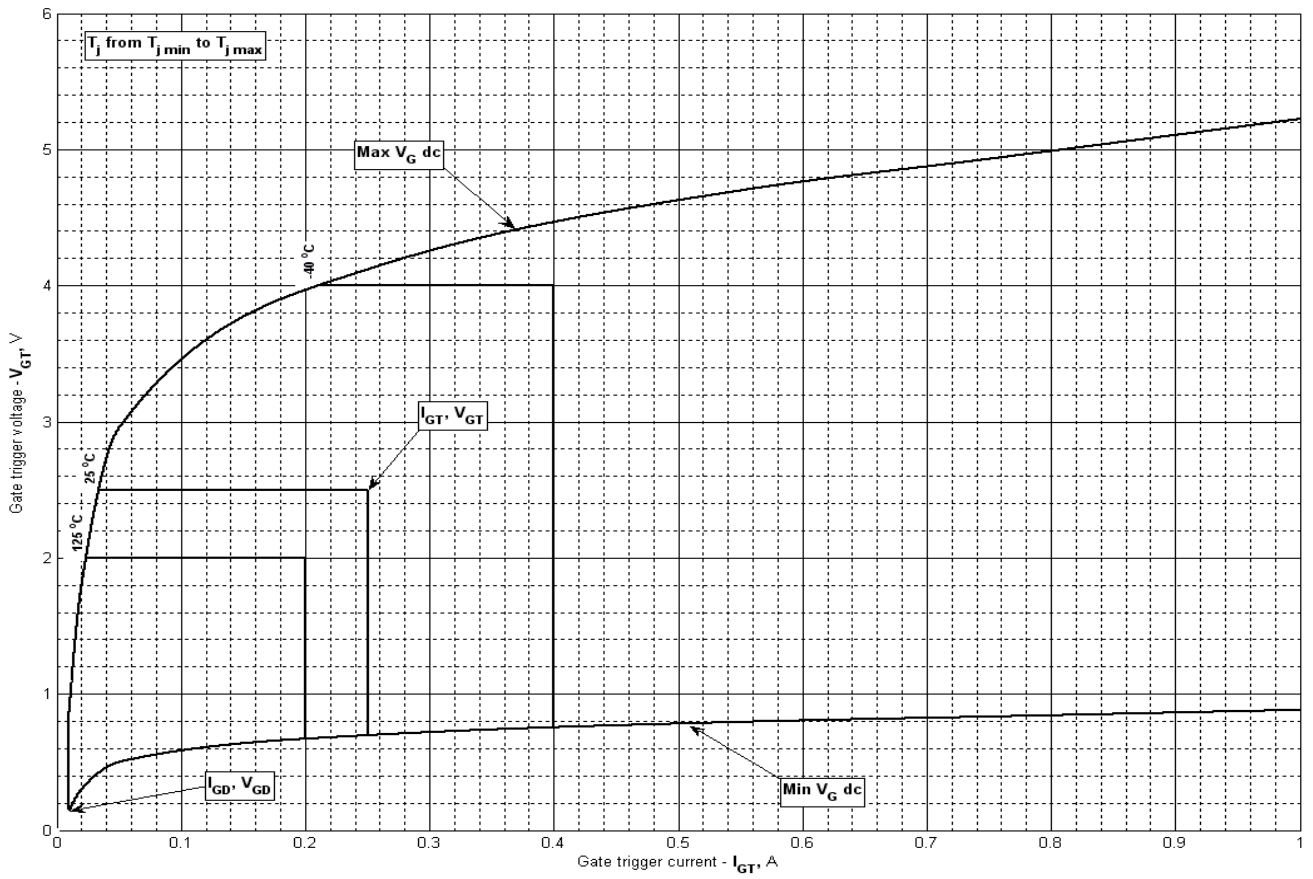


Fig 3 – Gate characteristics – Trigger limits

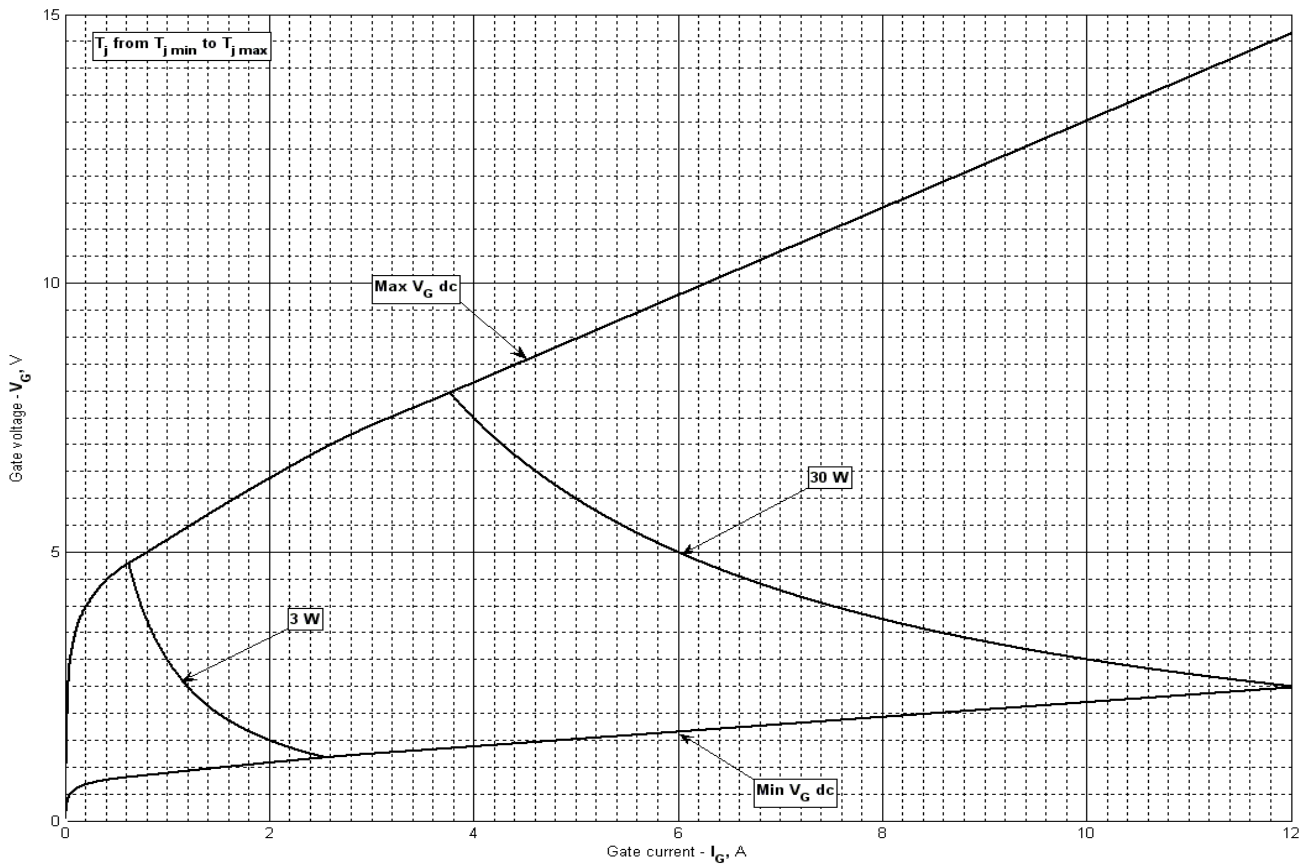


