



PROTON-ELECTROTEX RUSSIA

High power cycling capability
Low on-state and switching losses
Optimized for line frequency rectifiers
Designed for traction and industrial applications

Rectifier Diode Type D133-500-28

Average forward current			I _{FAV}	500 A		
Repetitive peak reverse voltage			V _{RRM}	2000...2800 V		
V _{RRM} , V	2000	2200	2400	2600	2800	
Voltage code	20	22	24	26	28	
T _j , °C	-60...+175					

MAXIMUM ALLOWABLE RATINGS

Symbols and parameters		Units	Values	Test conditions	
ON-STATE					
I _{FAV}	Maximum allowable average forward current	A	500 930	T _c =145 °C; Double side cooled; T _c =100 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I _{FRMS}	RMS forward current	A	785	T _c =145 °C; Double side cooled; 180° half-sine wave; 50 Hz	
I _{FSM}	Surge forward current	kA	11.0 12.0	T _j =T _{j max} T _j =25 °C	180° half-sine wave; t _p =10 ms; single pulse; V _R =0 V
			12.0 14.0	T _j =T _{j max} T _j =25 °C	180° half-sine wave; t _p =8.3 ms; single pulse; V _R =0 V
I ² t	Safety factor	A ² s·10 ³	600 720	T _j =T _{j max} T _j =25 °C	180° half-sine wave; t _p =10 ms; single pulse; V _R =0 V
			590 810	T _j =T _{j max} T _j =25 °C	180° half-sine wave; t _p =8.3 ms; single pulse; V _R =0 V
BLOCKING					
V _{RRM}	Repetitive peak reverse voltages	V	2000...2800	T _{j min} < T _j < T _{j max} ; 180° half-sine wave; 50 Hz	
V _{RSM}	Non-repetitive peak reverse voltages	V	2100...2900	T _{j min} < T _j < T _{j max} ; 180° half-sine wave; single pulse	
V _R	Reverse continuous voltages	V	0.6·V _{RRM}	T _j =T _{j max}	
THERMAL					
T _{stg}	Storage temperature	°C	−60...+50		
T _j	Operating junction temperature	°C	−60...+175		
MECHANICAL					
F	Mounting force	kN	9.0...11.0		
a	Acceleration	m/s ²	50	Device clamped	

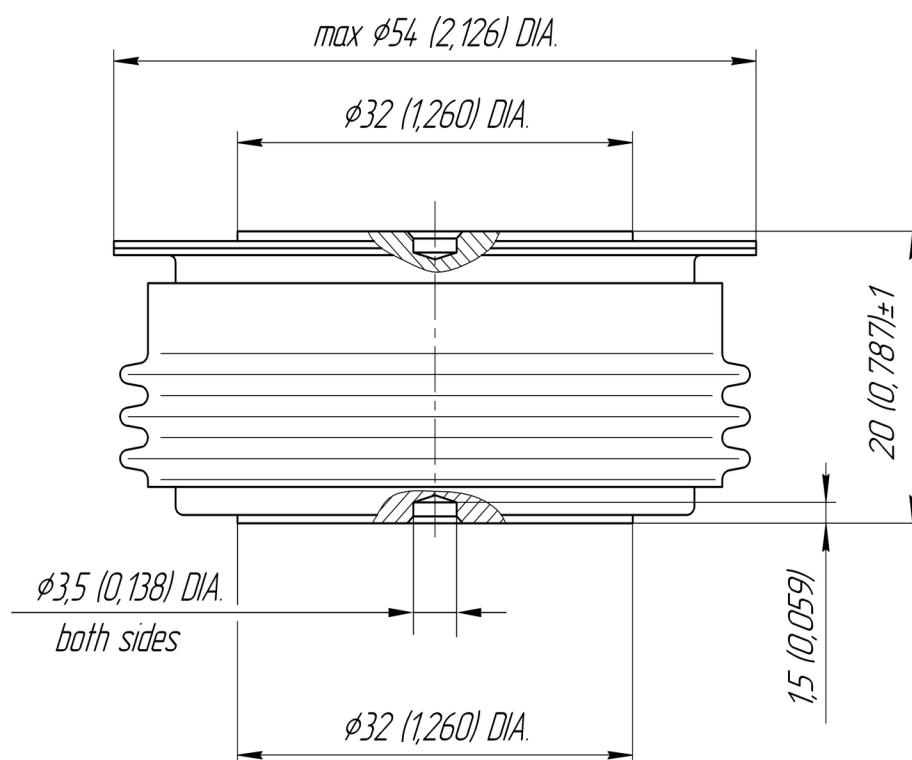
CHARACTERISTICS

Symbols and parameters		Units	Values	Conditions
ON-STATE				
V_{FM}	Peak forward voltage, max	V	1.70	$T_j=25\text{ }^{\circ}\text{C}; I_{FM}=1570\text{ A}$
$V_{F(TO)}$	Forward threshold voltage, max	V	0.929	$T_j=T_{j\text{ max}}$;
r_T	Forward slope resistance, max	m Ω	0.574	$0.5\pi I_{FAV} < I_T < 1.5\pi I_{FAV}$
BLOCKING				
I_{RRM}	Repetitive peak reverse current, max	mA	50	$T_j=T_{j\text{ max}}$; $V_R=V_{RRM}$
SWITCHING				
Q_{rr}	Total recovered charge, max	μC	2400	$T_j=175\text{ }^{\circ}\text{C}; I_{TM}=500\text{ A};$
t_{rr}	Reverse recovery time, max	μs	34	$di_R/dt=-10\text{ A}/\mu\text{s};$
I_{rr}	Reverse recovery current, max	A	141	$V_R=100\text{ V}$
THERMAL				
R_{thjc}	Thermal resistance, junction to case, max	$^{\circ}\text{C}/\text{W}$	0.036	Double side cooled
R_{thjc-A}			0.079	Anode side cooled
R_{thjc-K}			0.065	Cathode side cooled
R_{thck}	Thermal resistance, case to heatsink, max	$^{\circ}\text{C}/\text{W}$	0.008	Direct current
MECHANICAL				
m	Weight, max	g	180	
D_s	Surface creepage distance	mm (inch)	23.69 (0.933)	
D_a	Air strike distance	mm (inch)	19.10 (0.752)	