Fig 4 - Gate characteristics – Power curves

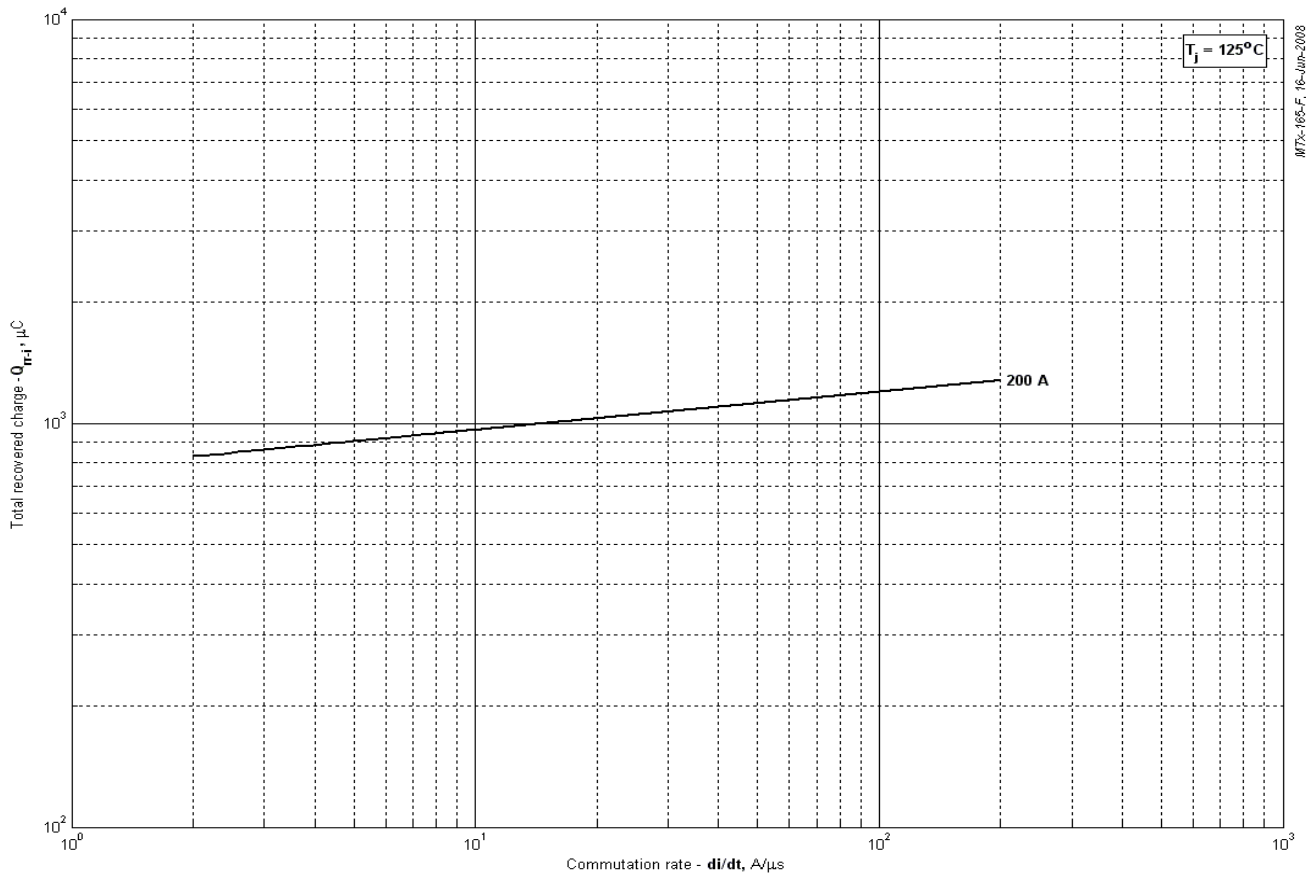


Fig 5 - Total recovered charge, Q_{rr-i} (integral)

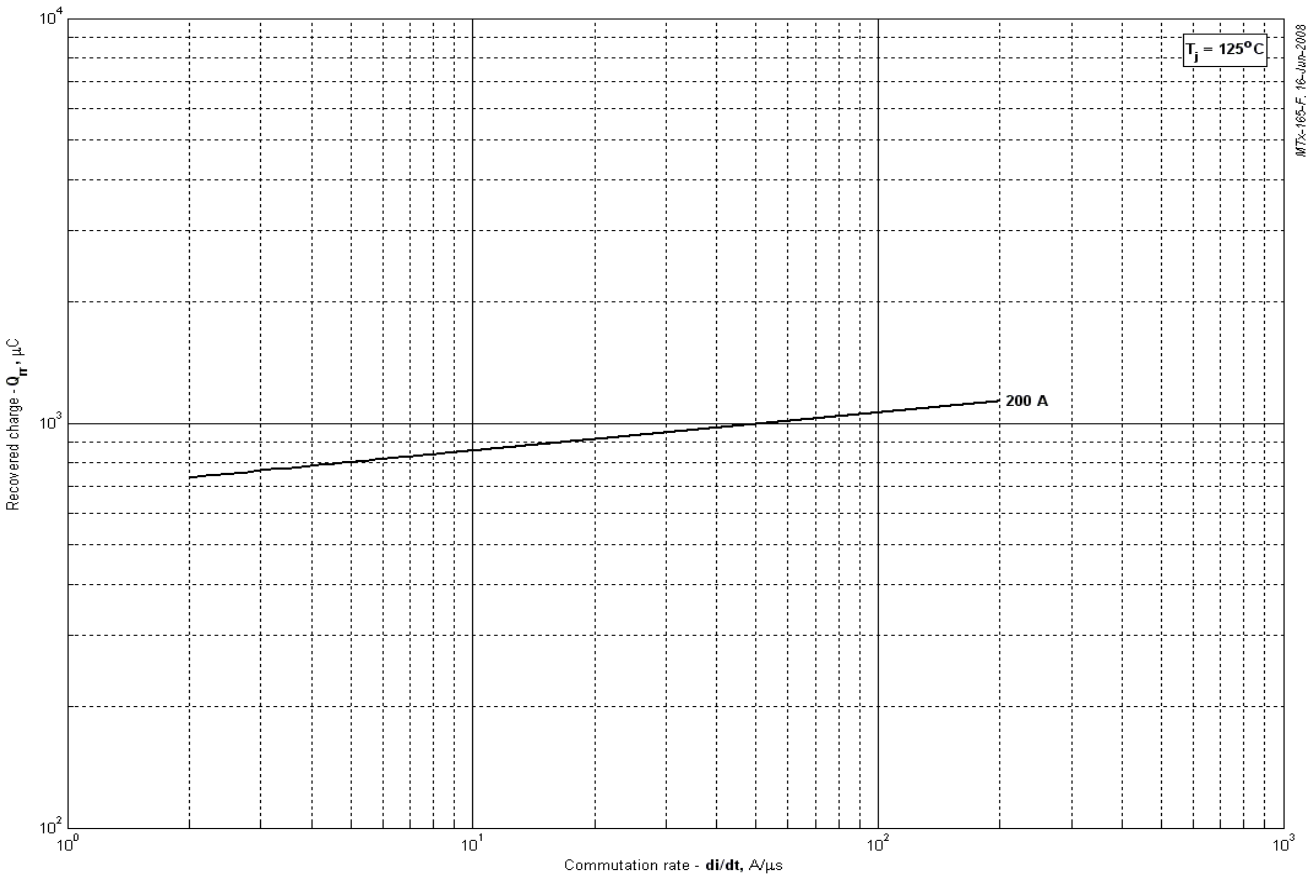


Fig 6 - Recovered charge, Q_{rr} (25% chord)