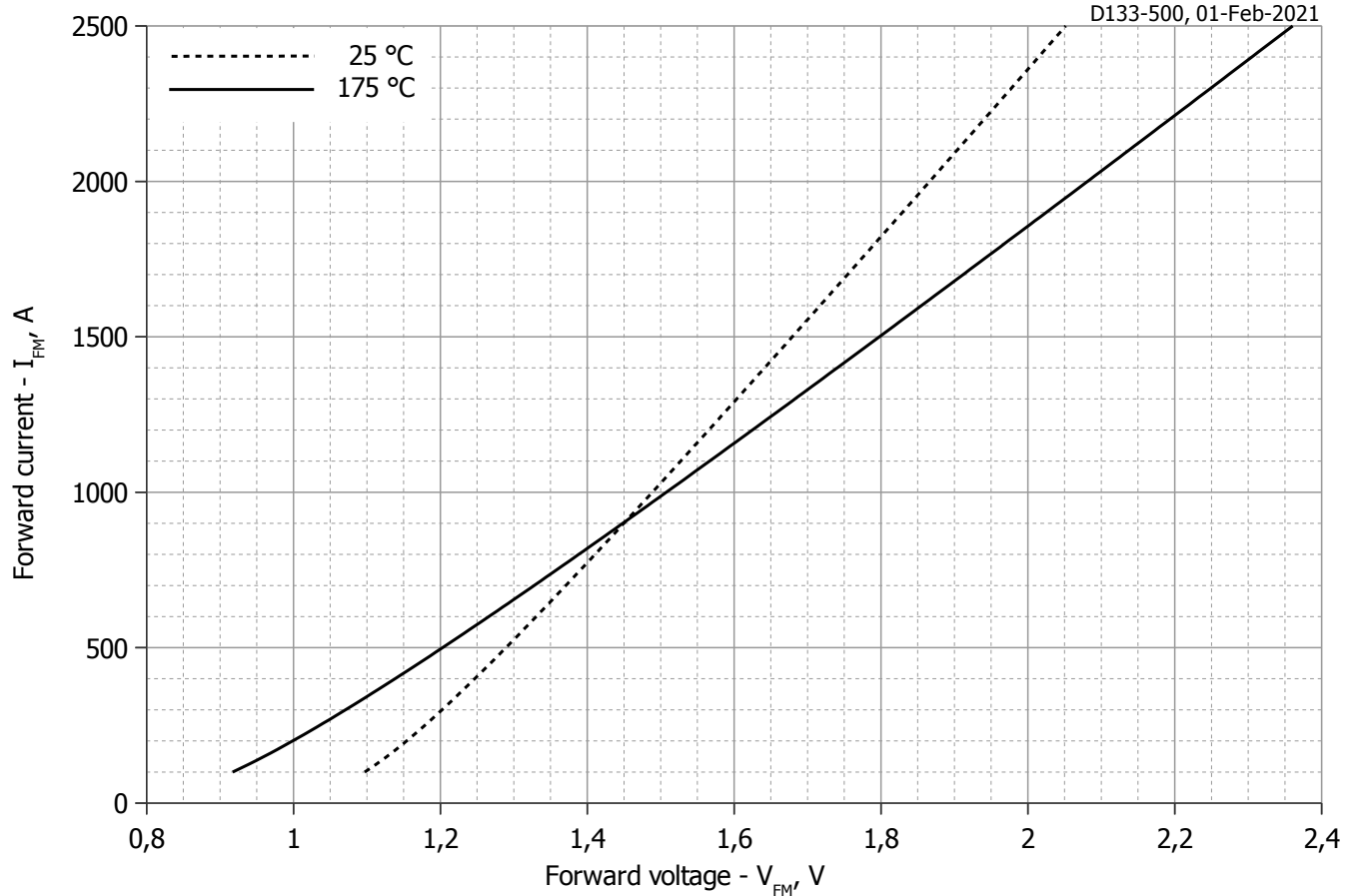
PART NUMBERING GUIDE

D	133	500	28	N
1	2	3	4	5

1. D — Rectifier Diode
2. Design version
3. Average forward current, A
4. Voltage code
5. Ambient conditions: N – normal; T – tropical



All dimensions in millimeters (inches)

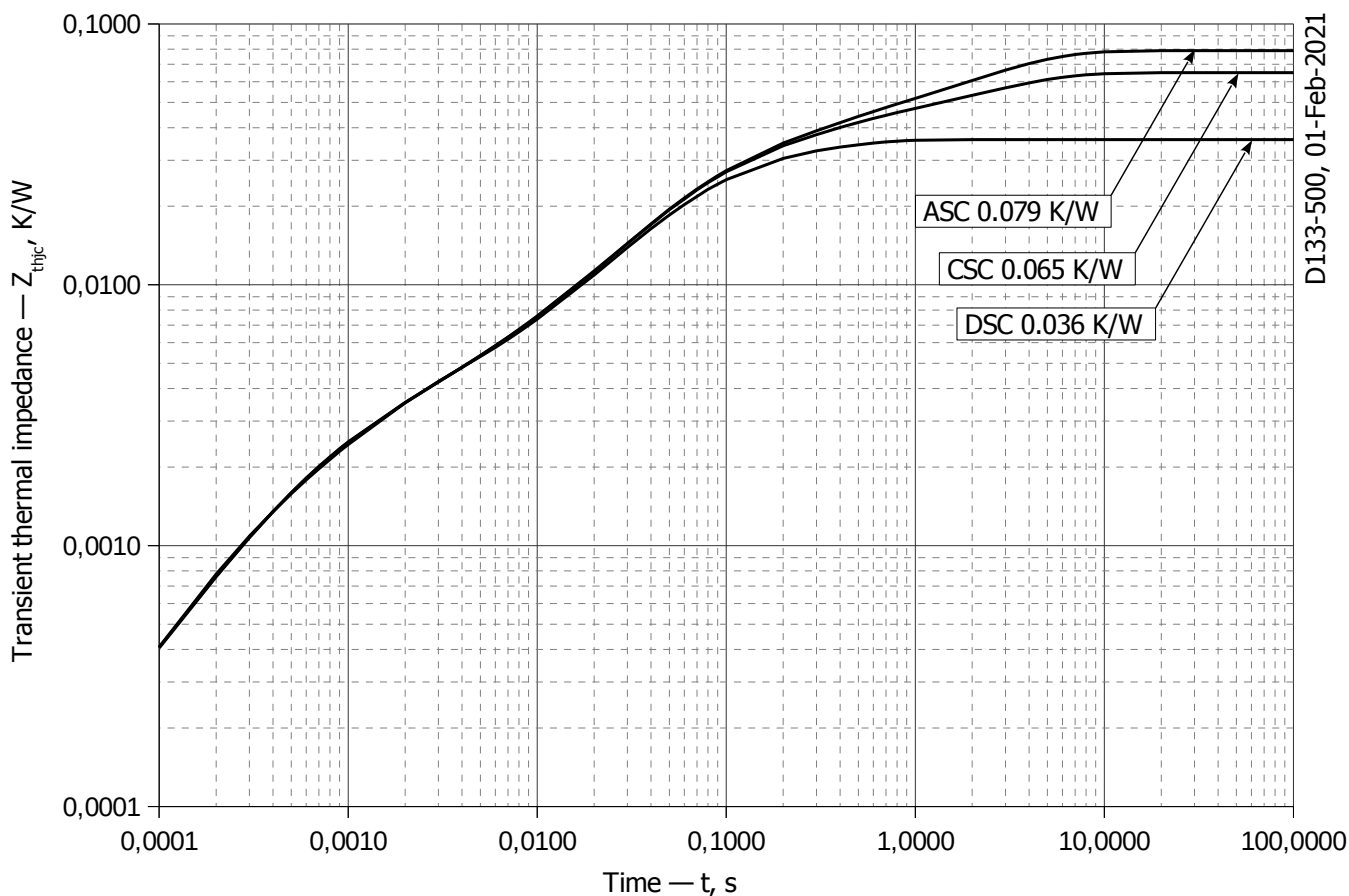
**Fig 1 – Forward characteristics of Limit device**

Analytical function for Forward characteristic:

$$V_F = A + B \cdot i_F + C \cdot \ln(i_F + 1) + D \cdot \sqrt{i_F}$$

	Coefficients for max curves	
	$T_j = 25^\circ\text{C}$	$T_j = T_{j\text{ max}}$
A	0.91360698	0.72615296
B	0.00035852	0.00050867
C	0.03246531	0.02214291
D	-0.00024595	0.00379008

Forward characteristic model (see Fig. 1).