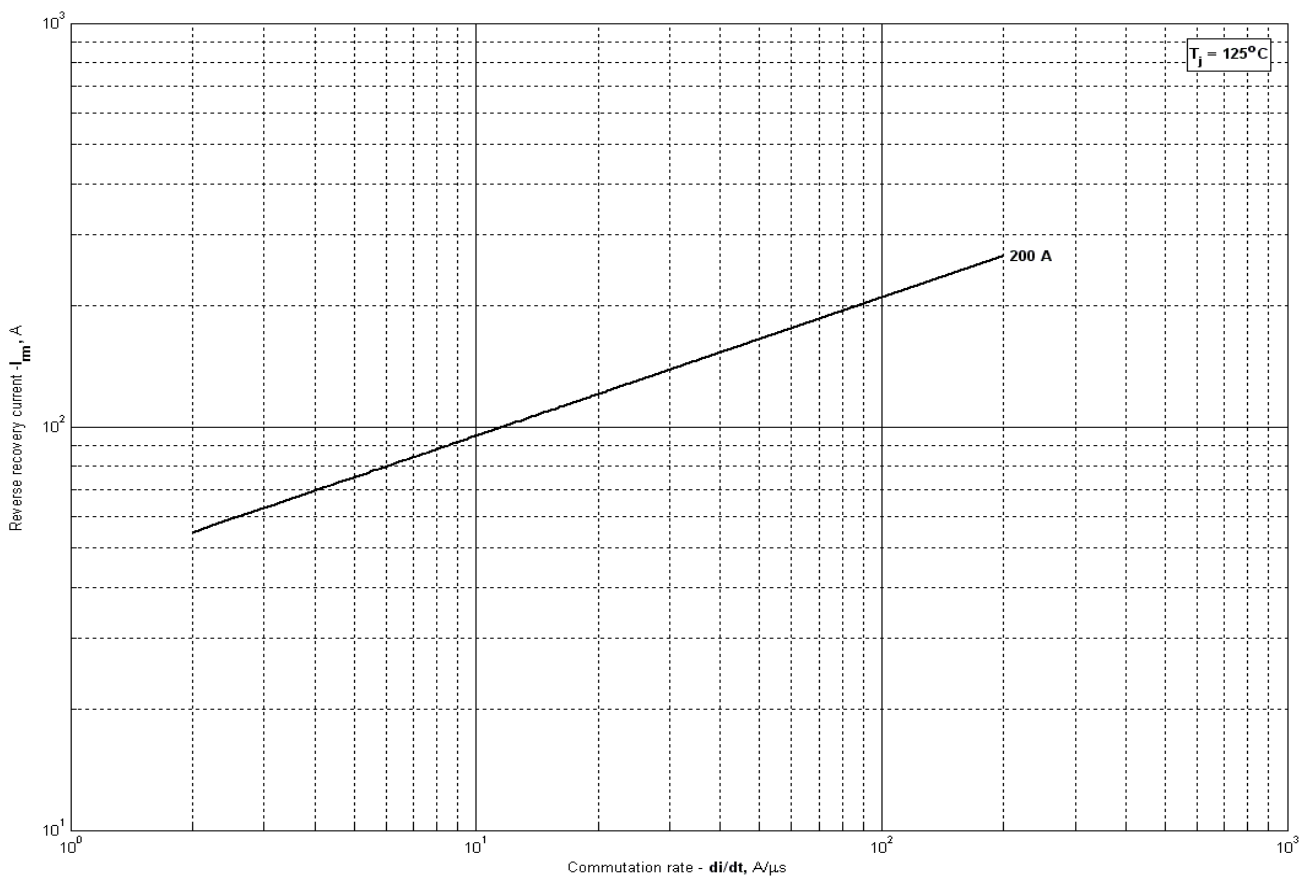


Fig 7 - Peak reverse recovery current, I_{rr}

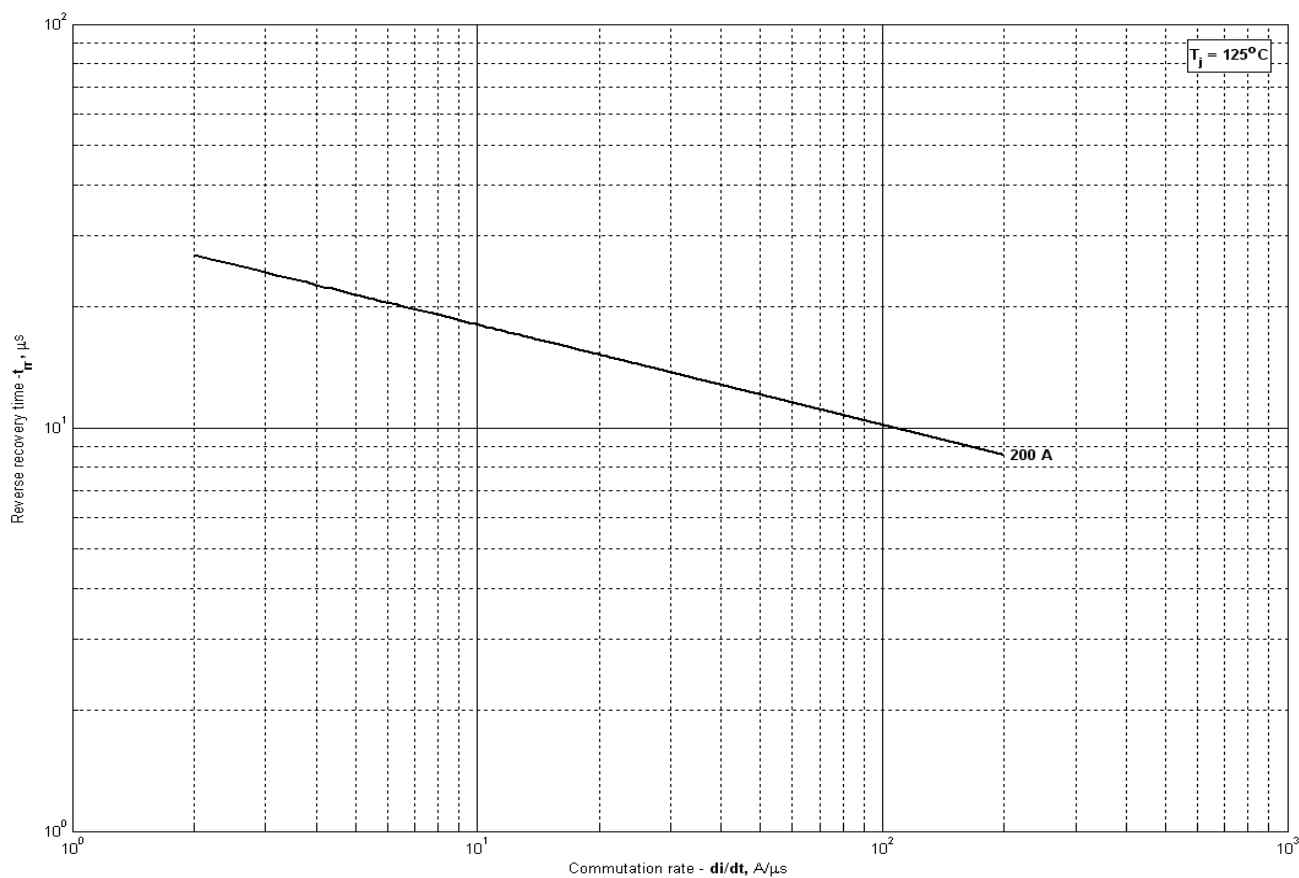


Fig 8 - Maximum recovery time, t_{rr} (25% chord)

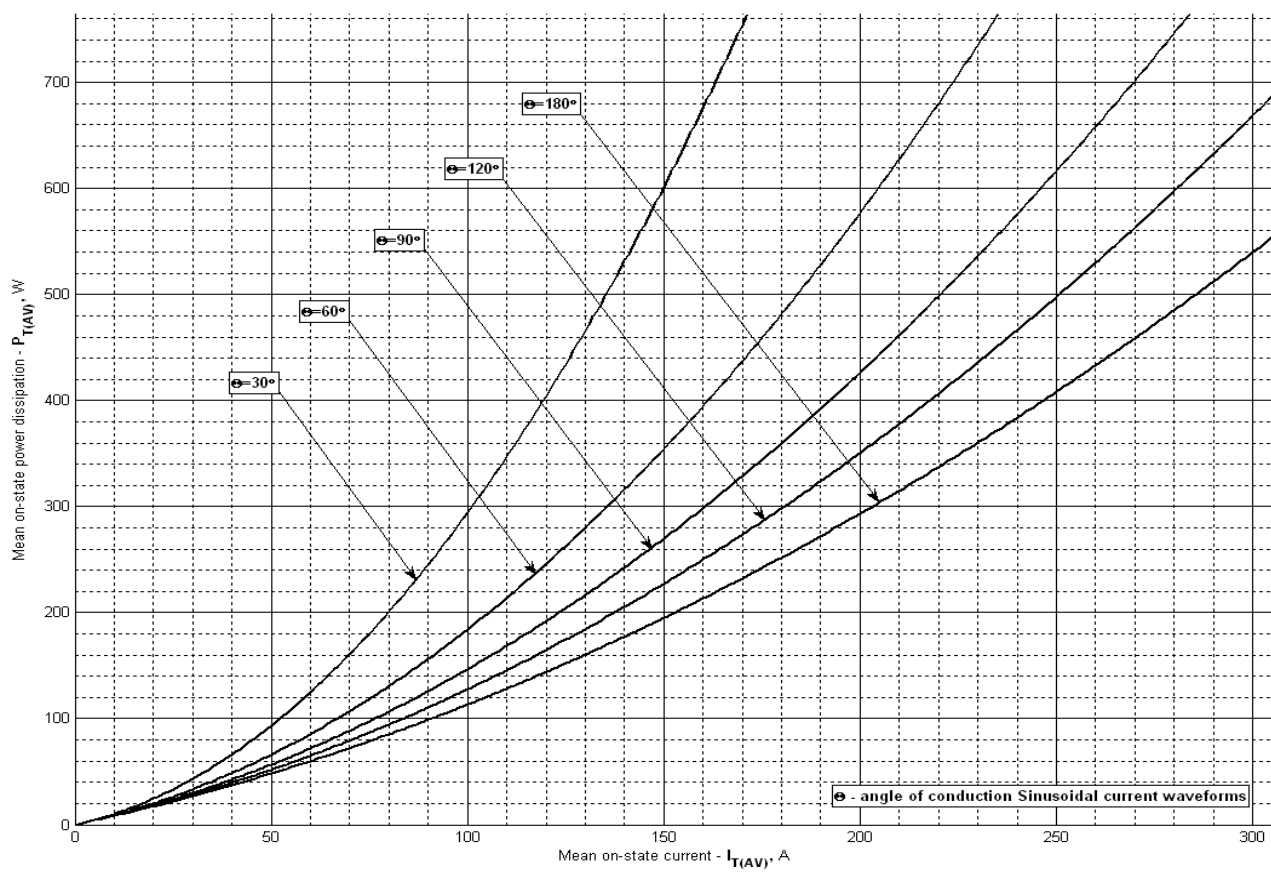


Fig 9 – On-state power loss (sinusoidal current waveforms)