D133-500, 01-Feb-2021

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.

DC Double side cooled

i	1	2	3	4	5	6
R_i , K/W	0.0102	0.01906	0.003576	0.002535	-4.67e-005	0.000648
τ_i , s	0.265	0.05901	0.03499	0.001252	0.000001	0.0002488

DC Cathode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.02506	0.01306	0.002934	0.0206	0.00149	0.00179
τ_i , s	2.647	0.2831	0.1455	0.05284	0.002255	0.0005519

DC Anode side cooled

i	1	2	3	4	5	6
R_i , K/W	0.03904	0.001789	0.01342	0.0215	0.00137	0.00195
τ_i , s	2.651	0.4195	0.2622	0.05451	0.002585	0.0005847

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

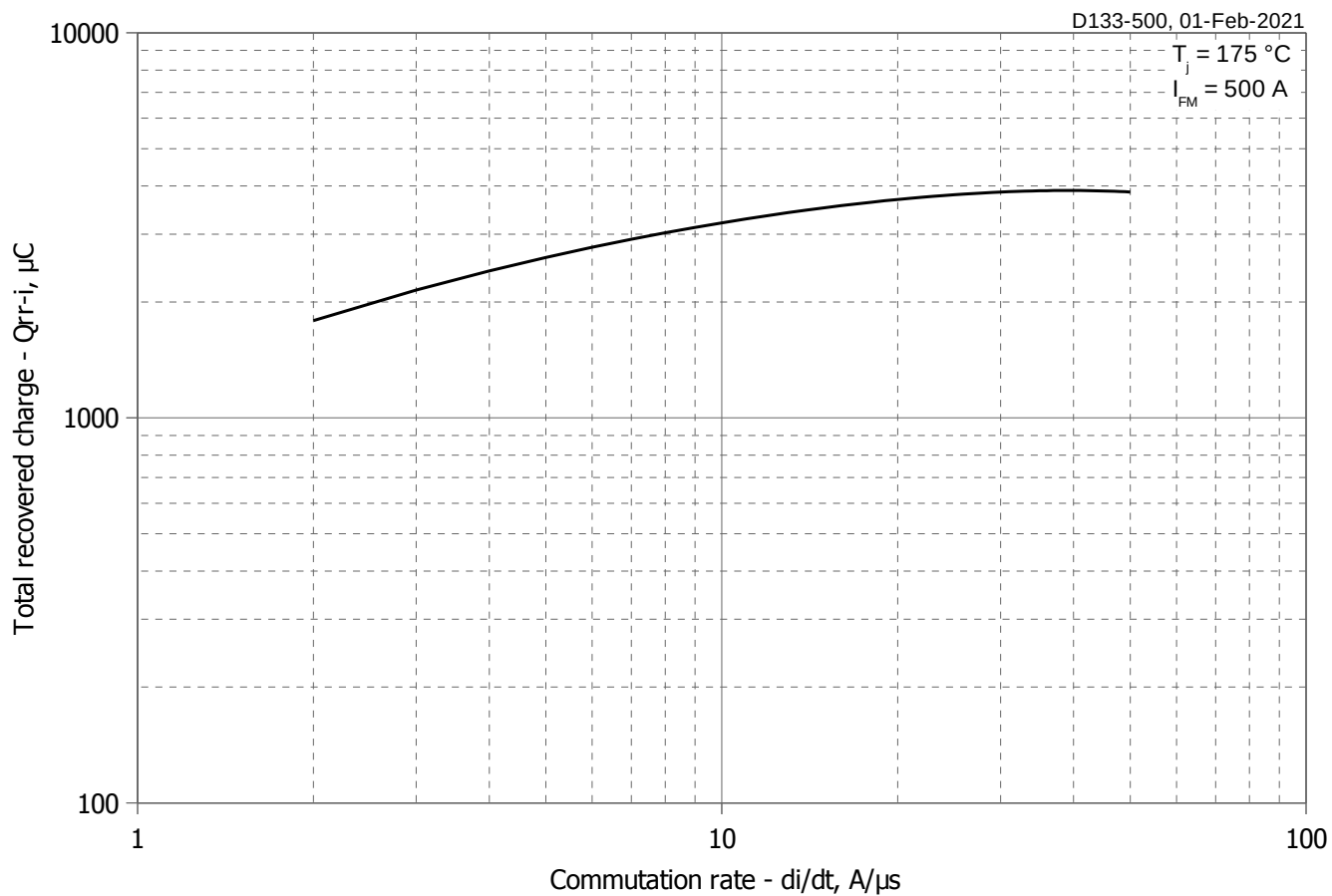


Fig 3 - Total recovered charge Q_{rr-i} (integral) vs. commutation rate di_R/dt

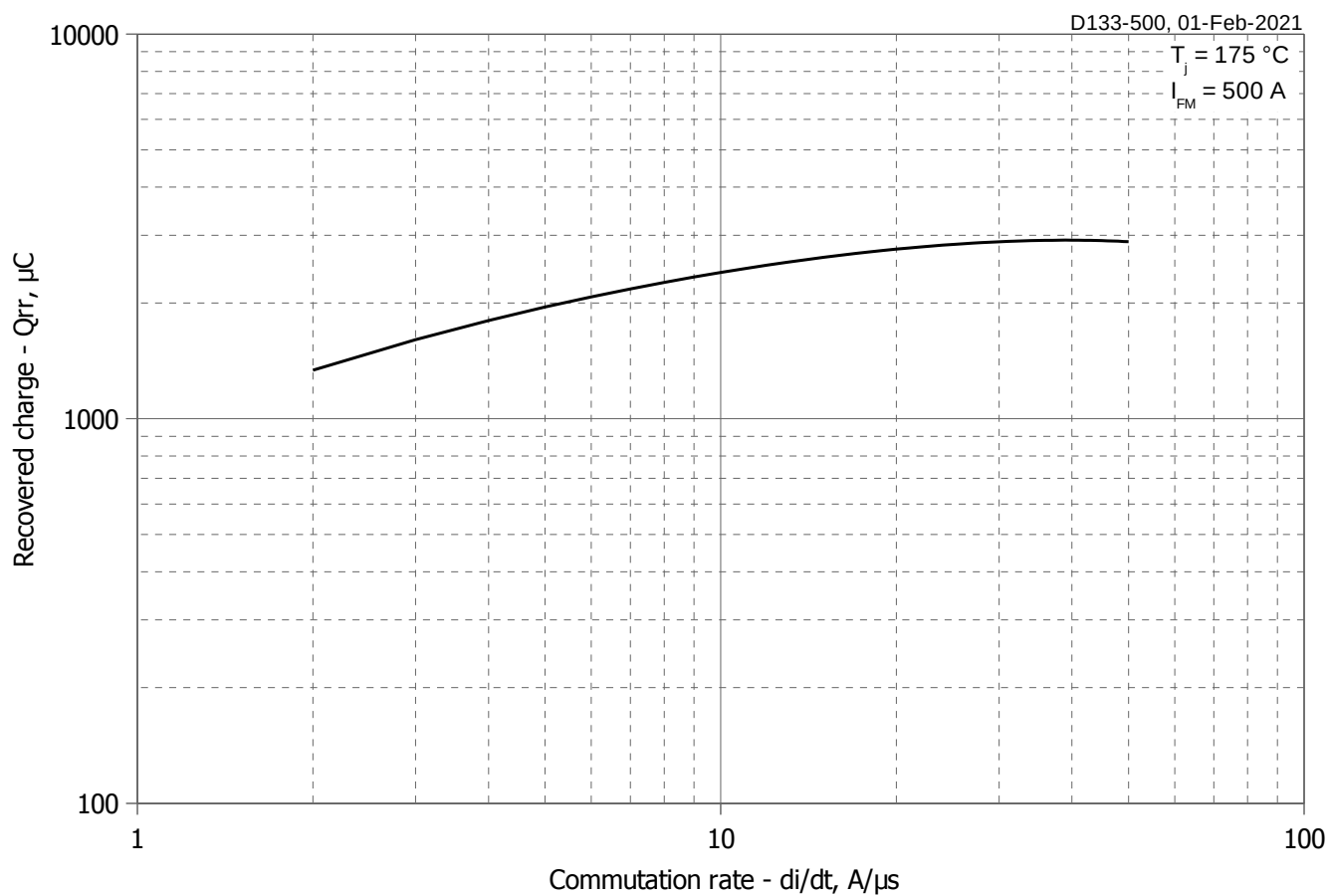


Fig 4 - Maximum recovered charge Q_{rr} vs. commutation rate di_R/dt (25% chord)