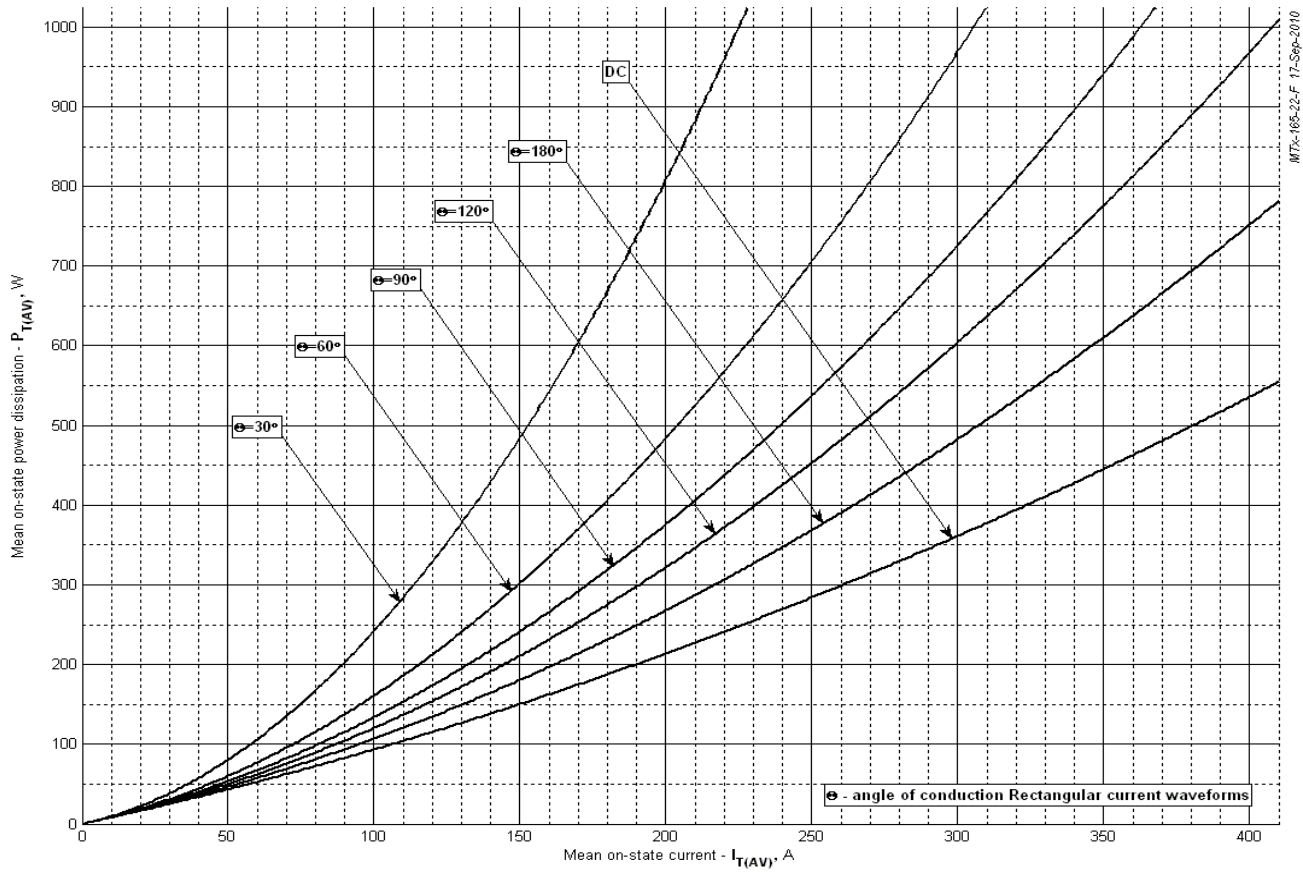


Fig 10 - On-state power loss (rectangular current waveforms)

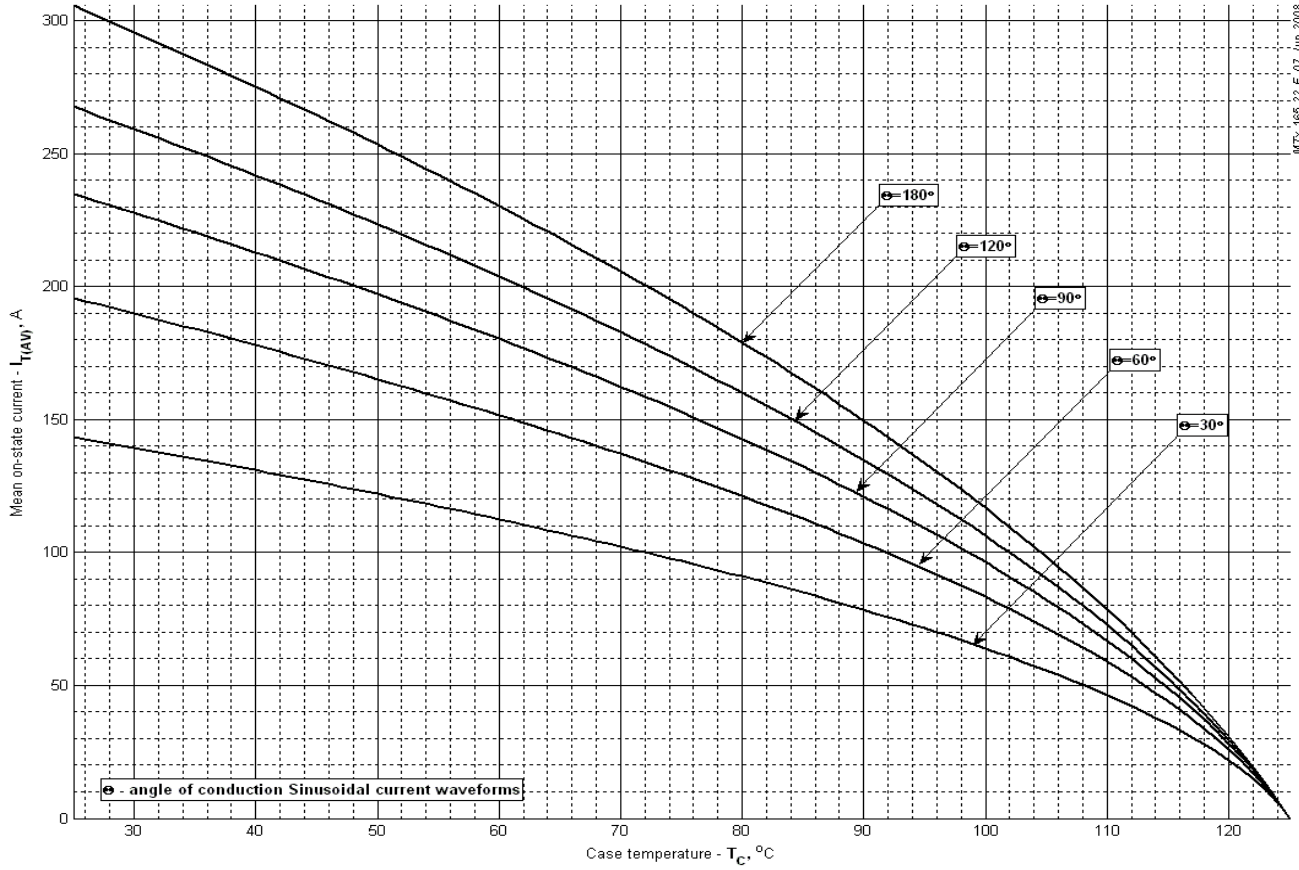


Fig 11 – Maximum case temperature (sinusoidal current waveforms)

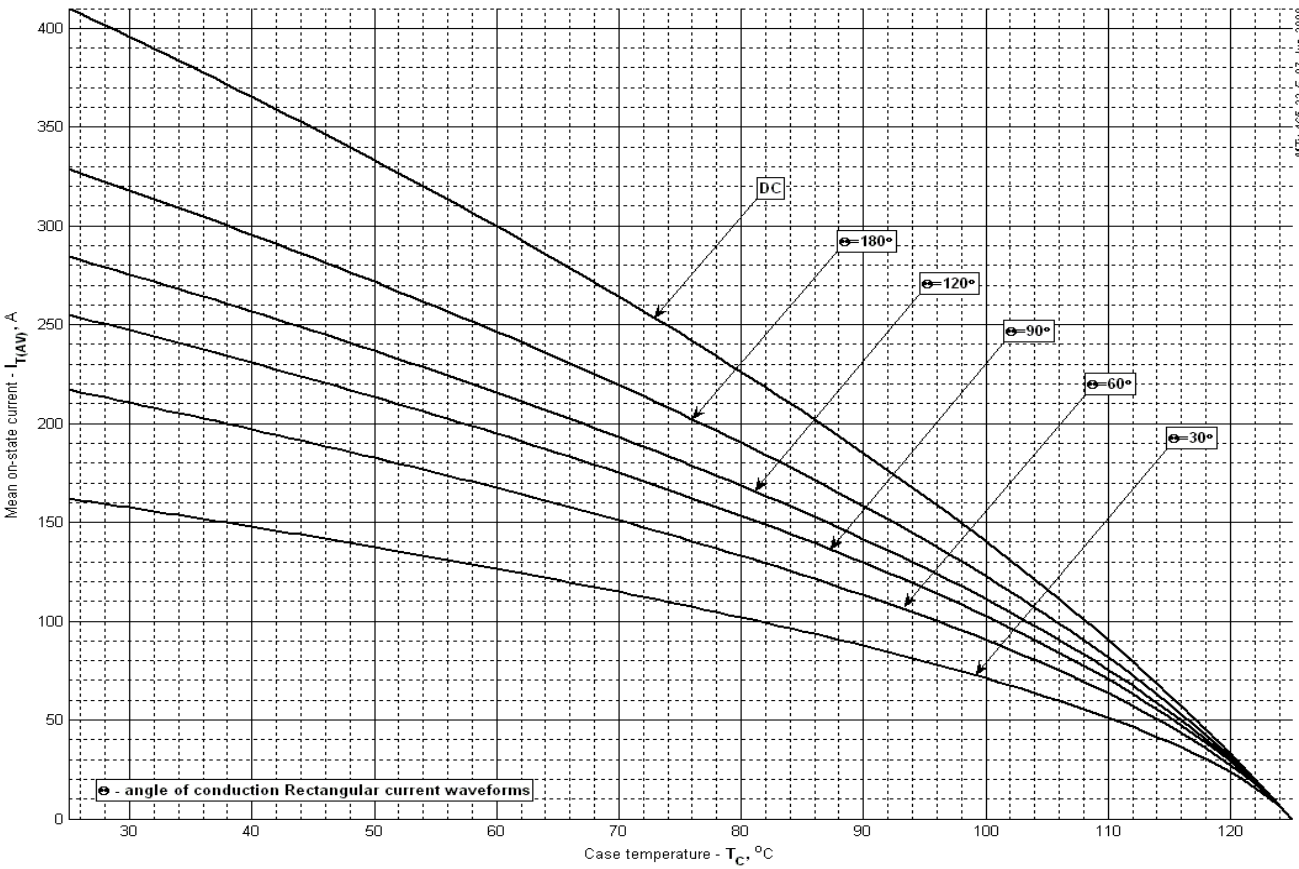


Fig 12 - Maximum case temperature (rectangular current waveforms)