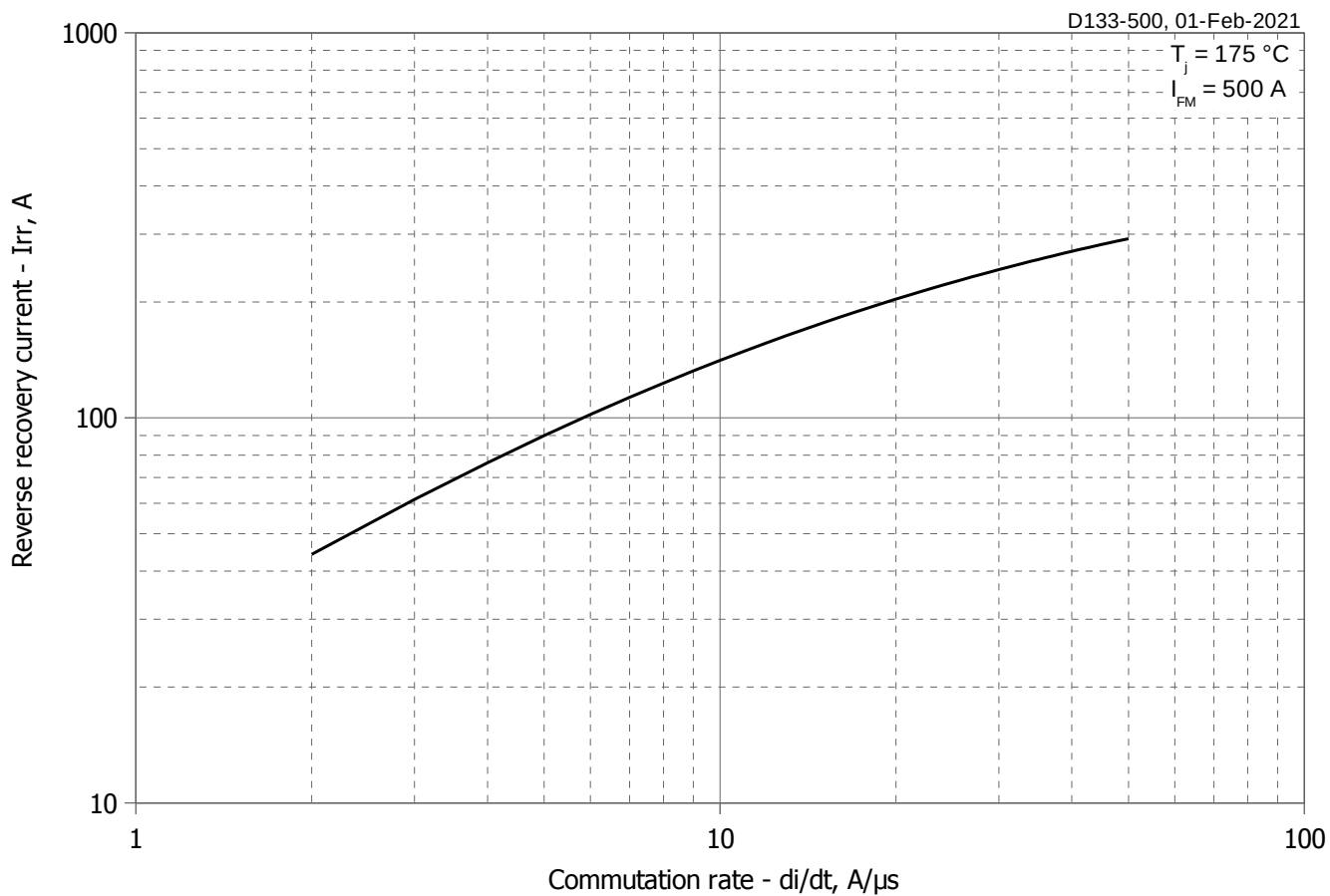


Fig 5 - Maximum reverse recovery current I_{rr} vs. commutation rate di_R/dt

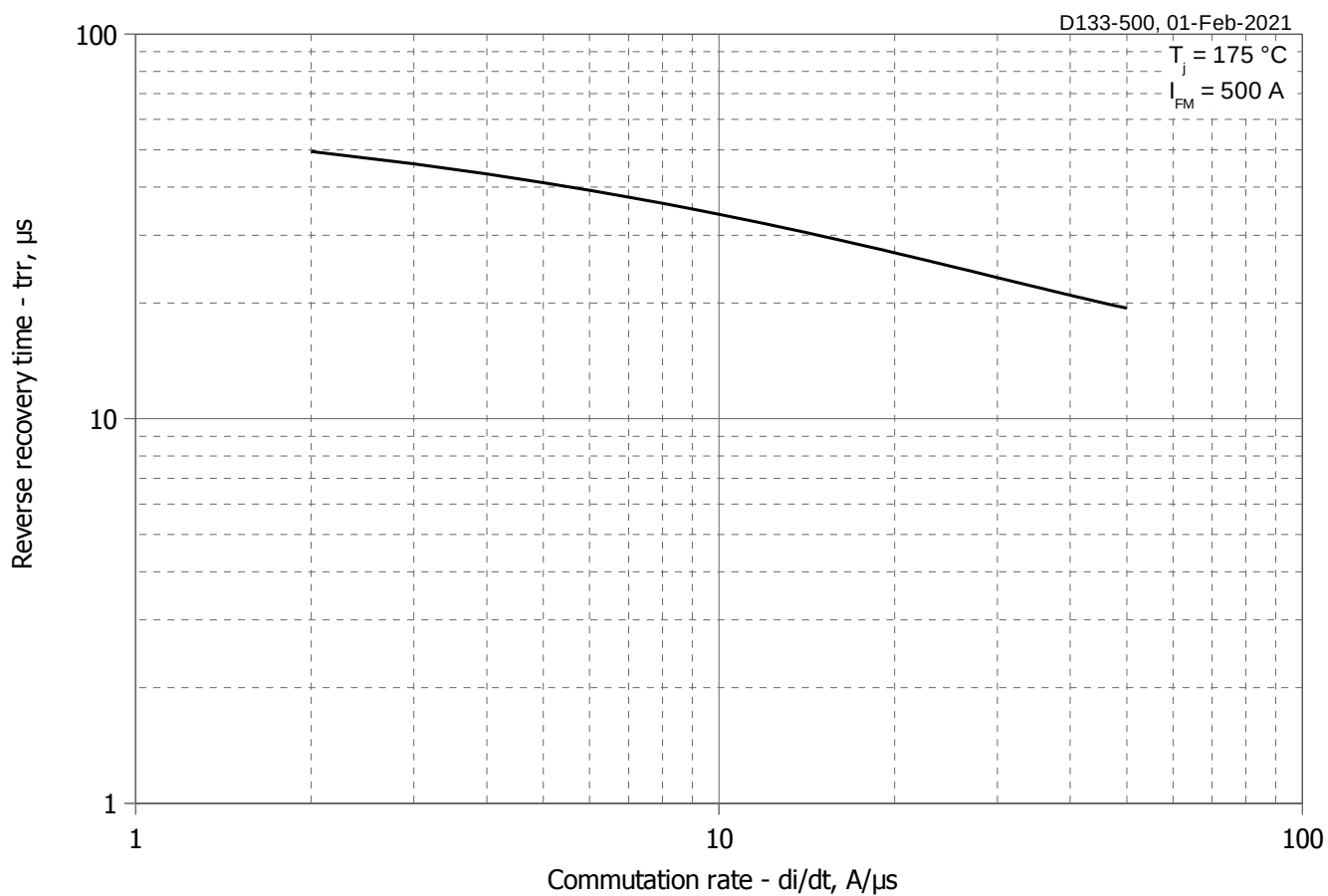


Fig 6 - Maximum recovery time t_{rr} vs. commutation rate di_R/dt (25% chord)

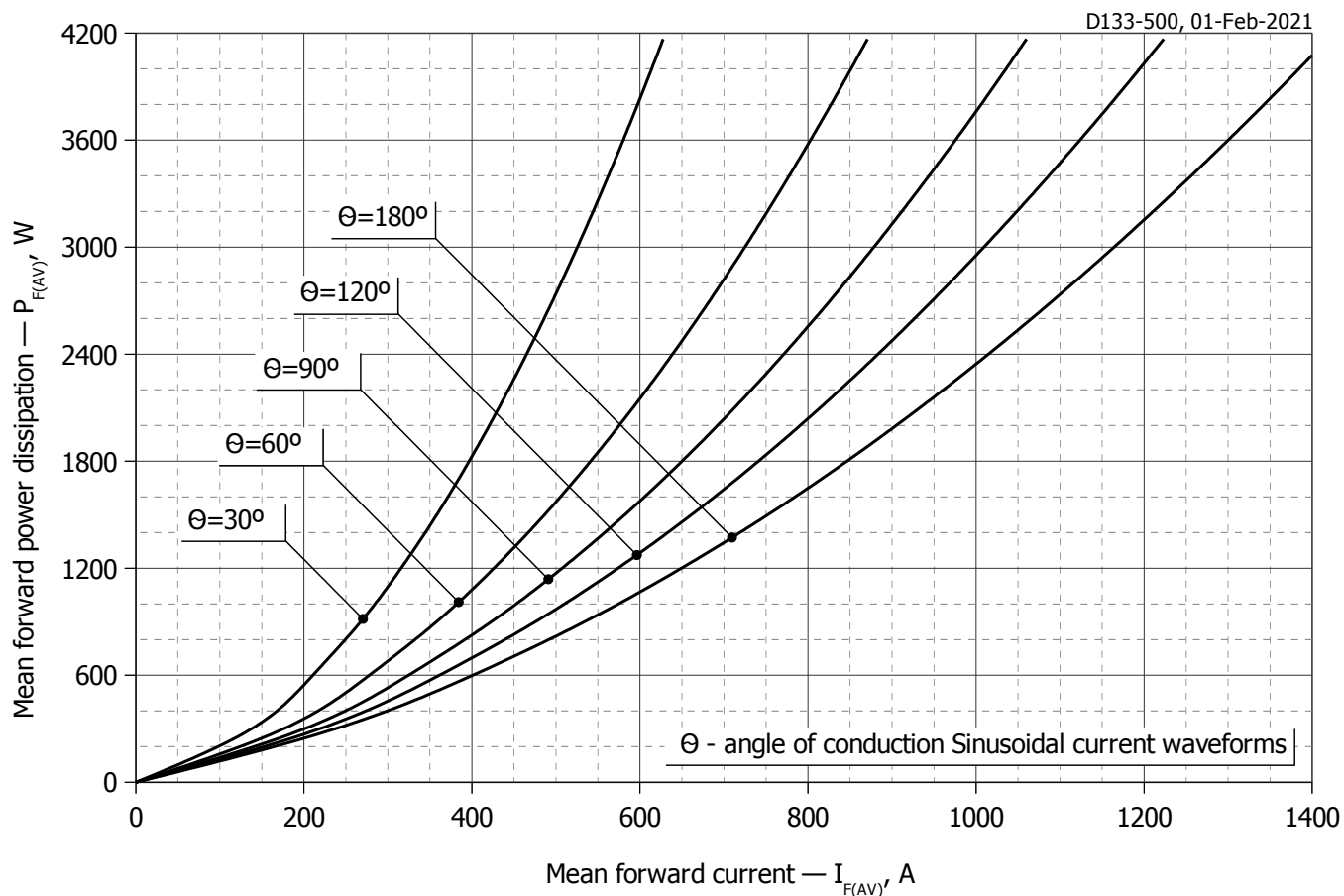


Fig. 7 - Mean forward power dissipation P_{FAV} vs. mean forward current I_{FAV} for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