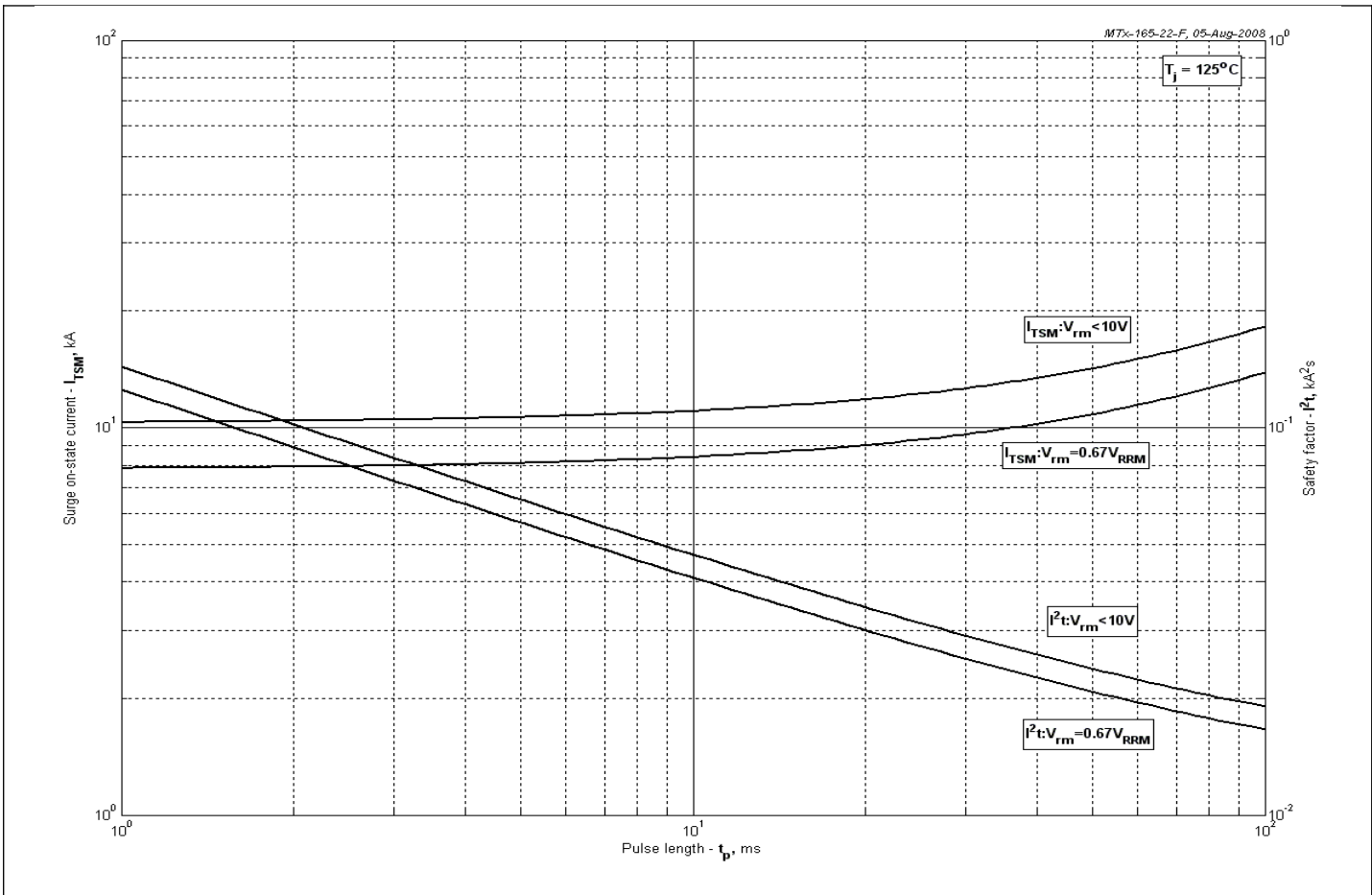


Fig 13 – Maximum surge and I^2t ratings

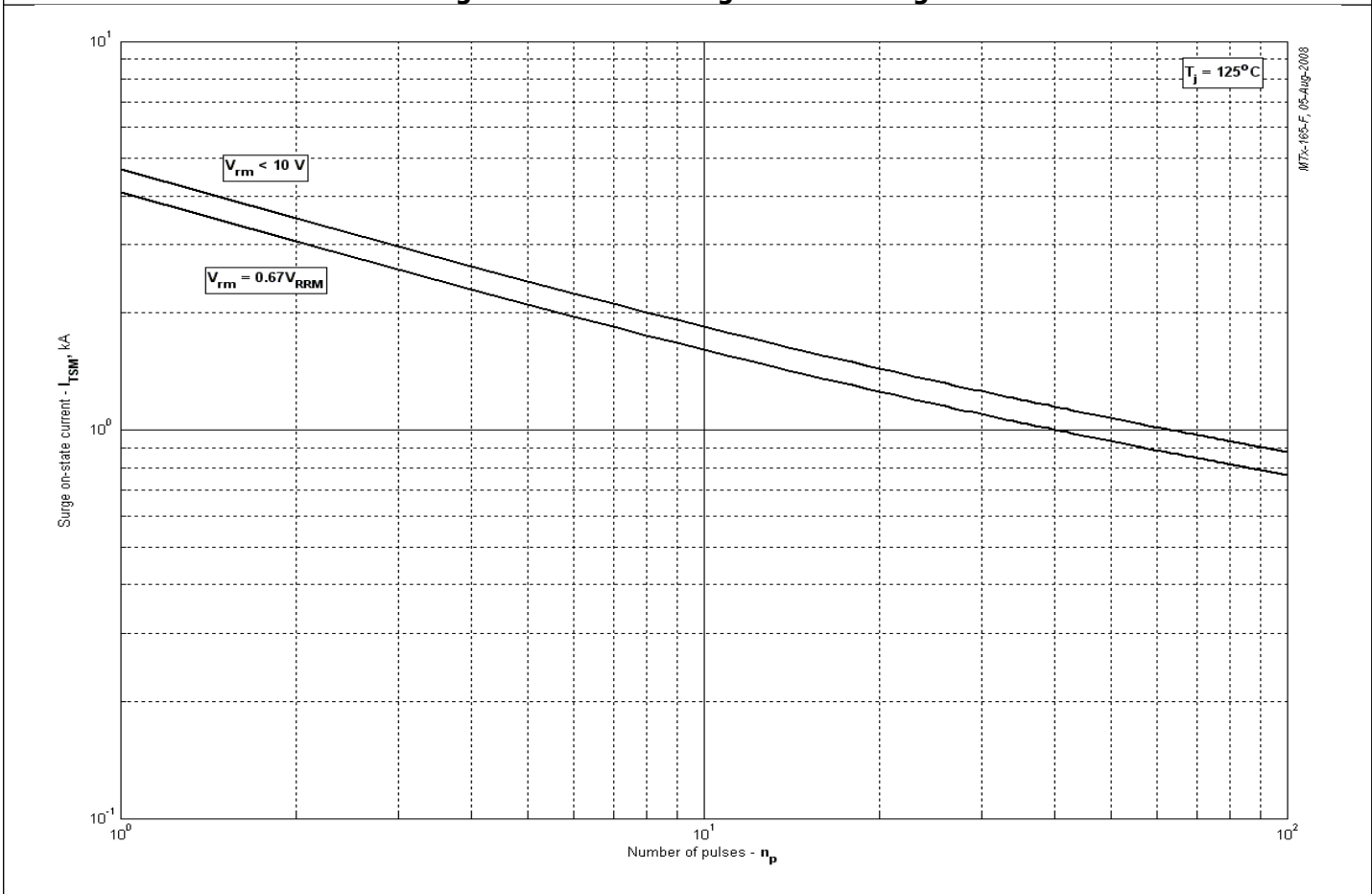


Fig 14 - Maximum surge ratings