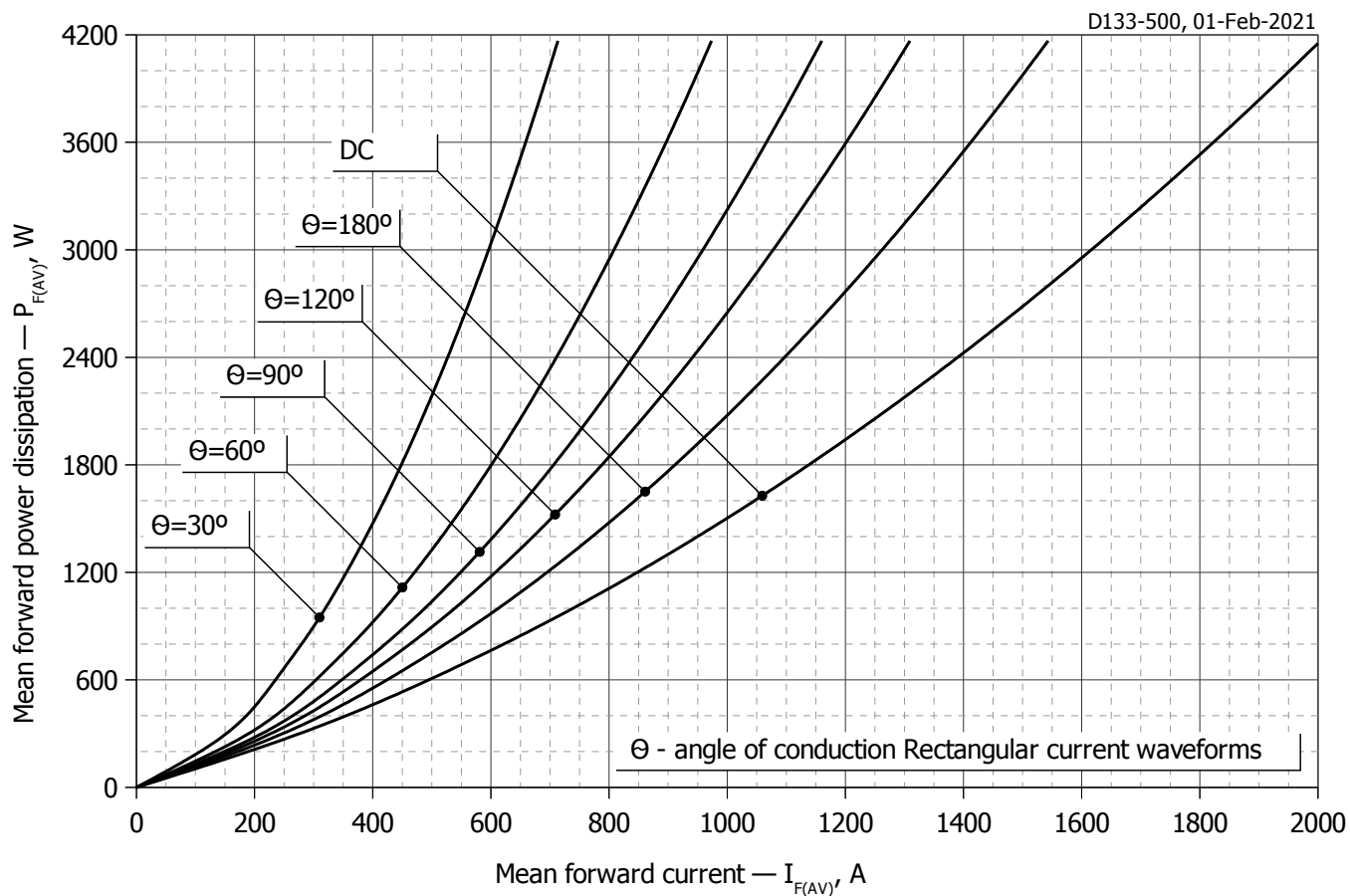


Fig. 8 – Mean forward power dissipation P_{FAV} vs. mean forward current I_{FAV} for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

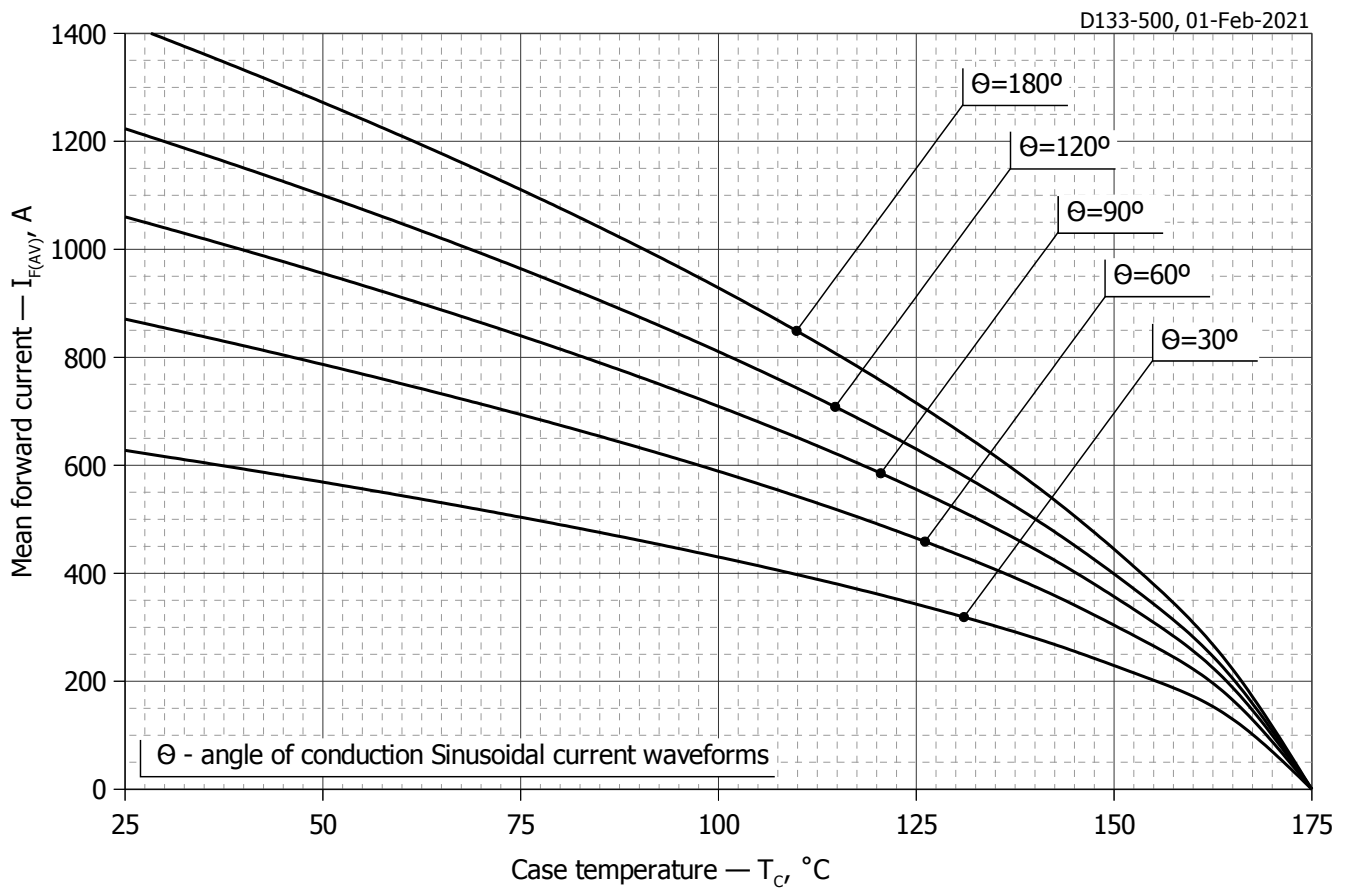


Fig. 9 – Mean forward current I_{FAV} vs. case temperature T_C for sinusoidal current waveforms at different conduction angles ($f=50\text{Hz}$, DSC)

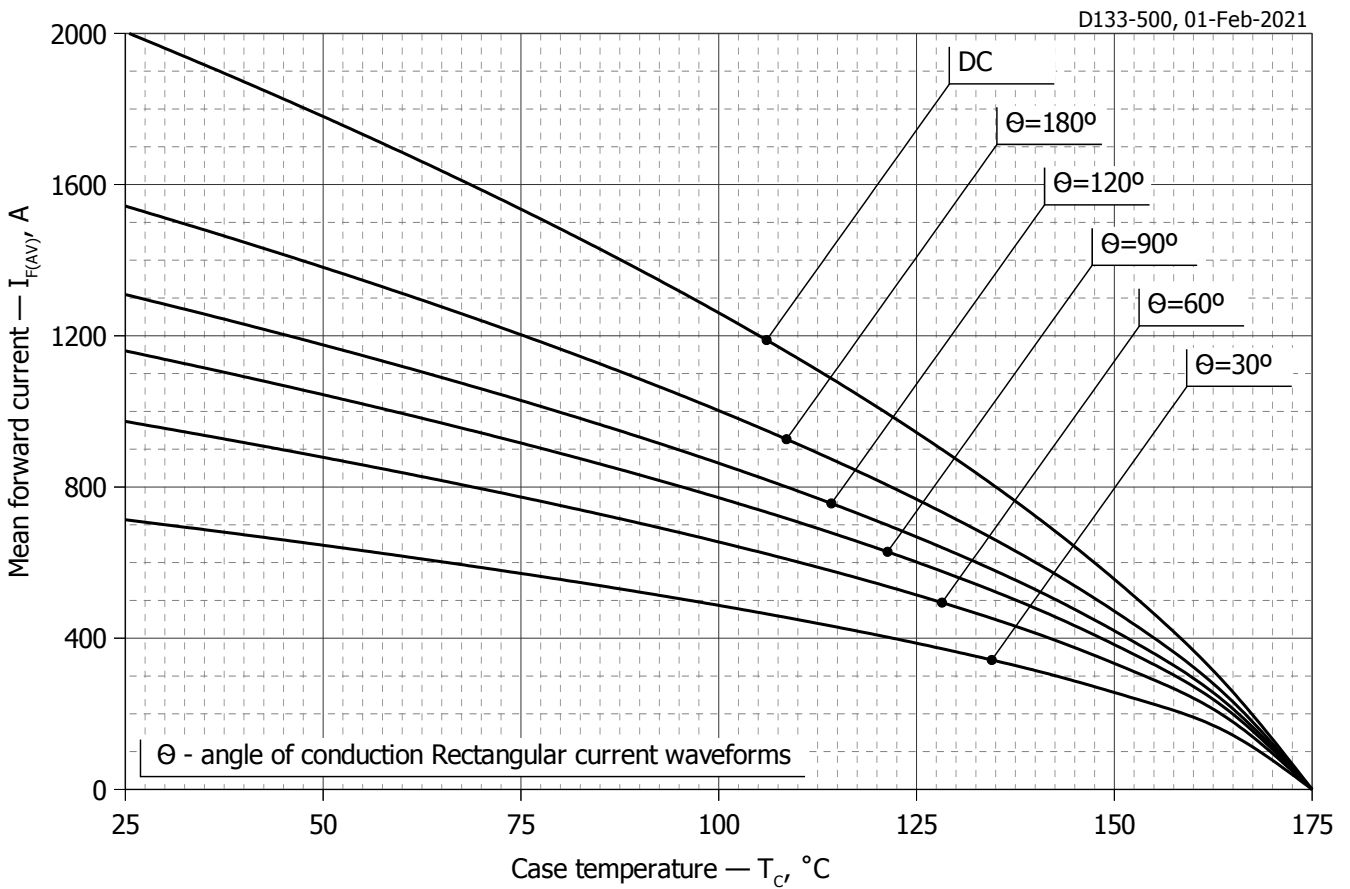


Fig. 10 - Mean forward current I_{FAV} vs. case temperature T_C for rectangular current waveforms at different conduction angles and for DC ($f=50\text{Hz}$, DSC)

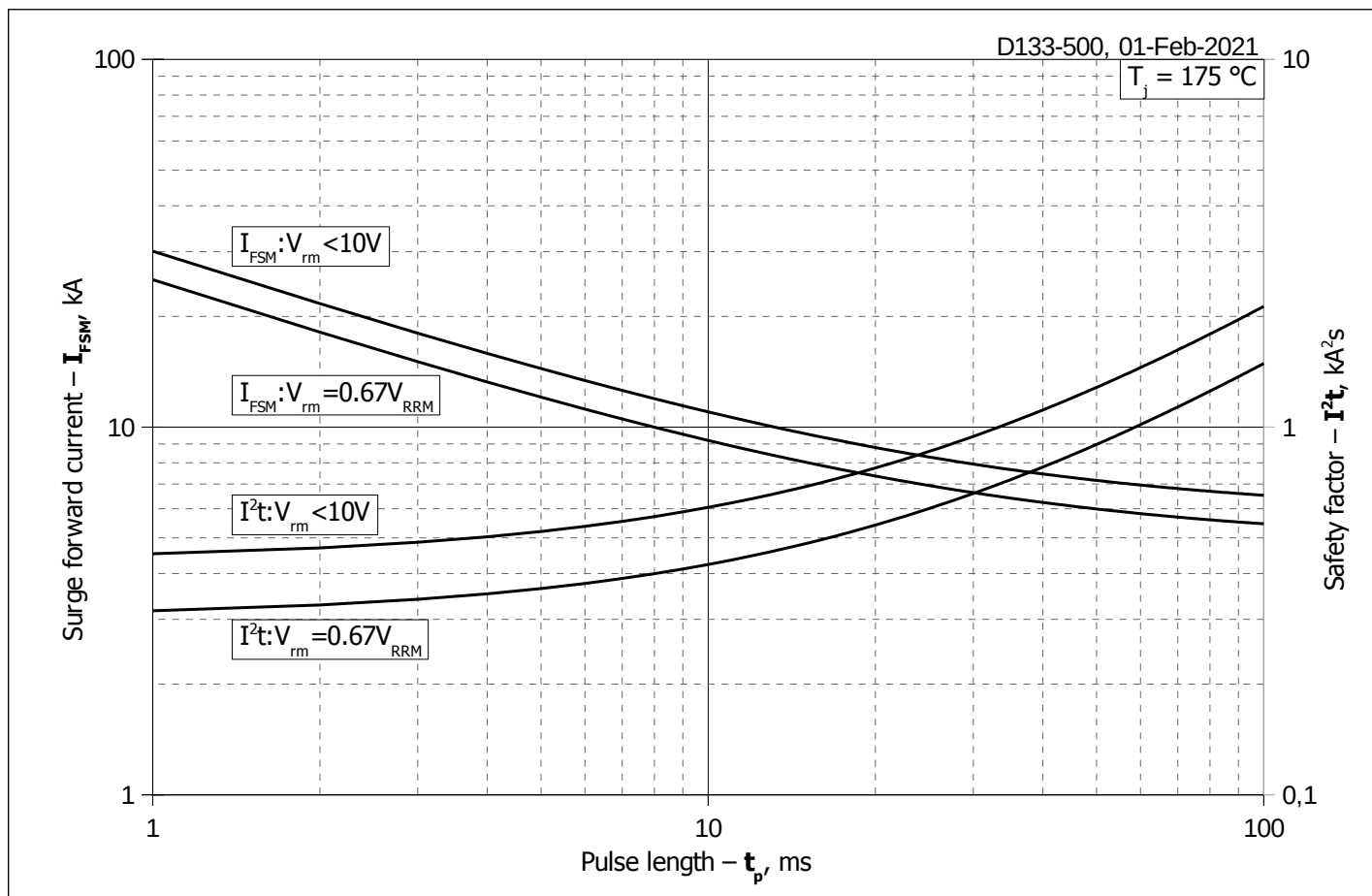


Fig. 11 – Maximum surge forward current I_{FSM} and safety factor I^2t vs. pulse length t_p

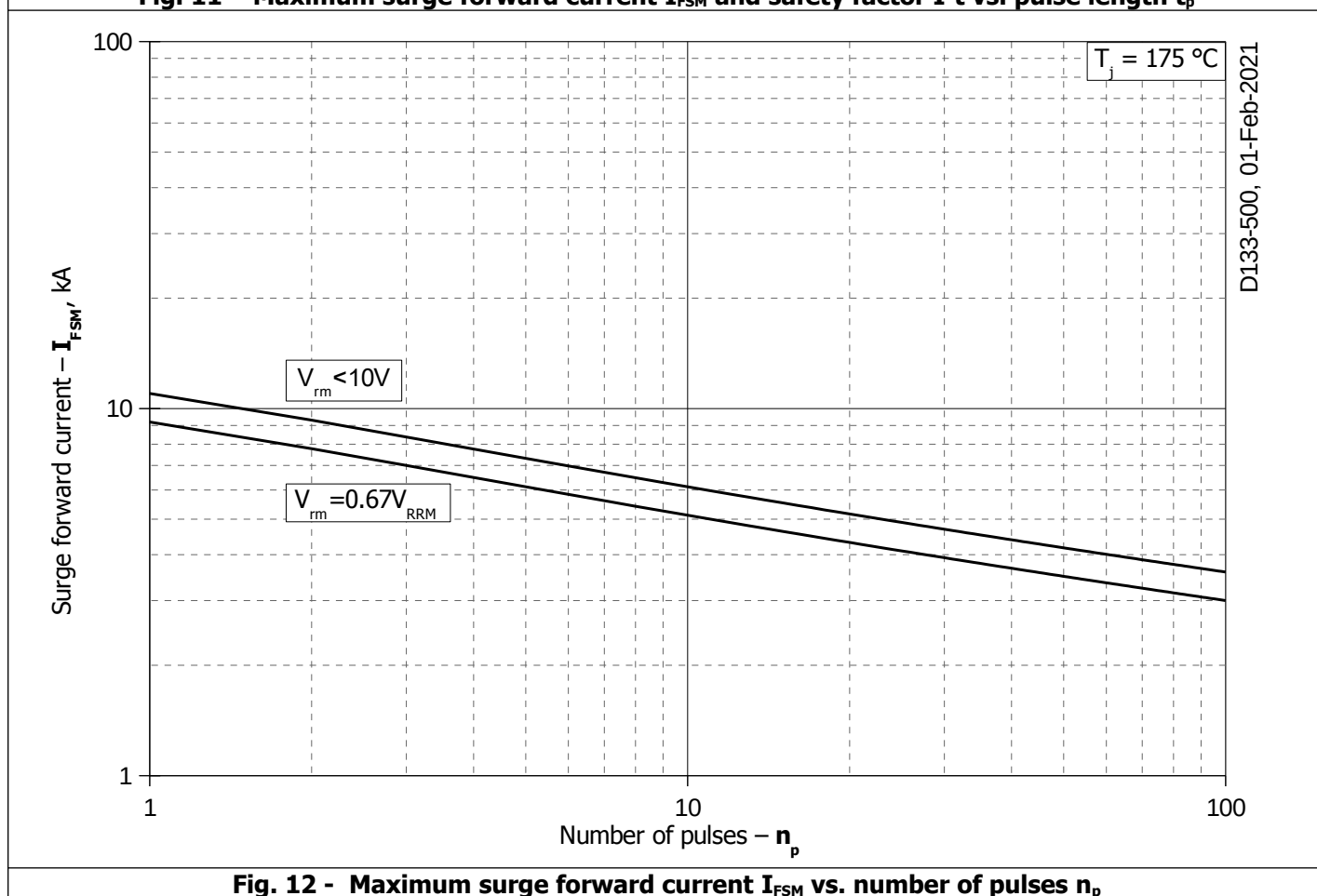


Fig. 12 - Maximum surge forward current I_{FSM} vs. number of pulses n_p